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Time Scales and Economic Cycles:
The Contributions of Kondratieff, Kuznets, Schumpeter, Goodwin, Kaldor and Minsky*

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Abstract

Economists and economic historians have proposed different cycles, on different time scales, to explain economic fluctuations. There seems to be sufficient evidence for cycles on the shorter time scale – business cycles. The endogenous dynamics of shorter cycles appear to be clear. But are there distinct and time invariant mechanisms for long waves? We discuss the theory of long waves proposed by Kondratieff (cycles in production and price movement) and Kuznets (cycles arising from infrastructure investments), Schumpeter's theory (innovation and technology waves), Goodwin's theory of growth and income distribution (employment and wage share dynamics), the Keynes-Kaldor demand driven cycle, and the Kalecki profit-investment driven cycles. Each of the authors has a certain time scale in mind and each author proposes certain economic mechanisms for economic waves. Although business cycles can still be related to some inherent mechanisms that result in cycles, taking a overly mechanical view of long waves – cycles on a very long time scale – may face some challenges. We discuss those challenges and introduce recently discovered components of cycles on a longer time scale. This is the Minsky theory of financial cycles which has not been stressed by earlier theories; yet, they appear to

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have become more relevant in recent times. We also undertake some empirical evaluation of the empirical evidence on cycles of different time scales by referring to spectral analysis and wavelet theory. In particular the latter method appears to allow studying mechanisms of cycles over various time scales..

JEL classification codes: C61; C63; G21; D83; D92

Keywords: production cycles, infrastructure cycles, accelerator - multiplier mechanism, innovation cycles, Goodwin cycles, Keynes-Kaldor Cycles, Samuelson accelerator-multiplier cycles, Kalecki cycles, Minsky asset price-leveraging cycles, spectral analysis, wavelet analysis

All things come in seasons -Herakleitos

One can never step into the same river twice - Herakleitos

1. Introduction

After a relatively long period of tranquility in the world economy, from the beginning of the 1990s to 2007— the period of "great moderation" as it was called — the US financial meltdown in the years 2007-2009 brought about a great disruption of the expansion, leading to what has been called the "great recession". Subsequently, economic research was in search of new theories that could explain this long period of expansion, but then, also, the sudden meltdown and huge recession. Many economists returned to the theories of economic long waves and endogenous cycles as suitable explanatory framework describing recent growth and the subsequent period of the great recession. Has the great moderation built up the instabilities that are suddenly visible in the years 2007-2009? To what extent are the old theories of long waves of Kondratieff, Kuznets, the Keynesian theories of cycles and the Goodwin 'theory of growth' cycles are useful for understanding these developments?

This paper highlights empirical and epistemological contributions made by economists, separated geographically and in time, yet addressing cyclicality of the economic and social development and the relevance of the historical analysis in economics. The paper attempts to discuss main mechanisms of economic cycles on different time scales, and in particular of long waves. This work derives intellectual motivation from a more attentive reading of the contributions of the early political economists (e.g., Smith, Malthus, Ricardo, Sismondi, Marx, Schumpeter, Keynes, Kaldor, Kalecki, Minsky, Rostow, etc.). We relate our work to the relevance of the theoretical constructs advanced by Nikolai Kondratieff (also, Kondratiev, Кондратьев) and Simon Kuznets (Кузнец), show how it is linked to modern macroeconomic analysis and offer analytical insight into possible future scenarios.

Empirical economics and economic historians have proposed different cycles on different time scales. There seems to be sufficient evidence for cycles on a shorter time scale – business cycles. The endogenous dynamics of shorter cycles appear to be clear and distinct. But are there distinct mechanisms for longer cycles, for example long waves? We discuss the theory of long waves proposed by Kondratieff (cycles in production and relative prices) and Kuznets (cycles arising from infrastructure investments), Schumpeter's theory (innovation and technology waves), Keynesian demand oriented theories of cycles, and Goodwin's theory of growth and income distribution (employment and wage share dynamics). Each author points to certain economic mechanisms to explain the cyclical fluctuations of the macro-economy.

Though business cycles can still be related to some inherent mechanisms of cycles, a mechanical view of long waves may face some challenges. We discuss those challenges and introduce recently "discovered" components of cycles on a long time scale. This is the Minsky theory of financial cycles, which did not seem to have been stressed by earlier theoreticians, but appears to have become more relevant in recent times. Thus, as the above two epigraphs indicate, there are likely to be cycles in economic development, but the cycles will never be the same as time goes on.

The remainder of the paper is organized as follows. In Section 2 we discuss cycle theories laid out in the work of Kondratieff and Kuznets.Section 3 discusses a variety of cycles models exhibiting different time scales. Section 4 introduces a Minsky type of long-period cycles. Section 5 discusses the challenges that faces an empirical methodology to detect in cycles and the movement of economic relationship over cycles of various time scales in the data. Section 6 concludes the paper.

2. The Legacy of Kondratieff and Kuznets

Next we briefly discuss the economic contributions of the seminal work by two important economists on long run fluctuations of macroeconomic relationships and variables.

2.1 Kondratieff and Theory of Long Waves

Writing in the early 1920s Nikolai Kondratieff[1] advanced the idea of the probable existence of long wave cycles in capitalist economies lasting roughly between 48 and 60 years. Within that time, there is a period of accumulation of material wealth. As a result, productive forces move to a newer, higher, level of development (Kondratieff, 1922). This mechanism has been dubbed, in economic literature, as Kondratieff cycles. Kondratieff carried out his work during a relatively short period of leading The Institute of the Conjuncture in Moscow. Unfortunately, his open support for the New Economic Policy in opposition to the official party's preference for heavy industry primacy in the Soviet economy, coupled with his unorthodox views on economic development did not make him popular with the mainstream. By 1928 Kondratieff was removed from his position at the Institute of the Conjuncture, in 1930 arrested on charges of anti-Soviet activity and on September 17, 1938 Kondratieff was sentenced to death with execution on the day the verdict was issued. Kondratieff was fully exonerated in 1987 and in 1992 The International N.D. Kondratieff Foundation was established.

It should be noted that prior to Kondratieff, some empirical efforts on systematizing the cyclicality of economic crises was carried out by van Gelderen (1913), Buniatian (1915), and de Wolff (1924), which Kondratieff admits to in his publications (see end note in Kondratieff, 1935). Though Kondratieff's ideas were not well accepted by the official Soviet economics he insisted on his main argument and in short time followed up with more rigorous publications. Only few English language translations were available at the time (most notably, Kondratieff, 1925; and Kondratieff, 1935). Nevertheless, the potency of his ideas was recognized quickly entering the work of subsequent economists (e.g. Schumpeter, 1934; Kuznets, 1971; Rostow, 1975; and others).

The gist of Kondratieff's argument came from his empirical analysis of the macroeconomic performance of the USA, England, France, and Germany between 1790 and 1920. The economist looked at the wholesale price levels, rate of interest, production and consumption of coal and pig iron, production of lead for each economy and price movements (Kondratieff, 1935). Using a peculiar statistical method– de-trending the data first and then using an averaging technique of nine years to eliminate the trend as well as shorter waves of Kitchin type– Kondratieff suggested a regularity of ups and downs in the data on a long time scale. Within that there were intermediate waves along with long waves. As a result Kondratieff stated that economic process was a process of continuous development. Among possible explanations to the long wave cycles Kondratieff mentions a) changes in technology; b) wars and revolutions; c) appearance of new countries on the world map; and d) fluctuations in production of gold (Kondratieff, 1935; and Kondratieff et al. 2002).

All four appear as valid external shocks in pushing any particular economy or the world economy in general into a downward or upward cycle path. However, after careful analysis Kondratieff thought that neither appears to be solely external factors, determining as shocks the economic transformation. The missing part is the accumulation of preceding events, and the development of economic economic – but also social, and political – relationships over long cycles that may help to endogenize the external factors.

[1] See Historical Notes in Appendix 2

		Start:	End:
First long wave	rising phase	1780s-1890	1810-1817
	declining phase	1810-1817	1844-1851
Second long wave	rising phase	1844-1851	1870-1875
	declining phase	1870-1875	1890-1896
Third long wave	rising phase	1890-1896	1914-1920
	declining phase	1914-1920	...

Table 1. Kondratieff cycles; Source: extrapolated from Kondratieff (1935).

Table 1 summarizes Kondratieff's original views on long wave cycles. Yet Kondratieff pursues more of a descriptive work and avoiding to a great extent some discussion of the mechanism driving long waves. Subsequently, with popularization of Kondratieff's views, extensions to the original analysis, roughly following the 40-60 years rule, began to appear. One of the first to catch on the logic was Schumpeter (1939) who pointed out the distinction between short (3-4 years or Kitchin), medium (9-10 years Juglar), and long (54-60 years Kondratieff) cycles in his analysis of economic development.

As to mechanisms, Kondratieff already pointed to a large-scale accumulation of innovative activity, i.e. inventions and processes modifications, that required fifty or more years before complete insertion, absorption in the production method. The role of innovation, implied in Kondratieff's work and the workings of those internal dynamic tendencies are described in detail in Schumpeter's Economic Development (1934). In turn, Garvy (1943) subjects Kondratieff's proposition to sharp criticism from positions of Soviet economists (including references to Leo Trotsky) and from the point of view of western economics. Paradoxically, in either case the conclusion appears to be that Kondratieff was too haste to assign a term "cycle" to his propositions as those do not correspond to the internal evolutionary dynamics following some mechanism of cycles.

There was a difference however in the Western economist's views and contemporary Soviet colleagues. From the western economist point of view, articulated by Garvy (1943), there was no sufficient statistical evidence to warrant any regularity, i.e. cyclicality, to Kondratieff's analysis. The Soviet economists writing around the time of Kondratieff's original publications and shortly after (e.g. 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's perpetuity. This was in direct opposition with the socialist revolutionary beliefs and phasing out of the capitalist economy into its next logical stage of socialism, as was implied by then dominant interpretation of Marx's Capital (e.g. Marx, 1867). These beliefs in rapid phase successions picked up from simplistic interpretations would feed into initial enthusiasm around shock therapy reforms in post-socialist economies in the early 1990s (Gevorkyan, 2011).

Recently, researchers working within Kondratieff's original methodological scope have attempted to extend their analysis across the twentieth century with focus on predictive capabilities of such work into the nearest future. Some find the ongoing economic deterioration in the world economy fitting calculations of the Fifth Long Wave of the Kondratieff cycle (e.g. Korotaev and Tsirel, 2010; Kondratieff et al. 2002; Akaev, 2009; and others), some of them using spectral analysis. A re-validation of the very four exogenous shocks (technology, wars, shifts in boundaries, and value of gold) so carefully documented and refuted by Kondratieff himself took place in some of those papers. Exogenous shocks are surely important "occurrences" (Kuznets), yet, the internal dynamics in the evolution of economic relationships over a long time period and staging economic development must be considered as well. We address this in further detail below, using more modern empirical methods.

2.2. Kuznets' Novel Analysis of Development

Simon Kuznets[2] received the Nobel Prize in Economics in 1971 for his empirical analysis of economic growth, where he identified a new era of "modern economic growth". His contributions to the contemporary fields of macroeconomic theory and economic development are profound and are critical in modern empirical methodology. Like Kondratieff, Kuznets relied on empirical analysis and statistical data in his pioneering research. Development economics was not seen as linear process, a mere replication the experiences of the advanced countries. Absorbing his findings on historical development of the industrial nations with initially abstract categories of the national income decomposition, Kuznets developed a concept of long swings, though disputed, referred to in literature as Kuznets cycles or Kuznets swings (for detailed review see for example Korotaev and Tsirel, 2010).

The Kuznets swings period is ranged between 15-25 years and initially connected by Kuznets with demographic cycles. In that analysis, the economist observed and quantified the cyclicality of production and prices, linking with immigrant population flows and construction cycles. Researchers have attempted to connect these cycles with investments in fixed capital or infrastructure investments (Korotaev and Tsirel, 2010 for literature review). Focusing on developed economies of North America and Western Europe (but mainly USA), Kuznets computed national income from late 1860 forward with structural breakdowns by industry and final products. He also provided measures of income distribution between rich and poor population groups, later called the Kuznets curve..

Adaptations of Kuznets's analysis today are present in studies of urban and environmental economics, in addition to development economics, macroeconomics, growth theory, and econometrics and environmental economics. Common between the work of both Kondratieff and Kuznets was the motivation to define the mechanisms of economic growth and development, and systematize core driving tendencies in the process. Kuznets unveiled the deficiency of constrained theoretical work built on simplified assumptions.

Instead analysis must encompass information on technology, population and labor force skills, trade, markets, and government structure. It was critical of factors that often were used a sole factors, capital and labor. Kuznets contested their role as sufficient for economic growth. Consistent with his insistence on empirics and complex economic interrelationships, Kuznets carried his analysis further in developing measures of national income through categories of consumption, savings, and investment (e.g. Kuznets, 1949, 1937, 1934, etc.). While helping the U.S. Department of Commerce to develop a standard measure of Gross National Product, Kuznets objected to the exclusion of the household labor that goes unpaid from the statistical measurements.

Spurring growth in econometric techniques these propositions offered an orderly structure to Keynesian views on economic activity and national economic growth, leading to a system of national income accounting. Today this is used as a routine conceptual framework in national income

[2]See Historical Note in Appendix 2

analysis. Working on the problems of inequality, Kuznets addressed issues of economic growth measurements in the developing world and was one of the first economists to attempt this (Kuznets, 1971, 1966, 1955 among others). 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 of the time (see earlier cited studies, but mainly Kuznets, 1955 for detailed qualitative analysis). The relationship is depicted in Figure 1. The conclusion is that while the economy remains in agricultural stage income inequality among different groups within the economy is low. As the national economy embarks on the process of industrialization inequality rises over time, then it falls again.

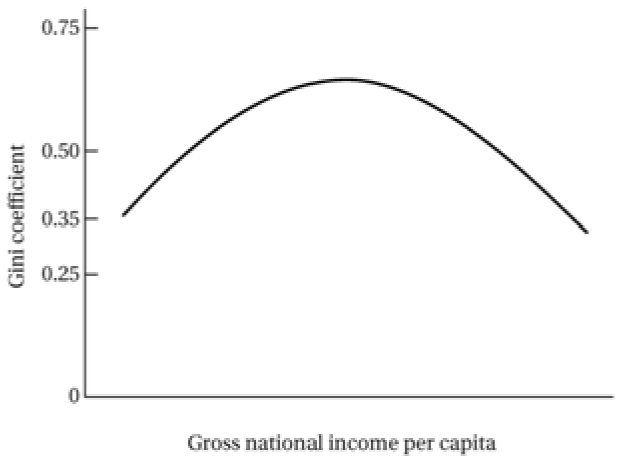

Figure 1. Kuznets curve

Upon reaching its critical saturation point inequality subdues but economic growth continues. This somewhat correlates to a now popular analysis in development economics (e.g. Todaro and Smith, 2009 for summary of approaches) on the transition mechanisms from traditional agricultural to modern industrial sectors. However, the eventual analytical construct of Kuznets curve is also based from empirical experience of the developed economies of Western Europe and North America. So initial phases of industrialization cause sharp rises in inequality until a certain point after which income distribution is equalized. This necessarily happens through emergence of the middle class, improved education facilities, health care, and governance. Though one might remark here, that further structural change and shift of resources to services and the financial sector, may increase inequality again, as for example visible in the US economy since the 1980s.

A variant of the Kuznets curve is also utilized in the analysis of environmental problems. This application suggests an immediate deterioration in air quality and intensification of environmental problems at the initial industrializing stages (i.e. with economic growth often appearing the nearest proxy) until spreading affluence and emergence of middle class introduces legislative and other restrictions on hazardous production (e.g. Stern, 2003). Furthermore, these implied predictions of fading inequality offered a strong intellectual foundation for the already mentioned shock-therapy reforms carried out in the early 1990s in Eastern Europe and former Soviet Union (Gevorkyan, 2011). Omitted in studies of sequencing of market liberalization reforms and limitations of the state in the economy were the negative externalities of shock therapy policies. Kuznets at the time when he first developed this conceptual framework was clearly aware of the such externalities, generating inequalities. In the early 1990s, the promise of immediate market reforms and mass access to greater income generating opportunities did not materialize at the height of the reforms. In fact, income inequality problems today are even relevant in high per capita income countries and at the front lines of policymakers' agendas, in the East two decades after since the introduction of socially and economic transformational measures.

In fact mechanisms and solid empirical evidence that the tendency is universal is missing, as there is no clearly identified tendency for income inequality to decline (or in some cases to change at all) in the process of economic development (see Todaro and Smith, 2009). This again raises important questions relating to the basics of analysis introduced by Kuznets. Specifically, how does one measure economic development and what is a "sufficient" to measure the rise of "welfare" over time? In turn these questions pertain directly to the discussion above on the existence (or not) of cyclicality in economic development, and if so whether that happens at any higher levels development, purely measured by per capita income or growth rates.

Kuznets (1973) notes six key characteristics of the modern economic growth, based on methodology consistent with national income accounting and historical analysis of economic development: 1) increase in per capita growth and population in developed economies; 2) increasing productivity rates; 3) increasing rate 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. Therefore despite seeming improvements, Kuznets noted persistence of disproportionate economic growth worldwide and has apparently some broader measures of welfare – then just per capita income– in mind.

3. Time Scales and Mechanisms of Economic Cycles

As mentioned, the work of Kondratieff and Kuznets fostered systematic approach to modern understanding of long economic swings. As they started the analysis numerous authors have further proposed not only different mechanisms underlying cycles but also cycles on different time scales. An early theory of cycles was put forward by Robert Owen in 1817, who stressed wealth inequality and poverty, originating in industrialization, yielding under-consumption as a reason for economic crises. Sismondi, in the middle of the 19th century took a similar view and 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 extensively contributed to.

More specifically, a mechanism of cycles on a shorter times scale, of 8-10 years duration, was developed by Juglar (Juglar cycles), resulting, as he saw it, from the waves in fixed investment. Later, Kitchin, in the 1920s, introduced an inventory cycle of 3-5 years. Later an important contribution was made by Schumpeter (1939), who referred to the bunching of innovations and their diffusion as a cause for long waves in economic activity.

Roughly at the same time, Samuelson (1939), influenced by the Spiethof accelerator and the Keynesian multiplier principle, developed the first mathematically-oriented cycle theory using the theories of difference equations.[3] Others had proposed the theory of stages of growth, such as Rostow (1978, 1975). Simultaneously to Samuelson, Kalecki (1937) developed his theory of investment implementation cycles where he saw significant delays between investment decisions and investment implementation, formally introducing differential delay systems as tool for studying cycles.

Kaldor (1940), based on Keynesian theory, developed his famous nonlinear investment-saving cycles, which took into account aggregate demand. Later, Goodwin (1967) proposed a model

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

of growth cycles, which took into account classical growth theory, but is actually based on an unemployment-wage share dynamics, since the growth rate as well as productivity growth is kept constant in the long run. We will first discuss cycle theories on a longer time scale and then move to the Goodwin and Keynes-Kaldor cycles. We also briefly include a discussion of Kalecki's cycle (1971) theory and how it might relate to Kondratieff.

3.1 The Kondratieff Long Swings

Above review raises few critical questions that need proper evaluation. For example, it is difficult to detect clear mechanisms in the Kondratieff cycles. If anything is working here as a mechanism, it must be some exhaustion of endogenous and exogenous factors: in the long upswing prices are rising, interest rate rise and wages rise, raw materials and non-renewable resources may be exhausted, causing to drive up prices and wages. New technologies are discovered in periods of long down swings which come to be used in a new upswing. New resources are discovered, such as iron ore, coal, gold and other metals, which Kondratieff argues to be endogenously expanded through new discoveries but both technology and resources will finally be exhausted too: resource and product prices rise, deposits at saving banks rise, but also interest rates and wages rise and a downturn begins. There is a struggle for markets and resources. New countries are opened up. There are market limits, such export limits, which restrict further expansions, as Kondratieff data on French exports show. Then, in the long downswing, prices fall, wages fall, interest rates fall, plenty of resources and unused production capacity push prices down, and unemployment reduces wages. Overall, there are some mechanisms indicated in Kondratieff, but not specifically modeled.

3.2. The Kuznets Long Swings

Further, 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 volume of al 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, with plenty of structural changes. Each stage may have its particular saving rate, consumption patterns, unevenness and disequilibrium as well as income inequality. As described above, inequality first rises with industrialization and later declines. Kuznets conceptual framework can be seen a a mixture of cycle theories, referring to the accelerator principle for infrastructure investments, and a theory of stages of economic growth that were similar to those pursued by Rostow (1978, 1975). A similar view on stages of growth, that taken by Kuznets and Rostow, is also pursued by Greiner, Semmler and Gong (2005). Overall, Kuznets was ambiguous whether there are regular mechanisms generating cycles. He conjectured that cycles may be in the economic data solely as a result of certain historical “occurrences”.

3.3. The Schumpeter Innovation Cycles

Schumpeter picked up from Kondratieff's long wave theory, but his concept of technological evolution and technological waves rests on his theory of entrepreneurship and competition.[4] Schumpeter's

[4]Such a dynamic concept of competition, which allows for transient surplus profits and differential profit rates is also very basic in Schumpeter's theory of competition as an evolutionary process goes back to Marx. In Marx,

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 engines of this development are capitalist enterprises: «Capitalism, then, is by nature a form or method of economic change and not only never is but never can be stationary .... The fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumer's goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates» (Schumpeter, 1970, p. 83). The incentives for developing these types of technical change originate in transient surplus profits. What is taken as given in neoclassical general equilibrium analysis as parametric data, when the price and quantity adjustments occur is the explicandum in Schumpeter: 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). Moreover, competition as an evolutionary process takes place through time, in discrete steps. For example, he writes: «Now the first thing we discover in working out the propositions that thus relate quantities belonging to different points in time is the fact that, once equilibrium has been destroyed by some disturbances, the process of establishing a new one is not so sure and prompt and economical as the old theory of perfect competition made it out to be, and the possibility that the very struggle for adjustment might lead such system farther away instead of nearer to a new equilibrium. This will happen in most cases unless the disturbance is small» (Schumpeter, 1970, p. 103). Indeed, in Schumpeter it is the product and process innovation, undertaken by the entrepreneur, which brings the economic system out of equilibrium, resulting in long waves and business cycles. Moreover, he even does not seem to be very interested in a theory of centers of gravitation for market forces as developed by the classical economists.

Third, in 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: «Thus, it is true that there is or may be an element of genuine monopoly gain in those entrepreneurial profits which are the prizes offered by capitalist society to the successful innovator. But the quantitative importance of that element, its volatile nature and its function in the process in which it emerges put it in a class by itself» (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, the entrepreneurial firms are powerful engines of progress and "in particular of the long-run expansion of total output » (p. 106).

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competition is not only an equilibrating force but also a force that produces disequilibrium, distortions, and misallocation of resources. Competition does not bring about a Pareto-optimal allocation of resources. Marx speaks about the «anarchy of the market» which is adjusted through crisis, see Semmler (1986), and Flaschel and Semmler (1987).

Following Schumpeter's footsteps, the literature after Schumpeter has distinguished between radical and incremental innovation. The major waves of radical innovations, which where followed by the diffusion of this new technology and incremental innovations where:[5]

- The water-powered mechanization of the industry of the 18th and early 19th century
- The steam-powered mechanization of the industry and transport of the middle of the 19th century (rail ways, 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 the war machinery (from the 1914th on)
- Computerization and information technology from the 1960s and 1970th on

According to Schumpeter oriented long wave theories, each of those radical innovations did not only create long waves in economic development, but each of those long waves were driven by different technology, originated in different countries and then diffused world wide.

3.4. The Samuelson Accelerator-Multiplier Cycles

A model of the medium time scale is the one by Samuelson (1939). It is a model of the interaction of the accelerator - multiplier model. The basic construction is as follows. Sales accelerates investment and output change results in income changes, through the multiplier, which again stimulates sales.

The multiplier-accelerator model of Samuelson (1939) can produce cycles. Take C_t =consumption, I_t = investment, Y_t = income, C_0 = autonomous consumption, I_0 = autonomous investment, and $G = C_0 + I_0; I = S = sY$, therefore the multiplier is: $Y = \frac{1}{s}$. Use:

$C_t = C_0 + \alpha Y_{t-1}$; (1)

$I_t = I_0 + \beta(Y_{t-1} - Y_{t-1})$; (2)

$Y_t = C_t + I_t$; (3)

substituting (1) and (2) into (3) gives

$Y_t = C_0 + \alpha Y_{t-1} + I_0 + \beta Y_{t-1} - \beta Y_{t-2}$

$G = C_0 + I_0$

$Y_t = G + (\alpha + \beta)Y_{t-1} - \beta Y_{t-2}$

The standard form of a second order linear difference equation is:

$Y_t - (\alpha + \beta)Y_{t-1} + \beta Y_{t-2} = G$; (4)

which is stable or unstable depending on the size of β. Moreover, one can have contracting or expanding cycles depending on whether there imaginary parts of the eigen values, see figures 2a-2d.

When we replace income by profit flows R_t one can turn the above into a kind of Kalecki (Bhaduri, Minsky) model such as:

$I_{t+1} = A + aR_t + b(R_t - R_{t-1})$; If one writes for $s_p R_t = I_t$, $R_t = \frac{I_t}{s_p}$ we get a similar second order difference

equation:

$I_{t+1} = A + \frac{(a+b)}{s_p} I_t - \frac{b}{s_p} I_{t-1}$; (5)

[5] For details see Reati and Toporowski 2004)

which again can be stable or unstable and it can produce unidirectional change or oscillations. The Kalecki model is further studied in sect. 3.7.

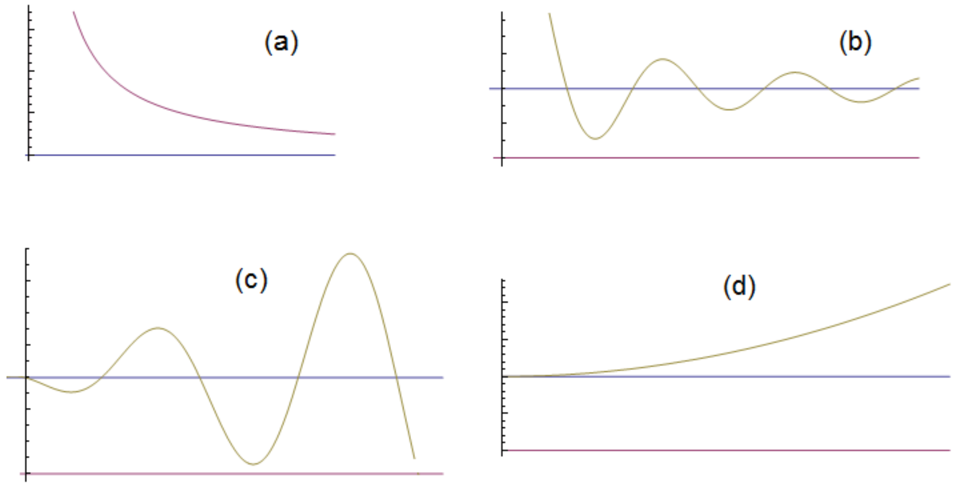

Figure 2a-2d: Stable and unstable development and oscillations

3.5. The Goodwin Growth and Income Distribution Cycles

Other types of cycles that have been discussed, particularly in the Post War II period, where Goodwin's growth cycle theory that postulates an interaction of employment and wage share. It looked like a business cycle model when it was first proposed but, in fact, empirically it seems to operate also on a medium time scale.[6]

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 gives rise to lowering the wage share: low wage share means high profit share and slowly rising investment, which reaches a turning point as employment and wage growth make the wage share rising and the profit share falling. By utilizing nonlinear differential equations, originally developed by Lotka and Volterra for models of interacting populations, we can rewrite the Goodwin model of wage-employment dynamics as follows.

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

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

or as

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

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

[6]For details of the subsequent dynamic modeling, see Semmler (1985)

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 the employment on the wage share. Due to this interaction of the variables the employment ratio is prevented from rising and the wage share from falling without limits.

For a growth model with trends as represented by Goodwin, 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 those are taken as constants. Assuming a linearized wage function (for instance, $\dot{w}/w = -e + cx$) and with m the growth rate of productivity as before, we obtain for the growth rate of the wage share the term $\dot{y}/y = \dot{w}/w - m$, with $d = e + m$. Thus the second pair of differential equations can be written as

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

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

which is indeed equivalent to the first equation (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 $(d/c, a/b)$. 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 $(d/c, a/b)$

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

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 of other important variables over time (such as waves of innovations, changes of capital/output ratio, productivity, relative prices and interest rates) as well as demand factors are neglected.

3.6. The Keynes-Kaldor Demand Driven Cycles

The demand factors are considered in the next section presented here. The Keynes - Kaldor model seems to operate on a shorter time scale. It essentially refers to the role of demand, defined by the relation of investment and savings. In his 1940 article, Kaldor proposed such a shorter scale cycle model, a nonlinear model of business cycles, which after that has 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 relies on a geometric presentation of a business cycle model which depends on a nonlinear relation between income changes and capital stock changes and which seems to generate self-sustained cycles without rigid specifications for the coefficients, time lags and initial shocks. The geometric presentation of his model of persistent business cycles due to the dynamic interaction between income changes and accumulation and dissolution of capital, indeed also includes the possibility of limit cycles, i.e. asymptotically stable cycles regardless of the initial shocks and time lags.

His ideas are also formulated for a stationary economic system and can be represented by nonlinear differential equations in the following way (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 =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 Keynesian-Kaldorian model can give rise to persistent cycles, see Semmler (1986), it does not model the specific role of growth and income distribution, as Goodwin has stressed. Yet it stresses the role of endogenously changing demand.

The linear approximation is:

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

,
where the Jacobian is

$$\frac{\partial(\dot{Y}, \dot{K})}{\partial(Y, K)} = \begin{bmatrix} \alpha(I_Y - S_Y) & \alpha(I_K - S_K) \\ I_Y & I_K \end{bmatrix}$$

where $\alpha(I_K - S_K) < 0$, since $I_K < S_K < 0$ and $I_Y > 0$ (Chang and Smyth, 1971, p. 41). The determinant is $\alpha(I_Y S_K - S_Y I_K)$, which is positive because for the existence of a unique singular point it is assumed that $(I_K S_Y - S_K I_Y)$. The element, $J_{22} = I_K$, is always negative. The linear approximation with the Jacobian represents at its core the investment-income dynamics according to which the change of income depends negatively on the level of the capital stock (J_{12}) and the change of capital stock depends positively on the level of income (J_{21}), but there is a negative feedback effect from the level of capital stock to the change of capital stock and an ambiguous feedback effect from the level of income to the change of income (J_{11}). This will be explained subsequently.

Analyzing the singular point one can conclude that the equilibrium is a focus or a node and that the equilibrium is stable or unstable accordingly as $\alpha(I_Y - S_Y) + I_K < (>) 0$. This singular point also allows for a limit cycle, since the necessary condition for a limit cycle is that the dynamic system has an index of a closed orbit which is 1 (Minorsky, 1962, p. 79). This excludes a saddle point as a singular point (see Minorsky, 1962, p. 77). Moreover, the most interesting point in this dynamic system is the ambiguous element J_{11}. According to Kaldor's graphical presentation, it is assumed (see Kaldor, 1940, p. 184) that

(1) $I_Y > S_Y$ for a normal level of income;
(2) $I_Y < S_Y$ for abnormal high or abnormal low levels of income; and
(3) the stationary state equilibrium has a normal level of income.

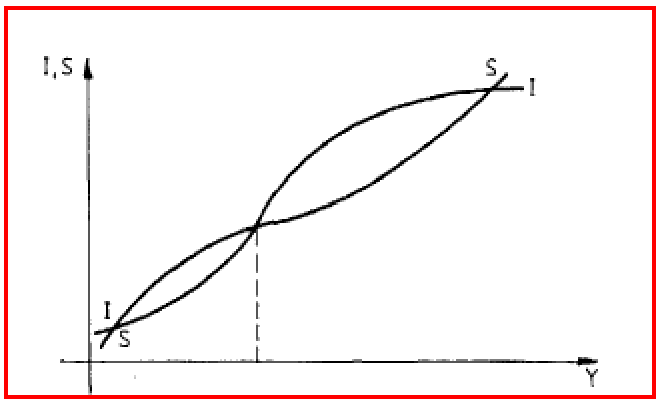

Figure 3: Kaldor graph on nonlinear investment and saving functions..

This might be illustrated by Fig. 3 with Y the level of output which shows that the normal level of Y is unstable and the extreme values of Y are stable. Mathematically this means that the trace $J_{11} + J_{22}$ changes signs during cycles. This is the negative criterion of Bendixson (Minorsky, 1962, p. 82) for limit cycles, i.e. if the trace $J_{11} + J_{22}$ does not change signs, persistent cycles –limit cycles – cannot exist (see also Guckenheimer and Holms, 1983, p. 44). As proven by Chang and Smyth (1971, section V) there indeed exists the possibility of stable cycles, limit cycles, under the assumption proposed by Kaldor.

However, the three conditions as formulated above and originally formulated by Kaldor (1940, p. 1984) are not necessary for the existence of cycles. What is actually necessary for cycles is only that $I_Y > S_Y$ (i.e. that J_{11}switches signs) 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. This is the case if:

(1) $\alpha(I_Y - S_Y) + I_K < 0$ and (2) $I_K S_Y < S_K I_Y$ everywhere.

The global asymptotic stability under these conditions follows from Olech's theorem (see Ito, 1978, p. 312).

Evaluating Keynes - Kaldor's model of a demand driven business cycles one can say that Kaldor's formulation of an income-investment dynamics brought some advances regarding a theory of endogenously produced business cycles, especially formulations of the theory of cycles in terms of a theory of nonlinear oscillations (see also Kaldor, 1971) one can extend this to include a formulation concerning the dynamics in employment and wage share which was originally more visible in classical models that referred to the profit-investment dynamics.

3.7 The 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[7] and allow for $J_{11} = \alpha(I_\Pi - S_\Pi)$ to change signs during the cycle. In some sense the role of profit, wages and income distribution – as in the Goodwin model– can be allowed to come in here.

In general it could be assumed that:

(1)$\partial I/\partial\Pi > \partial S/\partial\Pi$, for profit income in an interval such as $\Pi_1 < \Pi < \Pi_2$ (see Fig. 4). This may be due to a previous decrease in capital stock, production and employment which entail low construction cost for plants, low material and resource cost and low wage costs (relative to productivity), high profits and low interest rates and easy access to credit. These factors then may give rise to an expectation of rising profits on investments.

On the other hand in other regions we can have:

(2)$\partial I/\partial\Pi < \partial S/\partial\Pi$,

(a) for $\Pi > \Pi_2$ due to capacity limits, rising construction cost for plants and rising material and wage cost (relative to productivity), exhaustion of exhaustible resources, rising interest rates and but falling actual and expected profits. Profits and expected profits may fall due to the rise of those costs and wages – that cannot be passed on– in the long upswing. This looks similar to a mechanism that Kondratieff has indicated to eventually occur in his long upswing, see sect. 3.1.

(b) for $\Pi < \Pi_1$ in a recessionary or slow recovery period, where firms invest in financial funds instead of in real capital (Minsky, 1983) but due to the economic conditions in a recessionary period, the rate of change of saving in response to falling profits tend to drop faster than the rate of change of investment. Wage share may have been rising previously, and profit share falling but

[7]This conversion seems permissible as long as there are no savings out of workers income and thus workers income is completely spend for consumption. This is what Kalecki assumes.

here investment is still not dropping completely to zero. This resembles the Kondratieff scenario of a long downswing and recessionary or stagnation period.

Though the economic intuition appears the same in our above stylized business cycle dynamics and the Kondratieff long waves phases, the time scales are are probably different ones: one is a shorter one and the other a longer one, but the mechanisms may be the same. Yet, for a longer time scale much of the economic structure and relationships are likely to change.

In the history of economic thought the change of sign for J_{11} during the economic cycle was verbally anticipated by many writers on the study of capitalist dynamics (Kalecki, 1971, p. 123; Kaldor, 1940, p. 184) and can be regarded as an essential for a theory of fluctuations in economic development. Mathematically $J_{11} + J_{22}$ must change signs in order to generate self-sustained cycles. if J_{11} and J_{22} were zero, J_{12} and J_{21} alone would determine the profit-investment dynamics. There would only be structurally unstable harmonic oscillations. The negative signs of J_{12} and J_{22} exert a retarding influence on accumulation, and J_{21} represents an accelerating force on capital accumulation, whereas J_{11} exerts a retarding influence in the boom period and an accelerating impact on profit and accumulation in the later phase of the recession.

Intuitively, the existence of self-sustained cycles can be seen in figure 4 from the fact that the trajectories of $\Pi(t)$ and $K(t)$ are bounded in absolute values and the profit-investment dynamics follow certain directions in the plane. Roughly speaking, for large enough $\Pi(t)$, $\dot{\Pi}$ turns negative and for large enough $K(t)$, $\dot{K}$ turns negative and vice versa. Geometrically, this is illustrated by figure 4.

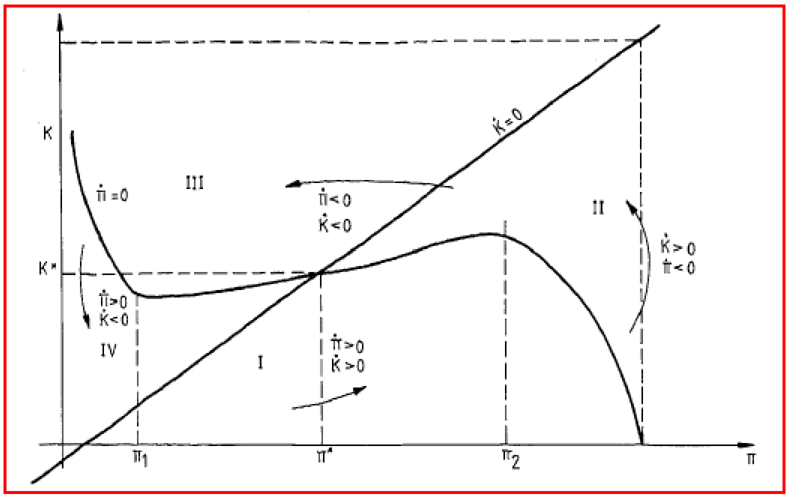

Figure 4: Phase Diagram

For $\dot{\Pi} = 0$ we get the slope

$$\frac{dK}{d\Pi} = \frac{S_\Pi - I_\Pi}{I_K - S_K} \lesseqgtr 0$$

and for $\dot{K} = 0$ the slope is

$$\frac{dK}{d\Pi} = -\frac{I_\Pi}{I_K} > 0$$

.

Thus in the plane of the Figure 4 there are four quadrants.

For reasons of simplicity we have assumed a linear investment function in Figure 4. The system has a unique solution at Π^* and K^* since the curve $\dot{K} = 0$ has a steeper slope than $\dot{\Pi} = 0$ when the latter is upward sloping in a certain region. This follows from the assumption in the model.[8] The determinant of the Jacobian of the dynamical system above is $\alpha(S_K I_\Pi - S_\Pi I_K) > 0$. The singular point is a focus or a node and is stable or unstable accordingly as $\alpha(I_\Pi - S_\Pi) + I_K \lesseqgtr 0$. A saddle is excluded, and the singular point has index 1 as necessary condition for a self-sustained cycle (Minorsky, 1962, p. 176). (The singular point does not have to be unstable as Kaldor originally assumed, Kaldor, 1940, p. 182.) The existence of a self-sustained cycle follows intuitively from the analysis of the vector fields in the different regions which correspond roughly to stages of economic cycles.[9]

For region I, which expresses the dynamics of a recovery period, $K(t)$ is below the $\dot{K} = 0$ curve and $\Pi(t)$ is below the $\dot{\Pi} = 0$ curve; the decline in capital stock and its effect on profit (i.e. the effects of cases (1) and (2) as well as other changes in economic conditions in a recessionary period will generate a positive rate of change of profit (since $I_\Pi > S_\Pi$ in region I, see also condition 1). Therefore, in region I we will find $\dot{\Pi} > 0$ and $\dot{K} > 0$.

The increase of profits and investments after a recessionary period will lead to rising $K(t)$, but through the effect of cases (1) and (2) (i.e. the negative effect of growth of capital stock on profits) the growth rate of II will become negative. Thus in region II, indicating a boom period, we have $\dot{\Pi} < 0$ and $\dot{K} > 0$. Hence the arrows in Fig. 4, indicating the direction of the vector field of Π and K, will start bending inward (see condition (2)(a) which leads to $I_\Pi < S_\Pi$). With capital stock rising and $\dot{\Pi} < 0$ due to a magnitude of capital stock greater than its stationary value K^*, the capital stock must eventually decline (i.e. through the effect of case (2). We also have $\dot{\Pi} < 0$ due to $I_\Pi < S_\Pi$ at the beginning of a downswing period (capital may be accumulated more as money capital than as real capital).

In region III, indicating a downswing period, through the influence of $\dot{\Pi} < 0$ on $K(t)$, $K(t)$ also starts declining; thus$\dot{\Pi} < 0$ and $\dot{K} < 0$. Hence for $\Pi(t) < \Pi*$ and $K(t) < K*$ the vector field is pointing inward. A decline of capital stock below K^* in region IV the recessionary period, however, causes profits eventually to rise. The recessionary period may slowly then turn into a recovery period, indicated by region I. This, of course, assumes again that eventually $\dot{\Pi} > 0$. The investment of money capital turns into investment in real capital, thus investment out of profit tends to become greater than savings out of profit. The recessionary period (with wage increase below productivity, low material and capital cost, low interest rates and easy access to credit as well as a decline in capital stock and thus rising profit expectation[10] must have its impact on $\dot{\Pi}$, for otherwise the recessionary period will endure.

Therefore under the economic conditions stated in conditions (1), (2)(a) and (2)(b) the profit-investment dynamics creates its own cycles by which profit, investment and thus output and employment cannot exceed certain boundaries. The dynamic system is self-correcting and fluctuates within limits: for large enough $K(t)$ is $\dot{K} < 0$ and for large enough $\Pi(t)$ is $\dot{\Pi} < 0$. A similar argument holds for small enough $K(t)$ and $\Pi(t)$. Thus, whereas the system with cases (1) and

[8] The curve $\dot{\Pi} = 0$ is downward or upward sloping when $S_\Pi > I_\Pi$ (or $S_\Pi < I_\Pi$). By assuming that for a certain region $\Pi_1 < \Pi* < \Pi_2$, $\dot{\Pi} = 0$ is upward sloping and $\dot{K} = 0$ also has a positive but steeper slope, it follows that there is only one unique equilibrium point. For similar assumptions concerning an income/ investment model, see Chang and Smyth (1971, p. 40).

[9] A proof using the Poincare-Bendixson theorem is given in Semmler (1986)

[10] A very important factor for the change of signs in J_{11} for a monetary economy seems to be the financial condition of firms and the banking system (see Minsky, 1983).

(2) becomes stable at its outer boundaries (indicated by the negative sign of $J_{11} + J_{22}$), it cannot converge towards equilibrium, since the equilibrium is unstable (indicated by the positive sign of $J_{11} + J_{22}$). Therefore, the dynamics of the system will result in cycles, see Semmler (1986) . These self-sustained cycles, resulting from the profit-investment dynamics, can be regarded as close to classical dynamics and conceptions and the original Kalecki model and reflects to a certain extent also the dynamics of output, income, resource cost, price level, wage and bank deposit and interest rate dynamics of the Kondratieff long wave theory. Though for such a cycle on long time scale many structural changes may occur that could could significantly change the mechanisms and economic relationship over the cycle.

4. The Minsky Asset Price and Leverage Cycles

Next we discuss a Minsky long cycle: a financially-based approach to long wave theory. 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.

Recently, Palley (2010, 2011) has argued that Hyman Minsky's (1992) financial instability hypothesis also provides a theory of long cycles which can be labeled the Minsky long cycle. This long cycle explains why financial capitalism is likely to be prone to periodic crises and it provides a financially grounded approach to understanding long wave economics. Minsky's financial instability hypothesis maintains that capitalist financial systems have an inbuilt proclivity to financial instability that arises in particular in periods of economic tranquility.

The dynamic behind this proclivity can be summarized in the aphorism "success breeds excess breeds failure". Minsky's framework is one of evolutionary instability and it can be thought of as resting on two different cyclical processes. The first cycle can be labeled the "Minsky basic cycle", while the second can be labeled the "Minsky long-cycle". The Minsky basic cycle has been the dominant focus of interest among those (mostly Post Keynesians) who have sought to incorporate Minsky's ideas into macroeconomics and it provides an explanation of the standard business 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.

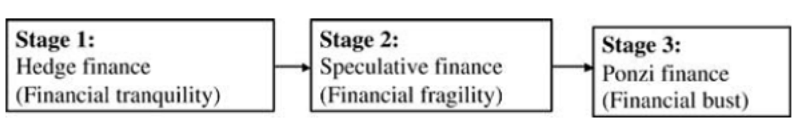

Table 2: Minsky financing practices

The basic Minsky cycle embodies a psychologically based theory of the business cycle. Agents become progressively more optimistic in tranquil periods, which manifests itself in increasingly optimistic 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 effects credit volume, this from 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, namely that with higher leverage, higher risk premia are to paid is not visible in the credit cost. Usually, in contrast, credit is cheap and plentiful in such a period. Below, in our empirical section, in sect. 5.4, this is illustrated for the recent long financial cycle starting in the 1990s. It was first a real cycle, driven by information technology. This bubble was bursting around 2000/2001, but continued as Minsky's financial cycle of overoptimism, high leverage, underestimation of risk, and expansion of new financial practices.

We observe a high degree of leveraging during this period, an optimistic view of profit expectations, low risk premia, low credit spreads, and few credit constraints. So, what one could observe in this tranquil period was high leveraging, but at the same time low risk premia— a phenomenon in contrast to what is stated in corporate finance books.

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", see Sect. 5.4 for empirical details. 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 which means market discipline is weakened both internally and externally. 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 on a longer time scale, a long-cycle that works over a period 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 longer-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.[11] 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 boomer's love affair with stocks explains its gradual disappearance. Changing taste for risk is also evident in cultural developments. One example of this is the development of the "greed is good" culture epitomized by the fictional character Gordon Gecko in the movie Wall Street. Other examples are the emergence of investing as a form of entertainment with changed attitudes toward home ownership; thus 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. University economics departments and business schools pedaled a common economic philosophy that was adopted by business participants and regulators worldwide. Organizations like the International Monetary Fund and World Bank also pushed these ideas. As a result, developments associated with the Minsky long cycle operated on a global basis giving rise to common financial trends across countries that multiplied the overall effect.

The twin cycle explanation of Minsky's financial instability hypothesis incorporates institutional

[11] For details of this aspect, see Johnson and Kwak (2011)

change, evolutionary dynamics, and the forces of human self-interest and fallibility. Empirically, it appears to comport well with developments 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 cycle. The Minsky long cycle enriches long wave theory. In addition to adding financial factors, the Minsky cycle also has different implications for the pattern of long waves compared to conventional long wave theory.

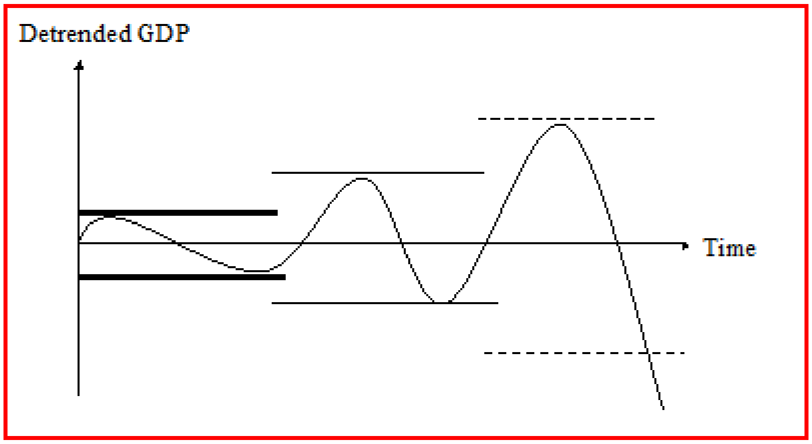

Figure 5: Detrended GDP - Symmetric Fluctuations

Conventional theories see a separate long wave on top of which are imposed shorter waves. In contrast, the Minsky cycle on the long time scale gradually and persistently changes 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 uncontainable and becomes a crisis. 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.

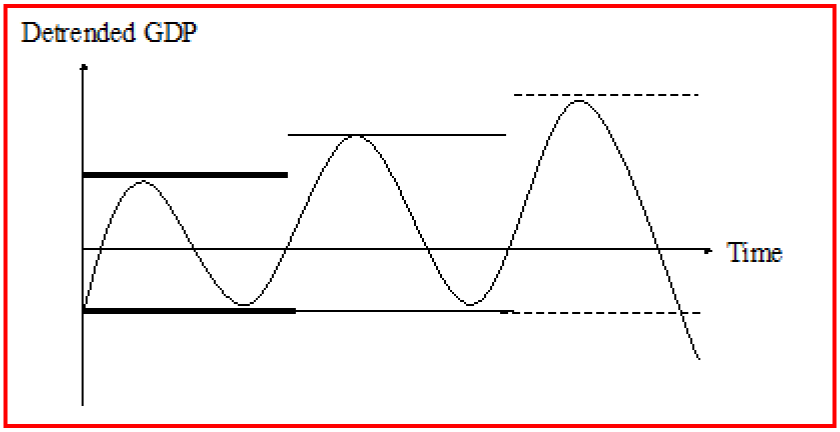

Figure 6: Detrended GDP - Asymmetric Fluctuations

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 (see Section 3.4). 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. The thwarting institutions are explicitly present in the floors and ceilings, but they can also be present in the coefficients of the multiplier - accelerator model which determine 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 innovation cycle. Despite these commonalities with existing cycle theory, formally modeling Minsky's financial instability hypothesis may be difficult and 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". Also, when actually the financial disruptions occurs — with strongly amplifying impact on the real side — could almost be accidental. A second problem is that the financial instability hypothesis is a quintessentially non-equilibrium phenomenon 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.

Minsky long cycles seem to be interlinked not only with Schumpeterian innovation cycles, but also with Goodwin cycles, based on changing the bargaining position of labor in stages of low and high growth rates.

5. Empirical Evaluation of Cycle Theories of Different Time Scales

Next we discuss some methodology used in the extraction of cycles from data. In the literature there are three typical methods to empirically study cycles. These are first spectral analysis (Fourier's theorem), second filtering methods (HP- filter, BP- filter and penalized splines), and third wavelet theory.[12] Since the advantages and disadvantages of the second one have been discussed widely we will here more extensively focus on the first and the third methods.

5.1 A General Approach of Extracting Cycles from Data: Fourier's Theorem

Generally speaking, a function is termed periodic if it exhibits the following properties:

$$f(x) = f(x + T)$$

In this case, T is known as the "period" and, if x is time, then $\frac{1}{T}$is the frequency. In the physical world there are many phenomena that exhibit periodic behavior, e.g., pendulums, springs, and waves, to name just a few. Mathematical examples also abound. A classic example, that of a bead moving around a wire circle, is given in the Appendix.

It is interesting to consider what happens when periodic functions are added together. For example, consider the the following:

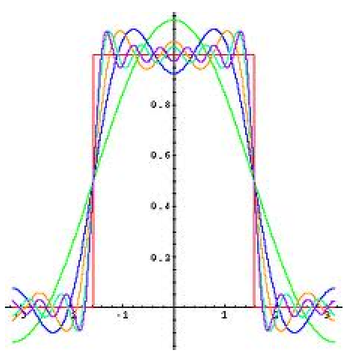

Figure 7: The reinforcing/complementing effects of multiple periodic functions added together

We can see that when several periodic functions are added together, some parts reinforce each other (when both are positive) and other parts cancel each other (when the functions are of opposite sign). But the interactions may be more or less complex and form surprising shapes, a square wave, as is shown in Figure 7.

[12]On the usefulness of wavelets to study cycles at different time scales, see Gallegati, Ramsey and Semmler (2009, 2011).

From the physical world, we can readily observe certain properties of periodic phenomenon, e.g., cancellation, reinforcement, damping, etc. When one moves away from two sound sources emitting tones of different frequencies, one hears, alternately, louder and softer tones.

It was observations of this kind that motivated Joseph Fourier, in the early 1800s to speculate that virtually any function could be formed by adding together the correct combination of periodic functions. In his famous analysis, Fourier defined a sequence of trigonometric values as follows:

for any function, *f*, which is integrable from $-\pi$ to π

$$a_n = \frac{1}{\pi}\int_{-\pi}^{\pi} f(x)cos(nx)dx$$

$$b_n = \frac{1}{\pi}\int_{-\pi}^{\pi} f(x)sin(nx)dx$$

using these terms, then the function, *f*, may be approximated by

$$f(x) = \frac{a_0}{2}\sum_{n=1}^{\infty}[a_n cos(nx) + b_n sin(nx)]$$

Thus, any function may be approximated by a sum of trigonometric functions. This is a powerful result. For example, we may write that the trivial function, $y = x$, thus

$$f(x) = x \sim 2\left(sin(x) - \frac{sin(2x)}{2} + \frac{sin(3x)}{3}...\right)$$

[13]

This is illustrated below:

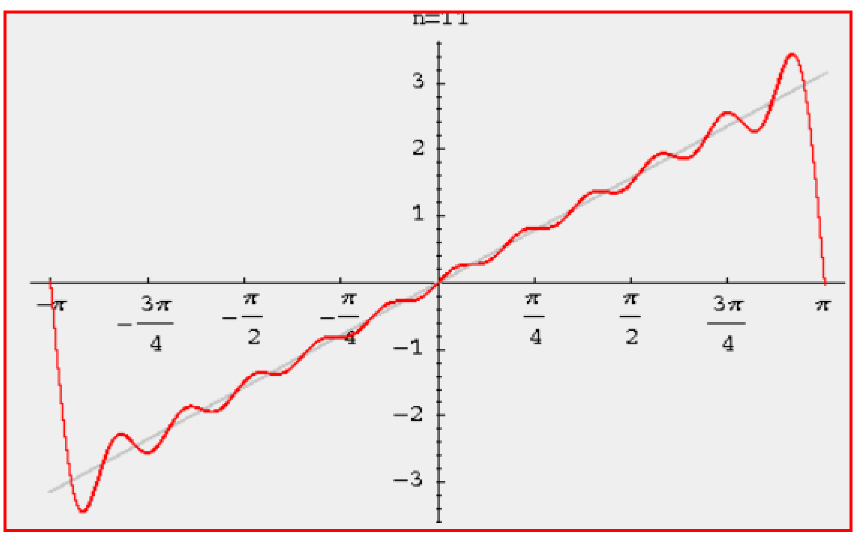

Figure 8: The function $y = x$ expressed as a sum of periodic functions

[13] Tolstov, G. (1962) "Fourier Series", Dover Publishing, New York, NY

5.2 Spectral Analysis and Kuznets, Kondratieff, and other Waves

The mathematical implication is that for any time series, a sequence of periodic functions may *always* be found that add up to approximate the original time series. The above mathematical fact does not, in and of itself, imply that there is any actual or other interpretation of this equivalence. In other words, the fact that there is a mathematical equivalence does not imply that there are real phenomena that exhibit the same characteristics. Nonetheless, it does not imply the reverse either, i.e., that there may be periodic behavior lurking behind some phenomena. In this case, Fourier analysis could be useful in teasing out the details.

Mankiw (2008) state flat out that there are no regularities in economic phenomena. Garrison (1989) states that Kondratieff waves are a product of "creative empiricism" and equivalent to the fanciful shapes, e.g., head-and-shoulders, of technical stock traders - and have "no basis whatever in theory." However, he later modifies this position to allow for wave-like phenomena that have some structural basis.

In fact, there is much reason to suspect that the latter is the case. Economists have long recognized periodic phenomena of both long and short periods. Business cycles are but one example, which are easily detected and found in data.[14] Thus, it is not unreasonable to replicate the stylized facts of an economic phenomena by suggesting that it is, in fact, the combination of a number of periodic phenomena. This has the advantage of reducing observable phenomena to other phenomena already explained.

Kondratieff waves, described in the previous sections, are cycles that alternate between periods of high growth, with rapid price rises, and periods of relatively slow growth, with falling prices. Regardless of the existence of the illustrated sequence of historical events, it remains controversial if there is, in fact, any fundamental periodic phenomenon of which these fact are manifest. However, recently, as we have outlined in the above sections, a number of researchers have found evidence for such waves.[15]

A number of arguments against this include: (1) the fact that even though certain types of human events tend to recur, people learn from their mistakes and some expectations of cycles may smooth them out. Also, (2) the the types of production and investment change over time, (3) long waves are hard to verify empirically, (3) we have shown (see section 3) that there may be different mechanisms working for cyclical behavior in different time scales, and, lastly, (4) Fourier's theorem shows one can always find waves in any data set.

Although Korotayev and Tsirel (2010) find evidence not only for Kondratieff waves, but also for Kuznets swings, Juglar cycles, and Kitchin cycles. Without going into too much detail, suffice to say that each of these periodic phenomena are characterized by different frequencies and amplitudes. Thus, it is no surprise, see (5) above, that analysis of data will show, with suitable adjustments/calibration, that the data series can be replicated by a sum of periodic functions.

Korotayev and Tsirel (2010) use spectral analysis in their research. They study world GDP growth rates and prices going back over 100 years. The particular form of spectral analysis they use is adapted to time-series. In this technique, the time-series is analyzed "based on the assumption that a broad class of aperiodic natural, technical, and social processes may be represented as sums of random process with stationary increments of different orders." Now although this seems natural enough, and, in fact, given what we know about Fourier Series, must be mathematically true, the problem with the reasoning is this: we are assuming, in some sense, that what we want to find

[14] See NBER cycles and their detection methods.

[15] see Korotayev, A. and S. Tsirel (2010)

is already there; and then we go and find it. On the other hand, in any sort of modeling, one generally assumes some sort of structural relationship and then considers empirical data to see if there is evidence that supports it. Some might criticize the method of Korotayev and Tsirel because the period of the Kondratieff waves in their research has a period of around 50 years. Thus, no more than three complete cycles could exist in their database.

However, their approach is statistical, *not* a simple Fourier decomposition, and it has been shown that, even with such a small sample, the test statistic follows a χ^2 distribution. Thus, they obtain low p-values for those components with periods of approximately 50 years (Kondratieff waves; $p = 0.04$), periods of around 8 years (Juglar cycles, $p = 0.025$), and periods of close to 3.5 years (Kitchin waves, $p = 0.025$). With such p-values, most statisticians would accept the presence of these cycles. The key arguments regard the interpretation of historical economic and political events. Note that Korotayev and Tsirel prefer to regard Kuznets swings as harmonic elements of Kondratieff waves, rather than as a separate cycle.

5.3 Other Methods of Cycle Detection

Another issue that comes up in Korotaev and Tsirel is the pre-processing of data. For example, in addition to eliminating the years of the two world wars, (1914–1919, 1939–1946), they also have "replaced all the values for the period between 1914 and 1946 with geometric means (1.5% per year)." This seem a rather extreme and arbitrary replacement. If cycles are to explain economic behavior, only limited adjustment of the data should be permitted. Further, in a second more radical departure from the actual data, "the values for years between 1914 and 1946 were replaced by the mean value (3.2%) for the whole period under study (1871–2007), that is, those values were actually excluded from the spectral analysis." Thus, it seems to bring into question as to what, in fact was being analyzed.

Additionally, we believe that a wiser course would have been to follow a more robust method of analysis - one that does not require such a large degree of pre-processing. For example, in Gallegati, et. al. (2011) a wavelet approach is used to determine the factors that effect output with considerations of size, scale, and time.

The key issue in the empirical analysis is the fact that there may be cycles of different times scales. This leaves open the possibility that they may amplify or counteract each other. For example, Kondratieff cycles in output and prices are estimated to have periods of around 45-60 years; Kuznets infrastructure cycles have periods of around 25 years; Schumpeter's 'innovation,' 50 years, the Goodwin cycle of maybe 20 to 30 years, and Keynes-Kaldor-Kalecki cycles of demand: 7-9 years. Thus the empirical analysis needs to be able to verify these cycles.

Wavelet analysis is similar to and sometimes more accurate than traditional spectral analysis because it uses short 'wavelets' instead of infinite periodic functions. In contrast to the Fourier analysis, wavelet analysis analyzes the signal at varied frequencies with varied resolutions. Instead of the fixed time-frequency results of the Fourier analysis, the wavelet method provides excellent frequency resolution at low frequencies and good time resolution at high frequencies. Thus, this methodology allows both time and frequency to vary in time-frequency plane, but also the mechanisms driving those cycles .

In Gallegati, et. al. (2009), a wavelet approach was used to analyze the time series data underlying the Phillips-curve:[16]

[16]Note that Goodwin uses such a Phillips-curve but assumes a constant productivity growth rate and real variables.

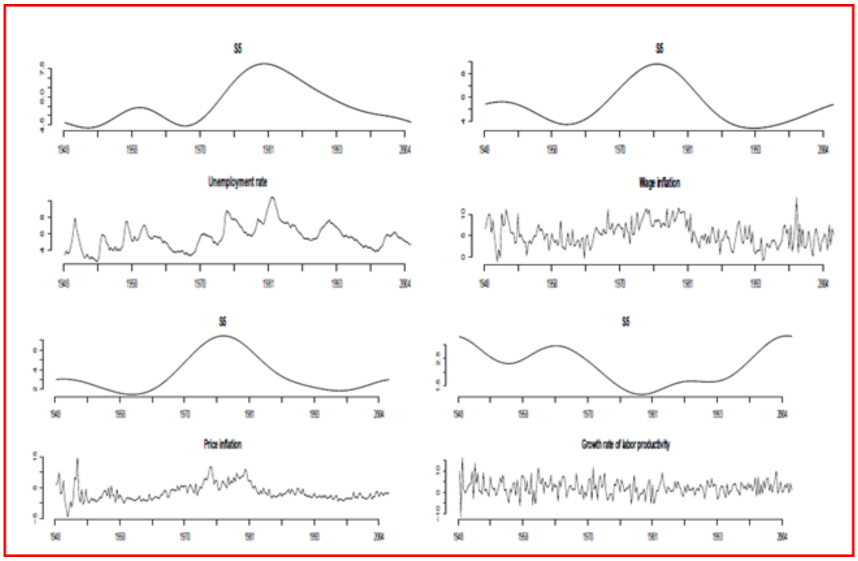

Figure 9: Wavelet analysis; longest times scale and actual time series for unemployment, wage inflation, price inflation and growth rate of labor productivity; US data 1948.1-2006.4

Thus, wavelets provide a good method to see relationships on different times scales and allow one to disentangle what drives output at different time horizons. Wavelet variance and cross-correlation methods can be used to determine leads and lags in time series and how different time scales effect them. This is likely to be better approach to cyclical analysis of macroeconomic time series. Figure 9 provides an example for the composition of the time scale for US Phillips curves time series variables.

Yet another methodology for (see Kauermann, et. al., 2011) the decomposition and filtering of time series is the technique of penalized splines. Here, a time-series is decomposed into a smooth path and a series of residuals, which are assumed to be stationary around the trend. This technique is robust with regard to correlation of residuals. The residuals exhibit business cycle features.

Splines are basically a type of smoothing in which piece-wise polynomial functions are joined together to form a "smooth" shape. The "smoothed" shapes can then be studied or periodicity and other features more easily than the original data-stream. In their paper, Kauermann, et. al. discuss several sub-methodologies including the Hodrick-Prescott (HP) Filter and the The Bandpass (BP) Filter; these are contrasted with the method of penalized spline. They study GDP and its components from 1953 to 1996. The data and the resulting filters are shown below.

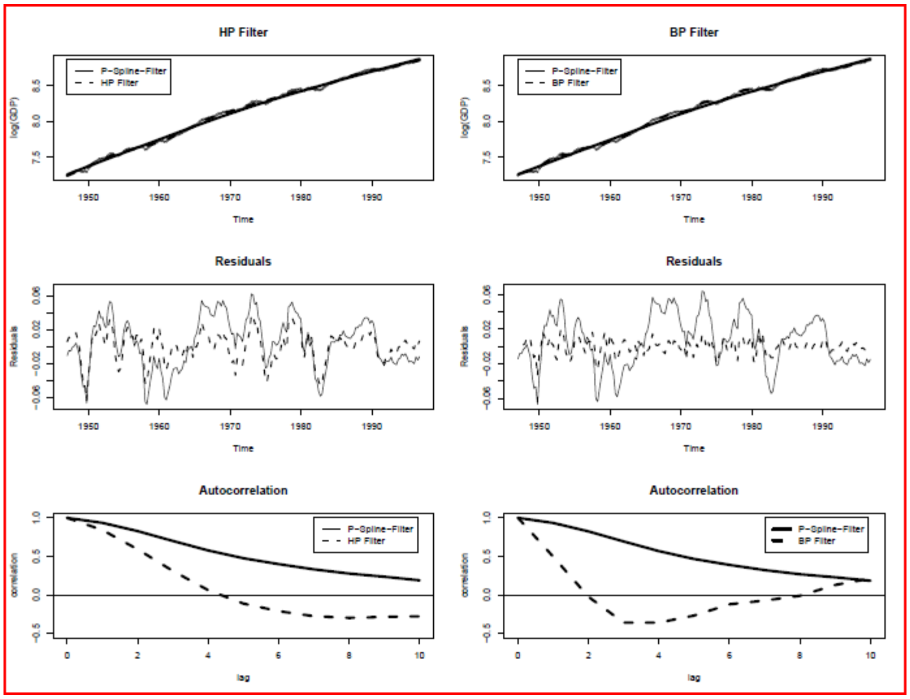

Figure 10: HP and BP filters and penalized splines; US GDP, quarterly data, 1953.1-1996.4

The top line illustrates the penalized spline filter as dark line in contrast with the HP filter (left) and with the BP filter (right). The first one shows almost a linear trend and business cycle components come out more clearly as compared to the HP and BP filters as shown in the middle row. The penalized spline filter can allow for distinct residuals with serial correlation. This is also seen in the auto-correlations of the residuals, which are illustrated at the bottom.

We see that there are a variety of approaches to the identification of cycles withing time series methods. Each of them have some advantages and disadvantages.

5.4 Some Empirics on the Goodwin Cycle

Other analysis, for example, Flaschel, et. al. (2008)[17] show how cyclical behavior can appear as Goodwin cycles, based upon predator-prey dynamics as discussed in Section 3.5. In their case, they show how, with suitable assumptions about the wage-price spiral and certain other variables, a Lotka-Voltera type of model gives rise to periodic phenomena, as explained in section 3.5 above. In this case, the ambiguities are only pushed into the background, i.e., into the parameters and structure of the pair of differential equations that give rise to the dynamical system. In other words, it is not in question if the system they develop gives rise to periodic behavior, it does. The question is whether the system is well-grounded in the empirics of the variables being used.

We do not seek to advocate for or against the existence of wave-like phenomena in economic behavior. Instead, we only wish to point out two things: (1) Fourier's theorem guarantees[18] that one

[17]Flaschel, P., D. Tavani, L. Taylor, & T. Teuber (2008) "Demand Driven Goodwin Growth Cycles with a Three-Regimes Wage Phillips Curve", working paper

[18]For example, consider penalized spikes as seen in Flaschel, 2008

can find a set of waves which fully simulate any curve; (2) there is a fundamental ambiguity about the nature of the economic behavior being explained, with respect to frequency, amplitude, etc. as there is sufficient freedom for interpretation of virtually any periodic phenomena as “economic” phenomena.

An empirical test of the cyclicality of synthesis of the Goodwin and Keynes-Kaldor models are given in Flaschel et al (2008). Often the Goodwin model has been interpreted as business cycle dynamics, but as Flaschel et al (2008) show, the employment and wage-share dynamics seems to hold more for a longer time scale, where the wage-share movement can be found to be related to a large time scale with a delay. Employment seems to lead the change of the wage-share in the context of long waves; see figure 11.

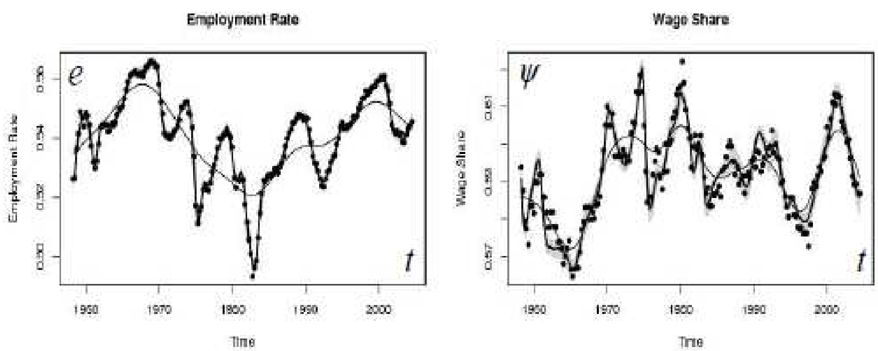

Figure 11: US Goodwin Cycles[19]

Yet, business cycle frequency there is some negative correlation between employment and wage share. This interaction appears to come less from real wage movements, but rather from procyclical productivity movements. As to the longer time scale— here captured by the thin solid trend line – as it is observable from the Figure 11 there seems to be strongly a delayed reaction: With employment rising wage share seems to rise with a delay, and as wage share is rising, employment seems to fall with a significant delay. Most of our current cycle models — on a short or long scale – have not properly build in such delays, since those models are difficult to solve.

5.5 Some Empirics on the Minsky Cycle

A typical period where the long Minsky cycle was visible were the years from the 1990 to 2007. The Minsky basic cycle embodies a sentiment-based theory of the business cycle, see also Semmler and Bernard (2009). The tranquil time period generates the greatest risk as agents become progressively more optimistic, which manifests itself in increasingly optimistic valuations of assets and associated revenue streams and willingness to take on increasing risk in belief that the good times are here forever. This optimistic psychology increases credit volume for both borrowers and lenders - not just one side of the market. That is critical because it means market discipline becomes progressively removed. Leveraging is increased but the usual text-book scenario of corporate finance, namely that with higher leverage implies higher risk premia is not visible in the credit cost. Usually, in contrast, credit is cheap and plentiful in such a period.

[19]Figure from Flaschel et al (2008)

Let us consider some data from that period. In Figure 12, we show the ratio of home prices to rents during the period of the 1960s - 2006. One notes how, beginning in 1999, the ratio suddenly starts to grow. Generally, this could be explained if there were a radical drop in interest rates, implying that the present value of the anticipated rents was greater, but this was not the case. Thus, the increase in price is evidence for higher anticipated resale values. In a word: speculation.

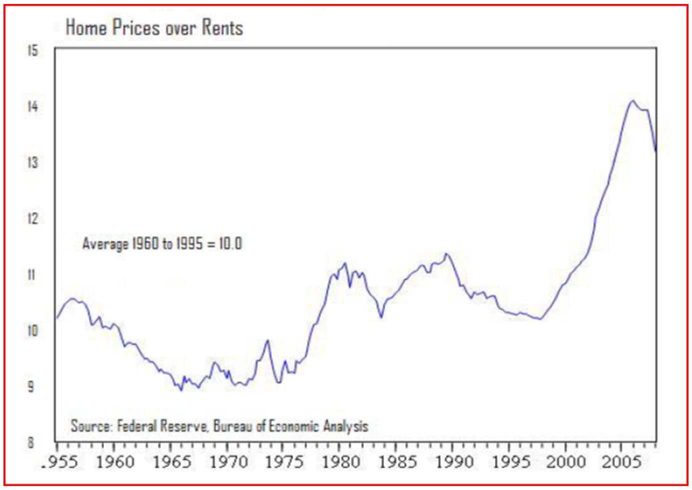

Figure 12: Ratio of Home Prices:Rents

Next, in Figure 13, we show mortgage rates during the same period.

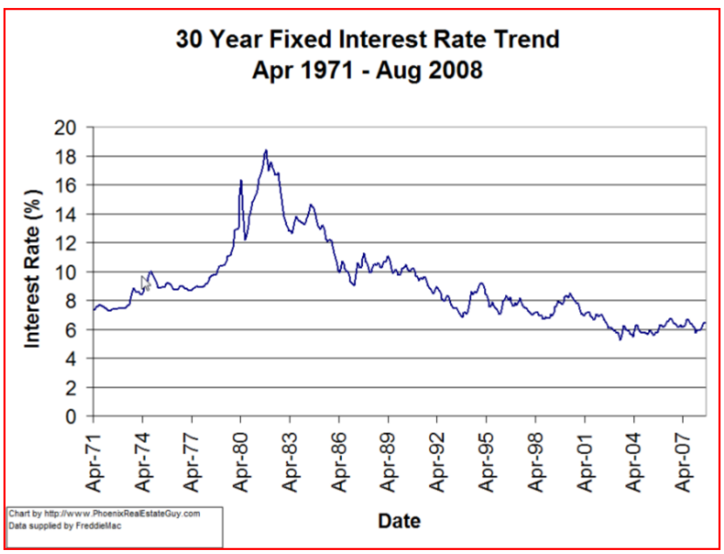

Figure 13: Historical Mortgage Rates

Under "normal" circumstances, we would be surprised by the simultaneous rising of both mortgage interest rates and the home price to rent ratio. However, the 1970s and 1980s were a time of rampant inflation, economic recession, oil-crisis, etc. Thus, the rise in the home price to rent ratio is probably explained by low rents due to a bad economy. If we want to search for the Minsky process, we need two more items. These are shown in Figures 14 and 15.

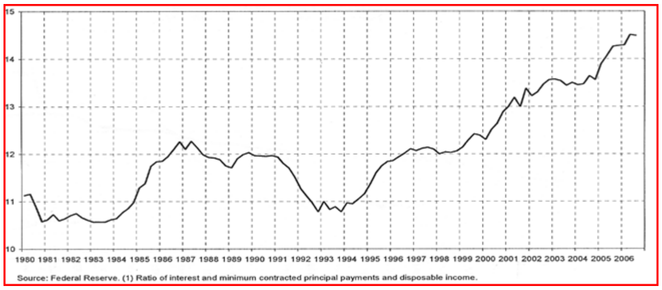

Figure 14: Debt Service to Disposable Income Ratio

Figure 14 illustrates the percentage of disposable income devoted to servicing debt. Thus, it is a fairly good proxy for risk since the lower the percentage of disposable income a borrower needs to pay, the less risky it is to lend money to him/her. Yet, though the leveraging is rising for households, see figure 14, the lower is the interest rate on mortgages, see figure 13. Thus a higher risk does not show up in a higher risk premium.

Figure 15 shows the the rise of the volume of funds in Collateralized Debt Obligations over the relevant period 1992 - 2002, which corresponds with the sudden growth of the Debt Service to Disposable Income Ratio.

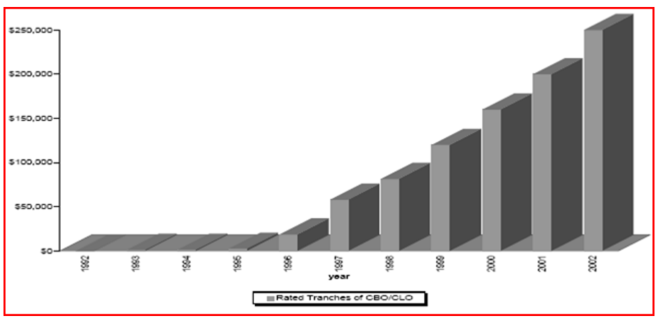

Figure 15: Securitization of debt: Complex securities

Figure 15 "explains" the "why?" of Figure 14. A collateralized default obligation (CDO) makes it possible for a bank to off-load risk, thus allowing the bank to write riskier loans without the fear of default. Mortgage-backed Securities (MBS) are but one example of a CDO. It is not the risk, per se, that is the issue, but the consequences of that risk that are the operative force. Thus, the possibility of an MBS allows the bank to worry less about the consequences of default. Under "normal" circumstance and according to conventional economic theory, a period of increased leveraging, as shown in Figure 14, should have been accompanied by higher risk premia. Instead, as is shown in Figure 13, we see interest rates actually decreasing. During the same period, see Figure 12, we see home prices (adjusted for rental income) sky-rocket. All of this accompanied by the growth of the CDO industry, which made it all possible. Conclusion: a Minsky long cycle.

This can be further discussed for the recent long financial cycle starting in the 1990s. It was first a real cycle, driven by information technology. This bubble was bursting around 2000/2001, but continued as (Minsky long financial cycle) over-optimism, high leverage and underestimation of risk, and with expansion of new financial practices, continued.

If one looks at the data from the mid-1990 through 2007, we can observe (slightly disrupted through 2001) two major stylized facts:

- Investment and Commercial banks, private investors, and mortgage buyers face, since 2000, exceptional funding conditions, not only concerning low interest rates, but because of over-optimism and underestimation of risk. Thus, there are also low credit spreads for the riskier borrowing. Not only is the Baa-Aaa spread very low but also the financial stress index provided by the KCFED[20] is at historical low levels, and so are the credit constraints[21]. All those declined markedly before 2007.
- Yet, at the same time investment and commercial banks with high profit expectations become more leveraged. For example, Blundell-Wignal and Atkinson (2008) demonstrate rising debt levels for US banks‘s balance sheets. According to the Fed, the debt of commercial banks rose from 59 percent of GDP in 1999 to 76 percent at the end of 2007. A similar rise of household debt could be observed as well.[22]

We could observe high leveraging during this period, an optimistic vision of profit expectations, low risk premia and low credit spreads, and few credit constraints. So, what one could observe in this tranquil period as high leveraging, but at the same time low risk premia— a phenomenon in contrast to what is stated in corporate finance books, where high leveraging should lead to high 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", and the risk taking goes up. The above empirics of asset prices, leveraging, and deleveraging seem to support the hypothesis of the Minsky long cycle discussed in Section 4.

6. Conclusions

It might be fair to say that the mechanisms of long cycles are difficult to detect empirically. Not only do the empirical methods of detecting cycles through filtering face great challenges. There also seems to be ever evolving new mechanisms of economic waves. Within such long time period of 50 years, or Kuznets waves of 25 years, there are many structural changes of the economy, for example sectoral changes from first agriculture then to the dominance of manufacturing, then rise of the service sector. There are institutional changes over time, for example labor market and regulatory institutions, but also new technologies that are less based on heavy physical production and resource, but knowledge based production activities, and new institutions and decision making bodies, alternations between market oriented and more interventionist policies, the evolving new interest groups in decision making and new financing practices. There are new phases of growth where the forces of growth are different then before, they may evolve from more copying from others, build up of education and human capital, infrastructure, knowledge creation and so on. So indeed one can not step into the same river twice... All this makes the long run mechanism changing over time and it is hard to empirically detect cycles of fixed periodicity and amplitude as well as time invariant mechanisms generating cycles. In order to capture the changing economic relationships over cycles at different time scales, wavelet method appears to be a most suitable one.

[20]See the KCFSI (2010)
[21]See the Fed survey on loan officers, Fed web-site.
[22]See Hudson (2005), see also Semmler and Bernard (2009)

Still, technical difficulties notwithstanding, the dynamics of the ups and downs in certain macroeconomic variables which relate to profits in market-driven economies are visible. It is possible to talk about stages, or phases, in economic dynamics of the developed and emerging markets. All that applies today, as the lag in jobs creations, limited loanable funds from the banking system, despite build up in reserves, woes of accelerating inflation linked to food crisis and reliance on energy exports in the emerging markets remain as some of the critical aspects of current development. That leads to possible imbalances and severe social problems, raising the challenge for economists and policy makers in a more informed interpretation of current events and successful future policy designs.

Appendix 1

Imagine the height of a bead as it moves around a wire circle centered at the origin. At first, the height is positive, then declines to zero again, becoming negative, and then returning again to 0. This is the *sin* function, which may be described either in terms of its Euclidean coordinates or in terms of the angle it makes with a drawn radius, Polar coordinates.

$b(c) = y(c) = \mathrm{b}(\theta) = sin(\theta) = sin(x); \theta = x$

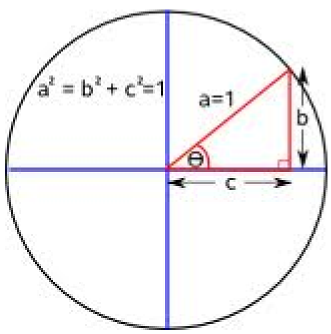

Figure 16: A bead moving around a wire circle

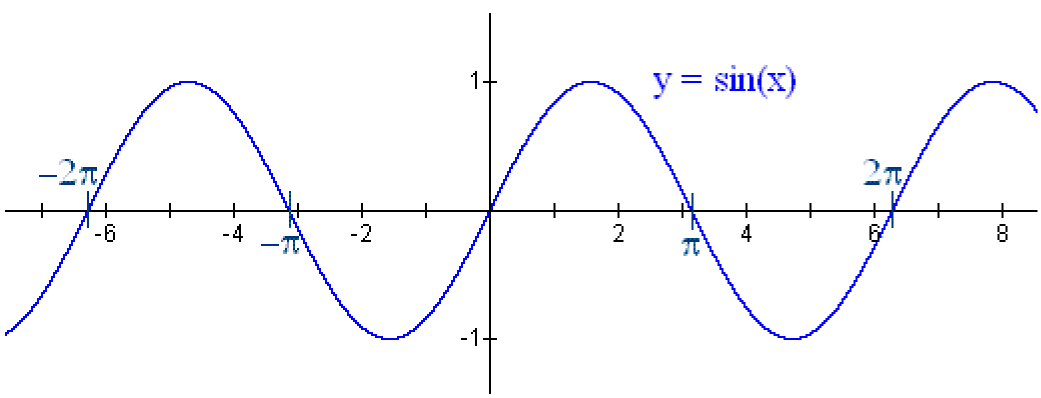

Figure 17: The height, *b*, of the bead expressed as a function of the angle with the center

Appendix 2

Historical Notes:

- (1) Although recognition has come late, the role of Kondratieff cycles proposition today is catching more minds and becoming very influential in macroeconomic analysis. Biographical summaries on Kondratieff and Kuznets Kondratieff, Nikolai D. (1892 – 1938) – was born in Galuevskaya, near Moscow, in the Russian Empire into a peasant family. Initially studying law at the St. Petersburg University he soon shifted to economics, and was tutored by M. Tugan-Baranovsky. Following Russia's 1917 February Revolution, Kondratieff worked on political economy issues of the agrarian reforms in Russia. He was appointed and briefly served as the Deputy Minister of Supplies in the Russia's Provisional Government under A. Kerensky. Following the Bolshevik Revolution of 1917 (in October) Kondratieff concentrated on academic research and from 1919 was closely associated with A.V. Chayanov (Russian economist / anthropologist). In October 1920 he established the Institute of the Conjuncture and dedicated his attention to the analysis of economic conditions in the agrarian sector. His open support for the New Economic Policy and opposition to the official party's preference for heavy industry primacy in the Soviet economy, coupled with his unorthodox views on economic development did not make him popular with the mainstream. By 1928 Kondratieff was removed from his position at the Institute of the Conjuncture, and in 1930 accused of anti-Soviet activity as a member of a "Peasants Labor Party" was arrested and sentenced to eight years in prison. Despite severely deteriorating health in containment he continued working. On September 17, 1938 Kondratieff was sentenced to death with execution on the day the verdict was issued. Kondratieff was fully exonerated (with A.V. Chayanov) in 1987. His books were re-published in Russian by 1989. Before that time Kondratieff's influence in Soviet economics was minimal. In 1992 in memory of N.D. Kondratieff The International N.D. Kondratieff Foundation was established.

- (2) Kuznets, Simon S. (1901 – 1985) – was born in Pinsk, Belarus, in the Russian Empire. After initial schooling in Pinsk, moved to Rovno, and in 1915 due to relocation of Jewish families from the combat lines Kuznets family moved to Kharkiv. There Simon Kuznets studied at the Kharkiv Commercial Institute. In 1921 he worked as a statistician in the Labor Department of the Southern Bureau of the All-Russian Central Trade Union Council. In 1922 Kuznets moved to the USA where he continued his education at Columbia University earning his Ph.D. in 1926. Kuznets worked on analysis of economic patterns in prices at the Social Science Research Council. Between 1930 and 1954 Kuznets taught economics and statistics at the University of Pennsylvania. In 1954 Simon Kuznets was the President of the American Economic Association. Between 1954 and 1960 he taught at John Hopkins University as a Professor of Political Economy. After, through 1971 he taught at Harvard University. Simon Kuznets died on July 8, 1985. Kuznets made significant contributions in national income accounting and systematizing the method for GNP calculation. He received the Nobel Prize in Economics in 1971 for his empirical analysis of economic growth, where he identified a new era of "modern economic growth". His contributions to the contemporary fields of macroeconomic theory and economic development are profound and are critical in modern theoretical methodology. Sources: The International N.D. Kondratieff Foundation http://ikf2009.ru Simon Kuznets, The Library of Economics and Liberty, http://www.econlib.org/library/Enc/bios/Kuznets.html

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