Economic cycles: historical evidence, classification and explication.

Bormotov, Michael

Canadian Economics Association

27 December 2009

Economic Cycles: Historical Evidence, Classification and Explication.

Working paper (the first draft)

By Michael Bormotov

Abstract

Severe economic fluctuations which had recently hit the entire world economy after relatively prosperous decades despite numerous institutional efforts to control them have recalled an interest to the theory of economic cycles. Historical data on main economic indexes and academic evidence show that recurrent fluctuations in the pace of economic growth are consistent over time. Technological revolutions and worldwide implementation of basic inventions are necessarily accompanied by the processes of creative destruction or "sanitation" of the economy, which cause long term economic cycles which appear to be predictable but practically unavoidable. This paper explores the theoretical background and formulates the basics of the mechanism of economic cycles driven endogenously by modern knowledge based economy. It analyses definitions of economic cycles, employs the concept of hierarchical economic cycles, studies the links between inventions, innovations and economic cycles, provides a concept of "economic organism" versus "economic mechanism", gives a definition of "good cycles" versus "bad cycles" and proposes taxonomy of business cycles according to four attributes. This working paper is the first in a range of several papers summarising the intermediate results of research undertaken by the author in order to reconsider and provide explanations on how modern economy creates cyclical movements.

Key words:

economic cycles, creative distraction, basic technology, innovations, endogenous economic growth.

1. Theoretical background.

The myth that fluctuations in economic growth are finally cured with Keynesian tools was discredited by financial cataclysms that have quaked the world economy during recent decades. Monetary and fiscal policies appear unable to overcome the nature of some severe economic cycles that cannot be comprehensively explained inside the framework of neither classical nor Keynesian models. The economy is a subject of evolutionary and revolutionary transformations. Modern economy and the economy to come are not the same that Adam Smith and even John Maynard Keynes described. The industrial economy has been transformed into post-industrial, service-based economy which now is being transformed into modern knowledge based economy. This is a great challenge for economic theory that is expected to deliver an adequate response by creating new economic models.

The foundation underlying modern economic cycles theories was settled by seminal proceedings of Josef Schumpeter, Nicolay Kondratieff and others. Unfortunately the fruitful ideas of those outstanding economists were set aside from mainstream economics due to post World War II decades of economic stability that gave rise to an unlimited faith in omnipotence of the Keynesian formula as a panacea and caused a sort of a common euphoria. "A primary consequence of the Keynesian Revolution was the redirection of research efforts away from this question (*understanding business cycles, M.B.)* onto the apparently simpler question of the determination of output at a point of time, taking history as given. … the most rapid progress towards a coherent and useful economic theory will result from the acceptance of the problem statement as advanced by the business cycle theorists, and not from further attempts to refine the jerry-built structures to which Keynesian macroeconomics had led us. … The abandonment of the efforts to explain business cycles accompanied a belief that policy could effect immediate or very short-term movement of the economy from an undesirable current state, however arrived at, to a better state." (Lucas,1981:215, 216).

The interest in techno-economical growth theories has increased recently due to inability of mainstream schools to provide a cogent and comprehensive explanation of how actual economic cycles work.

In the first quarter of 20th century, macroeconomics theory has been split on long-run approach dealing with macroeconomic trends of growth in time series and short-run approach explaining economic fluctuations around the trend. Later on IS-LM model provided by John Hicks (Hicks, 1937) and the models rooted in Solow (1956) found their division of labour addressing business cycles and growth, respectively. (Louca, 2001), (Dosi, 2008).

Later on, the "Keynesian" microeconomics was attacked by "new classical" theory that claimed its features irrelevant. New Keynesian models were defended on the grounds of informational and behavioural frictions ignoring that such "imperfections" are in fact structural, long-term characteristics of the economy. (Blanchard, 2008), (Dosi, 2008).

DSGE models embrace "fundamental dynamics" and "non-fundamental" shocks but do not pay any respect to Schumpeter theory of endogenous innovations. (Woodford, 2003), (Gali, 2007).

Schumpeterian approach is indeed imbedded in Endogenous growth models and Evolutionary models, but non-fundamental fluctuations do not appear in these models. (Nelson,1982), (Romer, 1990), (Aghion, 1992), (Dinopoulos, 1999).

Giovanni Dosi has recently created the model which attempts to embraces both Schumpeterian and New Keynesian approaches while exploring the feedbacks between the factors influencing aggregate demand and those driving technological change. (Dosi, 2008).

Despite great improvements in the integrated theory of economic cycles there is still an array of ambiguous questions to be explored and clarified by modern economics. "The incorporation of cyclical phenomena into the system of economic equilibrium theory, with which they are in apparent contradiction, remains the crucial problem of the Trade Cycle Theory." (Hayek,1933; cited from Lucas, 1981:215).

2. The definition of Economic cycle

The term business cycle (or economic cycle) refers to economy-wide fluctuations in production or economic activity over several months or years. These fluctuations occur around a long-term growth trend, and typically involve shifts over time between periods of relatively rapid economic growth (expansion or boom), and periods of relative stagnation or decline (contraction or recession). (Sullivan, Sheffrin, 2006).

These fluctuations in economic activity are usually measured by the growth rate of real gross domestic product and despite being recurrent they do not follow any strict harmonic pattern.

According to the NBER, a recession is a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment, industrial production, and wholesale-retail sales. (NBER, USA).

According to the Government of Canada definition, business cycles are periodic swings in an economy's pace of demand and production activity. These cycles are characterized by alternating phases of growth and stagnation. A period in which real GDP is rising steadily is called an economic expansion, and a period in which it is falling steadily is called a recession. The early stage of an expansion, following a recession, is called an economic recovery. (Government of Canada, 2009)

The widely accepted definition of business cycles refers to Arthur F. Burns' and Wesley C. Mitchell's definition: "Business cycles are a type of fluctuation found in the aggregate economic activity of nations that organize their work mainly in business enterprises; a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; in duration, business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar characteristics with amplitudes approximating

their own." (Burns, 1946.)

Other similar definitions is given in (Burns, 1951): "Business cycles are not merely fluctuations in aggregate economic activity. The critical feature that distinguishes them from the commercial convulsions of earlier centuries or from the seasonal and other short term variations of our own age is that the fluctuations are widely diffused over the economy – its industry, its commercial dealings, and its tangles of finance. The economy of the western world is a system of closely interrelated parts. He who would understand business cycles must master the workings of an economic system organized largely in a network of free enterprises searching for profit. The problem of how business cycles come about is therefore inseparable from the problem of how a capitalist economy functions."

3. Historical data and academic evidence of economic cycles.

Business cycles do not exhibit strict patterns or harmonic style oscillations. Periods of prosperity and periods of downturn rotate necessarily with certain regularity. Even in Bible one can find the evidence of cycles rocking the ancient economy: "And so the seven good years in Egypt came to an end. Then came the first of the seven years of need as Joseph had said…" (Genesis 41:53,54.)

The explanation of fluctuations in aggregate economic activity is one of the primary concerns of economics. In 1860, a French economist Clement Juglar identified the presence of economic cycles that are 8 to 11 years long, although he was cautious not to claim any rigid regularity. (Lee, 1955).

In the mid-20th century Joseph Schumpeter argued that a Juglar cycle has four stages: (i) expansion (increase in production and prices, low interests rates); (ii) crisis (stock exchanges crash and multiple bankruptcies of firms occur); (iii) recession (drops in prices and in output, high interests rates); (iv) recovery (stocks recover because of the fall in prices). In this model, recovery and prosperity are associated with increases in productivity, consumer confidence, aggregate demand, and prices. Schumpeter also proposed a typology of business cycles according to its periodicity,

so that a number of particular cycles were named after their discoverers or proposers (Schumpeter,1954):

- the Kitchin cycle of 3–5 years;
- the Juglar cycle of 7–11 years;
- the Kuznets cycle of 15–25 years;
- the Kondratieff wave or cycle of 45–60 years.

"The Kitchin inventory cycle - a pattern of fluctuations of growth rates of three or four years. Now, probably, is replaced by political cycle of the same length... Juglar or investment cycle … has a length of seven to eleven years... Kuznets cycle, of some fifteen to twenty five years... The Kondratiev cycle, or long wave, of some forty five to sixty years... Growth rates in the world economy have conformed very well to a long wave pattern, with a downswing in the 1930s and early 1940s and again since the mid-1970s, an upswing in between." (Tylecote, 1993)

According to Schumpeter, one of the reasons why the economic crisis of 1929-33 was so severe is a coincidence of troughs of Kitchin, Juglar and Kuznets cycles. The downturn in each cycle reinforced the downturn in the other cycles. However, most of the time, according to Schumpeter, the various cycles cross one another—a peak in one might correspond to a trough in another, thereby creating business conditions that are somewhere between all-out boom on one hand and the extreme crisis conditions on the other.

The National Bureau of Economic Research (NBER) keeps track of economic fluctuations in US since the end of 18-th century and has recognized business cycles since 1854 (Table 1).

Table 1. Business cycles indicated by NBER.

BUSINESS CYCLE REFERENCE DATES		DURATION IN MONTHS			
Peak	Trough	Contraction	Expansion	Cycle	
Quarterly dates are in parentheses		*Peak to Trough*	*Previous trough to this peak*	*Trough from Previous Trough*	*Peak from Previous Peak*
	December 1854 (IV)	--	--	--	--
June 1857(II)	December 1858 (IV)	18	30	48	--
October 1860(III)	June 1861 (III)	8	22	30	40
April 1865(I)	December 1867 (I)	32	46	78	54
June 1869(II)	December 1870 (IV)	18	18	36	50
October 1873(III)	March 1879 (I)	65	34	99	52
March 1882(I)	May 1885 (II)	38	36	74	101
March 1887(II)	April 1888 (I)	13	22	35	60
July 1890(III)	May 1891 (II)	10	27	37	40
January 1893(I)	June 1894 (II)	17	20	37	30
December 1895(IV)	June 1897 (II)	18	18	36	35
June 1899(III)	December 1900 (IV)	18	24	42	42
September 1902(IV)	August 1904 (III)	23	21	44	39
May 1907(II)	June 1908 (II)	13	33	46	56
January 1910(I)	January 1912 (IV)	24	19	43	32
January 1913(I)	December 1914 (IV)	23	12	35	36
August 1918(III)	March 1919 (I)	7	44	51	67
January 1920(I)	July 1921 (III)	18	10	28	17
May 1923(II)	July 1924 (III)	14	22	36	40
October 1926(III)	November 1927 (IV)	13	27	40	41
August 1929(III)	March 1933 (I)	43	21	64	34
May 1937(II)	June 1938 (II)	13	50	63	93
February 1945(I)	October 1945 (IV)	8	80	88	93
November 1948(IV)	October 1949 (IV)	11	37	48	45
July 1953(II)	May 1954 (II)	10	45	55	56
August 1957(III)	April 1958 (II)	8	39	47	49
April 1960(II)	February 1961 (I)	10	24	34	32
December 1969(IV)	November 1970 (IV)	11	106	117	116
November 1973(IV)	March 1975 (I)	16	36	52	47
January 1980(I)	July 1980 (III)	6	58	64	74
July 1981(III)	November 1982 (IV)	16	12	28	18
July 1990(III)	March 1991(I)	8	92	100	108
March 2001(I)	November 2001 (IV)	8	120	128	128
December 2007 (IV)			73		81
Average, all cycles:					
1854-2001 (32 cycles)		17	38	55	56
1854-1919 (16 cycles)		22	27	48	49*
1919-1945 (6 cycles)		18	35	53	53
1945-2001 (10 cycles)		10	57	67	67

Andrew Tylecote provides a following average timeframes for long-term business cycles (Table 2).

Table 2. World economic growth – a long wave pattern.

1850 – 1870	**Upswing**
1870 – 1890	**Downswing**
1890 – 1913	**Upswing**
1913 – 1929	**? ?**
1929 – 1947	**Downswing**
1947 – 1973	**Upswing**
1973 – 1990	**Downswing**

Source: Tylecote, 1993,

The historical picture of international economy growth is shown in Table 3.

Table 3. Growth rates of industrial production

	UK		**US**		**Germany**	
2nd Kondratiev						
upswing	**1845 - 1873**	**3.0**	**1864 - 1873**	**6.2**	**1850 - 1872**	**4.3**
downswing	**1873 - 1890**	**1.7**	**1873 - 1895**	**4.7**	**1872 - 1890**	**2.9**
3rd Kondratiev						
upswing	**1890 - 1913**	**2.0**	**1895 - 1913**	**5.3**	**1890 - 1913**	**4.1**
	1920 - 1929	**2.8**	**1920 - 1929**	**4.8**	**1920 - 1929**	
downswing	**1929 - 1947**	**2.1**	**1929 - 1947**	**3.1**	**1929 - 1947**	
4rd Kondratiev						
upswing	**1948 - 1973**	**3.2**	**1948 - 1973**	**4.7**	**1948 – 1973***	**9.1**
	France		**Italy**		**Sweden**	
2nd Kondratiev						
upswing	**1847 - 1872**	**1.7**				
downswing	**1872 - 1890**	**1.3**	**1873 - 1890**	**0.9**	**1870 - 1894**	**3.1**
3rd Kondratiev						
upswing	**1890 - 1913**	**2.5**	**1890 - 1913**	**3.0**	**1894 - 1913**	**3.5**
	1920 - 1929	**8.1**	**1920 - 1929**	**4.8**	**1920 - 1929**	**4.6**
downswing	**1929 - 1947**	**-0.9**	**1929 - 1947**	**0.5**	**1929 - 1947**	**4.4**
4rd Kondratiev						
upswing	**1948 - 1973**	**6.1**	**1948 - 1973**	**7.9**	**1948 - 1973**	**4.7**

**1948 -73 West Germany*

Source: *Tylecote, 1993*

The is another one interesting but debatable and not purely classical approach to time scale systematisation of economic cycles in four groups (the super long cycle with duration averages 53-54 years; the long cycle with length of about 18 years; the medium cycle coverings approximately 10 years and the short term cycle averaging 5 years). (Table 4.)

Table 4. Peaks (P) and Throats (T) in GDP deviations from the trend 1858 - 1933

Super long	Long	Medium	Short	Super long	Long	Medium	Shorts
1787 T			1787	1867 P	1858-1879	1867-1879	1870
			1793		1879	1879-1885	1879
	1798	1798-1805	1798			1885	1885
		1805	1805				1888
			1809				1890
1816 P			1812	1897 T	1897	1897	1893
1816 P		1819	1816	1897 T	1897	1897	1897
	1819	1819-1829	1819				1900
		1829	1829			1908	1903
1843T		1843	1838			1908	1908
1843 T	1843	1843-1849	1843		1914		1911
		1849	1849		1914		1914
		1858	1855	1921 P		1921	1919
	1858-1879	1858	1858	1921 P		1921	1921
1867P		1867	1861				1924
1867 P		1867-1879	1867		1933	1933	1927
					1933-??	1933-??	1933

Source: *Alexander, 2002.*

The great contribution to the theory of economic cycles had been provided by Moses Abramovitz: "… to reveal the secular trend in output we calculate moving averages for period long enough (nine- year, for example) to eliminate business cycles *(seasonal and short term regular fluctuations in output, M.B.)*, the resulting curve of output for the period since 1870 still reveals striking fluctuations – not in the level on output but in its rate of growth." (Abramovitz, 1989: 140).

" Kuznets find three complete swings in the rate of growth in the period since 1870 and one incomplete swing – a rise beginning 1932 and tentatively reaching its peak in 1945. The suggested chronology runs as follows:

Through	Peak
1873	1884
1892	1903
1912	1926
1932	1945

Table 5. *Saurce*: *Abramovitz, 1989: 140, 146.*

"Finally, we must consider the fact that, among the several elements of general Kuznets swing is a long wave in capital formation. This wave derives in part, though not entirely, from the well-known long cycles in railroad construction, in residential building and in construction of associated community facilities and consequently is associated with the wave in population growth…" (Abramovitz, 1989:258)

Freeman and Louca, (2001) have made vide historical research and systematized a big deal of key proceedings related to long-term economic cycles (Table 6) and particularly Kondratiev waves (Table 7).

Table 6. Timeframes of long term economic cycles

Author/ period	**First LW**		**Second LW**		**Third LW**	
	Upswing	**Downswing**	**Upswing**	**Downswing**	**Upswing**	**Downswing**
Engels		1825 – 42	1842 – 69	1869 – …		
Pietri-Tonelly			1852 – 73	1873 – 97	1897 – 1913	
Bresciani-Turroni			1852 – 73	1873 – 97	1897 – 1913	
Van Gelderen			1850 – 70	1870 – 95	1895 – …	
De Wolff		1825 – 49	1850 – 73	1873 – 95	1895 – …	
Trotsky	1781 - 1851		1851 – 73	1873 – 94	1894 – 1913	
Kondratiev	1780/90 – 1810/17	1810/17 – 1844/45	1844/45 – 1870/75	1970/75 – 1891/96	1891/96 – 1914/20	1920 – …

Source: Freeman,2001.

Table 7. Condensed summary of Kondratiev waves

Constellation of technical and organizational innovations	**Examples of successful, visible and profitable innovations**	**"Carrier" branch and leading branches of economy**	**Core input and other key inputs**	**Transport and commu-nication infrastruc-ture**	**Managerial and organoza-tional changes**	**Approx. upswing/ downswing**
Water -powered mechanisation of industry	Arkwright's Cromford mill (1771) Henry Cort's "pudding" process (1784)	Cotton spinning Iron products Water wheels Bleach	Iron Row cotton Coal	Canals Turnpike roads Sailing ships	Factory systems Entrepreneurs Partnerships	1780s – 1815 / 1815 – 1848
Steam- powered mechanisation of industry and transport	Liverpool – Manchester Railway (1831) Brunel's "Great Western" Atlantic steam ship (1838)	Railways and railway equipment Steam engines Machine tools Alkali industry	Iron Coal	Railways Telegraph Steam ships	Joint stock companies Subcontracting to responsible craft workers	1848 – 1873/ 1873 – 1895
Electrification of industry, transport and	Carnegie's Bessemer steel rail plant	Electrical equipment Heavy	Steel Copper Metal alloys	Steel railways Steel ships Telephone	Specialized professional management	1895 – 1918/ 1918 – 1940

the home	(1875) Edison's Pearl St. New York Electric Power Station (1882)	engineering Heavy chemicals Steel products			Systems "Taylorism" Giant firms	
Motorisation of transport, civil economy and war	Ford's Highland Park assembly line (1913) Burton process for cracking heavy oil (1913)	Automobiles Trucks Tractors Tanks Diesel engines Aircrafts Refineries	Oil Gas Synthetic materials	Radio Motorways Airports Airlines	Mass production and consumption "Fordism" Hierarchies	1941 – 1973/ 1973 –
Computerization of entire economy	IBM 1401 and 360 series (1960s) Intel micro-processor (1972)	Computers Software Telecommu-nicaion equipment Biotechnology	"Chips" (integrated circuits)	Internet	Internal, local and global networks	

Sours: Freeman, 2001:142

4. Vision of different schools on how economic cycles are driven

Every economic school of thought (Classic, Neo-Classic (RBC), Keynesian, Neo-Keynesian, Austrian, Endogenous, and Techno-Economical) provides its own explication on how economic cycles are driven. (Table 6)

Table 6. The basic phenomena that cause economic cycles.

Economics school	**Main driving engine**
Classical	Government interference, market freedom limitation
Keynesians	Low spending
New classical (RBC)	Exogenous shocks
New Keynesians	Prices and wages stickiness.
Austrians	Monetary intervention of Central banks
Endogenous	Technological breakthrough
Others	Sun and moon phases, elections, biological cycles, wars, etc.

Sometimes it appears to be a tautology in argumentation. Which came first the chicken or the egg? Low demand induces low supply, that leads to unemployment growth, that causes monetary injections, that induce inflation and make the investment bubble arise, that causes a financial system crisis, that requires sanitation,

that leads to re-allocation of resources, that pushes economic activity, that induces a rise in employment, that leads to a rise in demand growth, that leads to a rise in prices, that leads to real demand fall, etc. This is a circle chain. One can start pooling from any link and turns over the entire chain. (Table 7)

Table 7. Techno-Economic mechanism of different typology' economic cycles.

Type of cycle	Underlying Techno-Economic mechanism
Kitchin	Overshoots and undershoots of business inventories: recovery from recession left firms short of stocks which they then strove to rebuild. Suddenly they found they have succeeded all too well, and were obliged to cut back orders and output accordingly; which depressed the economy, and by doing so caused a further involuntary pile-up of stocks.*
Juglar	Assets reallocation inside sectors of economy. Investment in fixed assets overshoots at the peak, giving excess capacity, and undershoots at the through. The longer period between peaks and through reflects the slower process of adjustment involved.*
Kuznets	Assets reallocation between existent sectors of economy and territories, that requires substantial investment in infrastructure, particular in building
Kondratiev	Fundamental assets reallocation due to new sectors creating and structural reconstruction of entire economy on new generation technological base

(*) – Tylecote, 1993

Economic cycles are basically driven by complex of natural, technological, economical, financial and political causes.

"Technically, movements about trend in GNP in any country can be well described by a stochastically disturbed differential equations of very law order… Those regularities … are in the co-movements among different aggregative time series.

The principle among these are the following:

(i) Output movements across broadly defined sectors move together (high conformity, high coherence).

(ii) Production of producer and consumer durables exhibit much greater amplitude then does the production of non-durables.

(iii) Production and prices of agricultural goods and natural resources have lower

than average conformity.

(iv) Business profits show high conformity and much greater amplitude than ether series.

(v) Prices generally are pro-cyclical; long term rates slightly so.

(vi) Monetary aggregates and velocity measures are pro-cyclical….

Business cycles are all alike". (Lucas,1981:217, 218)

From our point of view there are no "right" and "wrong" theoretical explications on how business cycles work. The underlying core economical problem is so complicated and complex itself, that it pools out an adequate multifaceted explication. All and every schools possess and deliver a true judgment, but not a comprehensive or final one. A permanent evolution is an attributive characteristic of an economic system, therefore the mentioned economics theories, by influencing each other, are hopefully moving to some kind of positive diffusion and convergence.

5. The concept of Hierarchical Economic Cycles

Following Marshall, Schumpeter and Frisch traditions let us assume that the process of application and co-movement of economic cycles of different nature can be illustrated by a system of four swinging pendulums, organized in a hierarchical order. Top level applies to the super-long time Kondratieff cycle, second level refers to the long time Kuznets cycle, third corresponds to the Juglar and the bottom level simulates the Kitchin inventory cycle. The pendulums are of different sizes, they can swing freely and are attached one to the other hierarchically – the biggest one is at the top and the smallest one is at the bottom. Let us assume that the top pendulum is attached to a slow forward-upward moving escalator (Figure 1.). Every pendulum follows its own trajectory and because of inertia passes the static equilibrium point and swings further to the point of dynamic equilibrium and back. The bottom pendulum is involved in a complicated movement that results from an application of movement of all overlying pendulums and its own swings. That combined movement appears to be very complicated and difficult for mathematical analysis.

For the case of one single pendulum the general solution for the equation of may be given as following

$$\Theta(t)=H\, e^{-\beta t}\, sin(\varphi - \alpha t)$$

where β is the parameter for friction, α is a frequency, φ the phase and H the amplitude. (See more at Lucas, 1981)

In case of four pendulums the awful system of four differential equations extremely difficult for analytical solution arises. It appears to be too complicated and hardly fruitful to dig any further than a mere graphic illustration.

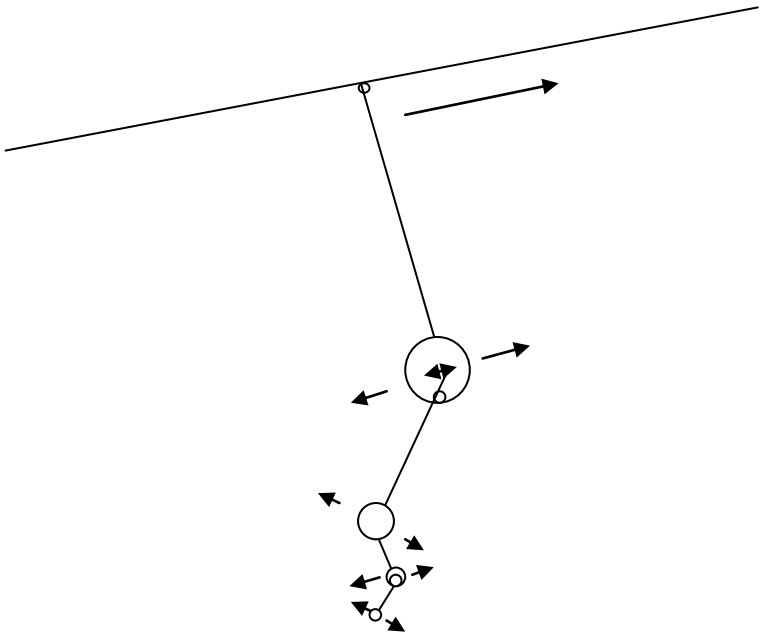

Figure 1. Hierarchy pendulum system

The point where the pendulum stops and starts moving backward is where the force of inertia becomes equal to the force of gravity. “Gravity” for “economic pendulum” is represented by market self-regulating force, that pushes the economy towards its static equilibrium, and “inertia” is represented by the human nature. This point requires some explications. Economic agents are represented on the market by human beings. Due to their nature, humans often overvalue their own experience and consequently default to resist to innovations. Furthermore, economic agents need

time in order to react properly on oncoming events that drive the economy away from the balance.

We recognize seven steps on the way from the event occurred to the reaction carried out: recognition; cognizance; comprehension; exploration; decision; preparation; action. The bigger the economy, the more time it requires to react. We consider this phenomenon as an economical analog for physical inertia.

6. Inventions, innovations and economic cycles.

Since Adam Smith to now all economic schools recognize in some way technological improvements as an important factor of economic growth. "The invention of all those machines by which labour is so much facilitated and abridged, seems to have been originally owing to the division of labour" (Smith, 1776/1937 :9) "The basic hypothesis was refined and extended over time by Karl Marx, Joseph Schumpeter, and Robert Solow, among others. Yet, obtaining independent measures of the rate at which capital embodied (or "investment-specific") technological change has progressed has long eluded us. Absent knowledge of this rate, it is impossible to correctly measure the *productive capacity* of the economy's capital stock." (Wilson, 2003). At least Kondratiev, Kuznets and Juglar cycles have their roots in technological ground.

Significant links between long term waves of innovation activity and economic waves fluctuations are illustrated by the following table (Table 8)

Table 8. Correspondence between long term economic and innovative waves.

	Downswing	**Upswing**	**Downswing**	**Upswing**	**Downswing**
Economic wave	**1873 – 1893**	**1893 – 1913**	**1913 – 1939**	**1939 – 1974**	**1974 –**
Innovative wave	**1961 – 1881**	**1981 – 1901**	**1901 – 1927**	**1927 – 1962**	**1962 –**

Source: Kleinknecht, 1990.

The importance of technological changes leading to productivity growth and the emergence of new products is now recognised by practically all mainstream economic theories. The relationship between technological change and economic

growth and development can be tracked from a variety of theoretical perspectives (see Verspagen, 2004). Technological changes depends not only on the work by scientists and engineers, but also on a wider range of economic and societal factors, including institutions such as intellectual property rights and corporate governance, the working of markets, a range of governmental policies (science and technology policy, innovation policy, macroeconomic policy, competition policy, etc.), historical specificities, etc. (Verspagen, 2007).

Any economic models work inside certain technological concepts, employed by the economy in a particular period of time. (Figure 2).

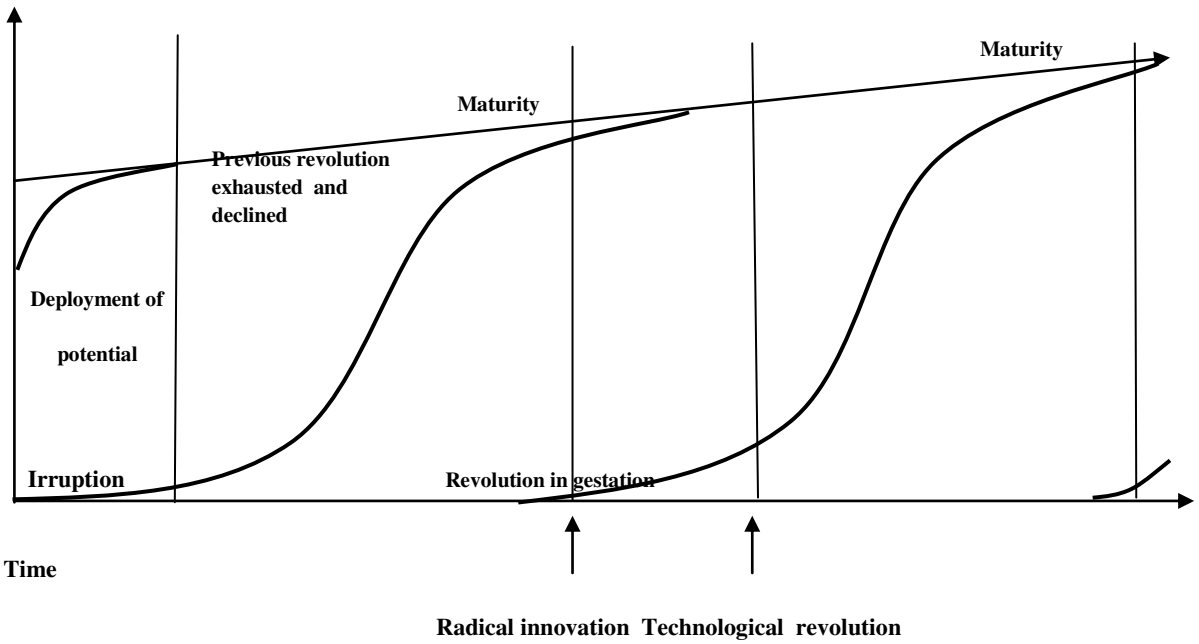

Figure 2. The life trajectory of technological revolution
(Sourse: Perez, 2004)

The evolution of economy is based on the evolution of knowledge in general and on the evolution of technological knowledge in particular.

Let us to bring up some example. Steam engine passed through several generations and every next one was showing better performance than previous models. But electric engine appeared and overcame steamers. Even the worst of electric machines have been demonstrated some better performance than any of the best steam driven предок. Similar story happened with hors driven cards and

automobiles. The entire industry had passed away.

Some authors name those basic, changing the map technologies as General Purpose Technologies. From our point of view the term Basic Technologies sounds more as precision. Changes in the base consequently and necessarily trigger the process of changing in all other related elements of economic system.

The phenomenon of obsolesce leads to diminishing return that stimulate business to undertake innovative activities such as investing in new R&D, imitation or even illegally reproducing existing inventions. Rate of return on intensive investments in innovated product is higher than on extensive one. This economic fact makes innovations so attractive. Business invests in R@D in order to increase returns and fill up full market capacity. Customers do not use to run product related R@D. They chose among products existing on the market.

In fact, Schumpeter's concept of innovation goes far beyond technological change in the narrow sense. He is concerned with what he calls "the carrying out of new combinations" interpreted broadly. (Langlois, 1991).

"The concept covers the following five cases:

(1) The introduction of a new good – that is one with which consumers are not yet familiar -- or of a new quality of a good.

(2) The introduction of a new method of production, that is one not yet tested by experience in the branch of manufacture concerned, which need by no means be founded upon a discovery scientifically new, and can also exist in a new way of handling a commodity commercially.

(3) The opening of a new market that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before.

(4) The conquest of a new source of supply of raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created.

(5) The carrying out of the new organisation of any industry, like the creation of a monopoly position (for example through trustification) or the breaking up of a monopoly position." (Schumpeter 1934, p. 66).

According to Freeman interpretation (Freeman, 1982) business (endogenous scientific and technical activities conducted by large firms) seize upon … basic inventions and transforms them into economic innovations. Inventive activities are increasingly under the control of large firms and reinforcing their competitive position. The successful innovators reap large short-term profits, which are soon bid away by imitators. The effect of the innovations is to disequilibrate and to alter the existing market structure – until the process eventually settles down in wait for the next wave of innovation. The result is a punctuated pattern of economic development that is perceived as a series of business cycles. (Cited from Langlois, 1991).

Any production function on default is considered to be linked to a time scale. An increase in stock capital ΔK means that the amount ΔK is invested in fixed assets at the moment t or during the period ΔT and time matters. (Figure 3)

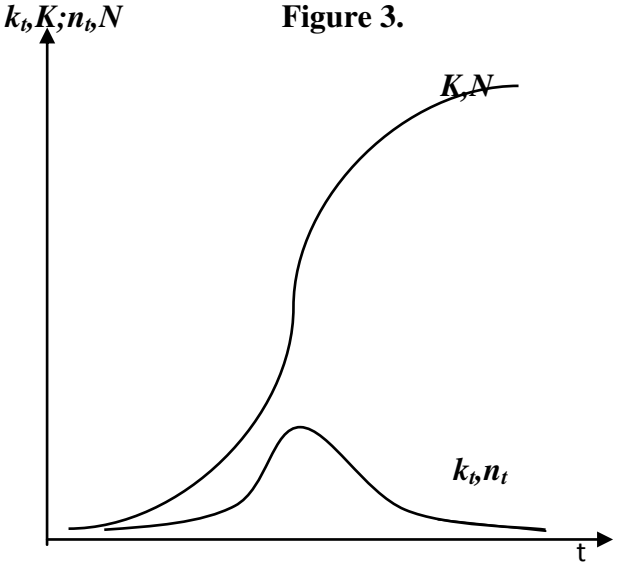

Figure 3.

K, N – total investments and total number of firms that inter the particular sector of market during period [0,t] retrospectively.
k_t, n_t – value of investments and number of firms that came in period t retrospectively

Economic stagnation appears when the potential of employed basic technology is finally exhausted and the market capacity for related products is full, so further investments does not bring extra yields. Losses are caused by ineffective utilisation

of recourses, over stock, etc. Production gets slow and shuts down; facilities must be sold or rebuilt; stocks are to be liquidated. Capital moves to another sector.

Forrester (1977) concludes that sufficient causes for long waves are the long lifespan needed to change the production capacity of the capital sectors, the way capital sectors provide their own input capital as a factor of production, the need to develop excess capacity to catch up on deferred demands, and psychological and speculative forces that can cause overexpansion in the capital sector. (Berry, 1991:51)

Investors follow either aggressive, conservative, or mixed strategies. An experienced investor will never put an excessive amount of money into a risky project, with no market evidences of returns. So, in the beginning, serious investors are watching and waiting for the first business results to appear. Meanwhile these investors' capital is being stored in safe shelters (government bonds, real estate, saving accounts, etc.) So, k_t is growing slowly. After the apparition of reliable evidence, after it is delivered and received, the capital starts to hurry in order to occupy a profitable sector. Capital reallocation takes time. It is not like moving boxes in the garage or shutting down a faucet and opening another one. So, economy possesses some significant inertia and requires a substantial period of time to come up with a proper reaction. The more the mass is, the more the inertia is. The mass of the economy refers to its size, indicated for instance by GDP. So, it appears that an economy contains a retarding mechanism inside itself.

7. Organism versus Mechanism and "Good cycles" versus "Bad cycles".

Basic inventions may be so general, that they do not generate any economic effect by themselves. Those inventions increase stock of knowledge only and create the platform for consequent minor inventions and innovations that generate economic effect and become instrumental in economic development. That are consequent innovations who drive period of economic prosperity. When all innovative potential contained in the basic invention is extracted, processed and employed the flow of

consequent innovations abates and peters out. No more marketable innovations on former platform are possible. It leads to a slowdown in economic growth and stagnation. Business realises that and starts aggressively seeking for new technological concept by increasing investments in R@D. Those efforts sooner or later necessarily result in invention of new basic technological concept. After that the period of creative destruction begins. Structural reconstruction of key sectors drives entire economy into period of turbulence that causes fundamental downswing. Any minor fluctuations despite of demonstrating short term upswings follow in average that general trend. After on the period of turbulence switches over to period of stability and growth. Dense surge of consequent inventions arises and brings numerous business opportunities. New period of prosperity arrives.

Depression is a term for future expansion. Stagnation is a necessary round of techno-economic evolution when economy reallocates and accumulates recourses required for future growth. Innovation, that is, propels the capitalist economy with "gales of creative destruction," the memorable phrase that Schumpeter borrowed from Werner Sombart (Sombart, 1916/2001). Schumpeter characterized innovation as "industrial mutation," which "incessantly revolutionizes the economic structure *from within*, incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism. It is what capitalism consists in and what every capitalist concern has got to live in. . . ." (Schumpeter, 1950: 83). (Sited from McCraw, 2006).

"Capitalist reality as distinguished from its textbook picture, it is not [textbook] . . . competition which counts but the competition from the new commodity, the new technology, the new source of supply, the new type of organization (the largest-scale unit of control for instance) – competition which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives" (Schumpeter, 1950: 82).

All those spectacular perturbations are performed on the stage of market and obey market rules. Business hunts for innovations just because of profit that shrinks and drops down to zero when market capacity for obsolesce technology bearing commodities gets full.

Concluding the mentioned above, it appears that the economic cycle is not pure evil, though it hearts the economy.

Let us employ an analogy between the economy and a living organism, a human being, for instance. It looks some reasonable, because economic relations are relations among people, not among mechanisms or materials.

In 1923, answering to the critiques … Kondratiev stated, that the economy is an irreversible and dynamic process, comparable to an organism with cyclical functions (blood circulation, nutrition) and irreversible processes (Kondratiev, 1923: 496, quoted at Freeman, 2001:83).

Even more straight analogy between an economy and a living organism is given by Schumpeter: "…if we deal with, say, the organism of a dog, the interpretation of what we observe divides readily into two branches. We may be interested in the processes of life going on in the dog, such as the circulation of the blood, its relation to the digestive mechanism, and so on. But however completely we master all their details, and however satisfactorily we succeed in linking them up with each other, this will not help us to describe or understand how such things as dogs have come to exist at all. Obviously, we have here a different process before us, involving different facts and concepts such as selection or mutation or, generally, evolution. In the case of biological organisms nobody takes offense at the distinction. There is nothing artificial or unreal about it and it comes naturally to us; the facts indeed impose it on us." (Schumpeter, 1939: 28, 29).

It appears difficult or even impossible to make sound judgements about how economy grows if the economic order is taken as a mechanism rather than an organism. A genuine economic order differs from a mechanism or machine in a number of ways. The fundamental difference is that a true economy is from nature, whereas the machine is from man. The physical organism is an indivisible entity composed of whole natural parts, each having its own operation, but all contributing to the welfare of the whole body. The mechanism is composed of many artificial substances combined by art. (Young, 1997).

Let us consider some characteristics of a physical organism which are applicable on the economy (Woodbury, 1951, p. 310):

1. It is heterogeneous: it has many parts, each different from the others.
2. Each part has a special operation.
3. Each is so related to the other parts that its operation tends to the good of the whole body.

The economy is from nature in the sense that it is required by human nature and its essential features are from human nature. (Young, 1997). The economy has many parts in the sense of the millions of individuals who constitute it, and also in the sense that it is made up of many groups such as authorities, workers, investors, consumers, etc. Each of these has a special part to play in the whole. This part tends, from its nature, to the good of the whole. "Whereas a machine functions by man and for man, the organism constructs itself by the forces which lie hidden within it". (Woodbury, 1951, p. 309).

The activities proper to living beings remain within the operant, perfecting it. Knowledge, for instance, remains within the knower as a perfection of himself. Likewise, when people form an economic society, the activities in which they engage (provided these are in accord with the natural laws that should regulate the economy) contribute to the perfection of the whole economic body. They generate a marvellous common good in which any number of people can share without it being diminished. (Young, 1997).

If the economy was a mechanism, it could be designed and drove like a machine. But because it is an organism, the desire to invent and mechanically compose a new perfect economy appears in some sense akin to Dr. Frankenstein' experiments. Economical behaviour can hardly be adequately controlled by simple mechanical tools.

Humans have to work in order to have food, so does the economy. Humans need nutrients – economy needs production factors. Humans must sleep at nights, have fun on weekends and enjoy vocations at least once a year, otherwise they cannot work productively. Human organism requires proper rest in order to get recovered, i.e. to collect and save enough power for caring out the following hard day at work. Something similar happens to the economy. After hard work it needs a break in order to re-allocate resources, to accumulate sufficient capital (both investing and human)

and to sanitise itself of dead or incapable of surviving cells and elements. If any person pushed himself to work too hard and too long over its individual capacity, he would necessarily fall ill or even pass away unnaturally. A parallel thing happens to the economy. Once again, the economic cycles that interest us refer to structural reconstruction, assets reallocation, physical capital rebuilding and redevelopment of infrastructure due to technological revolutions breakthroughs and major improvements in general purpose technology. They are considered to be unpreventable and unavoidable. They are moreover considered to be of "creative destruction" that drives the economy forward. This group of cycles is denoted as "good cycles".

But there is another story, when the human is a drinker, or gambler, a slob or merely fool. Such an individual may not work enough or work, running "monkey business", can sleep and rest too much, use his time inefficiently, make unaffordable debts, and ruin his body, etc. As for an economy it means inadequate institutional regulation, overdriving or over speeding the economy. Those economic cycles are considered preventable and avoidable thus denoted as "bad" cycles.

To keep running household while weekend and vocations, when no wages come human have to keep some saving, sufficient for surviving. So the economy should do – to keep proper reserves for "rainy days" and to use all it means to shorter the duration of turbulent "creative destruction periods". That is all what institutions may undertake in order to smooth over the "good" cycles.

Vice versa, the "bad cycles" are subject of institutional regulation improvement and so are reasonably put in focus of almost every of mainstream economic theories.

There are three groups of causes that make economic cycles to move: directly unmanageable (scarcity of natural non-renewable recourses – oil, coil etc.), slow manageable (knowledge) and manageable (taxes, money supply, interest, government spending, subsides, wages, prices and import regulation, etc.).
The "manageability" of economy is limited; hence either "overdrive" or "poor drive" causes unwanted economic fluctuations. Implementation of Keynesian's tools is able to smooth over minor economic fluctuations, while long cycles left unaffected.

8. The proposed taxonomy of business cycles.

The taxonomy employed in present paper categorizes economic cycles according to several attributes of classification, namely: duration, severity, the nature of underlying techno-economic processes, manageability and preventability by institutions.

By duration from through to through or from peak to peak there are recognized four typical time frames of economic cycles:

- cycles, with duration 50 – 60 years;
- cycles with duration 25 – 30 years;
- cycles with duration 10 – 12 years;
- cycles with duration 5 – 7 years.

Economic cycles are categorized here by a magnitude of severity which is recognized as a continuance of recession (significant decline in economic activity visible in real GDP, according to the NBER*),* in three groups:

- extra severe, over 5 sequential years;
- severe, 3 – 5 sequential years;
- moderate, less than 3 sequential years.

By the nature of underlying techno-economic processes economic cycles are divided in five groups:

- economic cycles caused by technological revolutions which affect the fundamentals of economic system;
- economic cycles driven by major basic inventions that cause structural changes and create a base for upcoming basic inventions;
- economic cycles driven by basic inventions that cause surge of consequent minor inventions and innovations;
- economic cycles caused involuntary by inadequate institutional, entrepreneur and customers behaviour leading to inflation and overshoots or undershoots of business inventories.
- economic cycles occurring due to “force major”: nature cataclysms, wars, pandemics, etc.

The real rate of manageability and preventability, or at least ability to smooth the

severity of economic cycles, is floating somewhere between the classical economics concept of "laisser passé" and the communist concept of "planned economy". Since the economy is considered to be partially manageable, economic cycles are not completely avoidable, but are subject of "smoothing" regulations. Therefore in this paper economic cycles are categorized as the following:

- preventable economic cycles; in that category fall all cycles caused by human (institutions, entrepreneur and customers) behaviour;
- unpreventable but partially manageable economic cycles; cycles of all other nature fall in that category.

Concluding Remarks

1. There are strong empirical evidences that economic cycles are the matter of reality and exhibit recurrent fluctuations around trend do not following harmonic or any other strict oscillation pattern.

2. Economic cycles demonstrate fluctuations in temps of growth rather than alternating upswings and downswings of total output.

3. Economic cycles may be categorized according to five attributes of classification: duration, severity, the nature of underlying techno-economic processes, manageability and preventability by institutions.

4. Economic cycles are not limited to particular sector but hurt entire economy, group or economies or entire world economic system.

5. Economic system is rather organism then mechanism. The problem of how business cycles are driven is inseparable from the problem of how an economy functions.

6. Technological revolutions and general purpose technology breakthroughs cause long term "creative destruction" economic cycles.

7. The lag between destruction of old technology infrastructure and development of new infrastructure initiates a period of economic turbulence, which causes economy slowdown. The core economic processes represent during the period of creating destruction are: resources reallocation, capital reinvestment and sanitation.

8. The process of creative destruction has to overcome resistance and inertia of

economic system, hence extra investment resources are required. That is why the economy agents tend to increase savings rather than spending, and economy slows dawn.

9. The shorter period of structural reconstruction, the less it hurts the economy. Duration of the period depends on the speed of knowledge diffusion, which in turn depends on investment in knowledge.

10. There are three groups of causes that drive economic cycles: directly unmanageable causes (natural non-renewable recourses scarcity – oil, coil etc.), slow manageable causes (knowledge) and manageable causes (taxes, money supply, interest, government spending, subsides, wages, prices and import regulation, etc.)

11. There are "good" (unpreventable, unavoidable, "creative destruction") cycles and "bad" (relatively preventable, theoretically avoidable, policy made) cycles.

12. Economy "manageability" is limited; hence either "overdrive" or "poor drive" cause unwanted economic fluctuations. Keynesian's tools implementation is able to affect minor economic fluctuations, while long cycles left uncured.

References

Abramovitz, Moses. (1989). *Thinking about growth and other assays on economic growth and welfare.* Cambridge University Press.

Aghion, P. and P. Howitt (1992). *A Model of Growth through Creative Destruction.* Econometrica, 60:323-351.

Alexander, Michael A. (2002). *Generations and Business Cycles.* http://www.safehaven.com

Berry, Brian J. L. (1991). *Long-wave rhythms in economic development and political behaviour.* The John Hopkins University Press.

Bible in Basic English. (1965). Hooke, S.H. (red.), Cambridge University Press.

Blanchard, O. (2008). *The State of Macro.* Working Paper 14259, NBER.
Burns , A. F. and Mitchell, W. C. (1946). *Measuring business cycles.* New York, National Bureau of Economic Research.

Burns, A. F. (1951). Introduction. In: Wesley C. Mitchell. *What happens during business cycles: A progress report.* New York, National Bureau of Economic Research.

Dinopoulos, E. and P. Segerstrom (1999). *A Schumpeterian Model of Protection and Relative Wages.American Economic Review*. 89: 450-472.

Dosi, Giovanni; Fagiolo, Giorgio; Roventini, Andrea, (2008). *Schumpeter meeting Keynes: a policy-friendly model of endogenous growth and business cycles.* LEM, Sant'Anna School of Advanced Studies, 2008/21.Forrester, Jay. (1977). Growth cycles. De Economist 125:525 – 543.

Kondratiev, N. (1923). *Questions controversees d'economie mondiale et de crise*.
Freeman, Chris and Louca, Francisco. (2001). As time goes by. From the industrial revolution to the information revolution. Oxford University Press.

Freeman, Chris. (1982). *The Economics of Industrial Innovation*. Cambridge: MIT Press, second edition.

Frisch, (1933). *Propagation problems and impulse problems in dynamic economics.* in Koch, K. (ed.), *Economic Essays in Honour of Gustav Cassel*, London, Frank Cass, pp. 171-205.

Government of Canada. (2009). www.canadianeconomy.gc.ca

Gali, J. and Gertler, M. (2007). *Macroeconomic Modelling for Monetary Policy Evaluation.* Journal of Economic Perspectives, 21: 25-46.

Hayek, F.A. von. (1933).*Monetary Theory and the Trade Cycle.* London: Jonathan Cape.

Hicks, J. R. (1937). *Mr. Keynes and the "Classics": A Suggested Interpretation.* Econometrica, 5:147-159.

Juglar, C. (1889). *Des Crises Commerciales et de leur retour périodique en France, en Angleterre et aux États-Unis*, 2nd edition, Paris: Alcan (Reprinted New York:Kelly, 1967).

Kleinknecht, Alfred. (1990). *Schumperian waves of innovations.* Vasko, T and others Red. *Live cycles and long waves.* Spriger-Verlag,.

Kondratiev, N (1923). *Questions controversees d'economie mondiale et de crise*.

Kuznets, S. (1930) *Equilibrium economics and Business cycles theory.* Quarterly Journal of Economics, 44 (3), pp. 381–415.

Langlois, Richard N. (1991). *Schumpeter and the Obsolescence of the Entrepreneur.* Working Paper 91-1503. Department of Economics, University of Connecticut.

Lee, M. W. (1955) *Economic fluctuations*. Homewood, IL, Richard D. Irwin.

Louca, F. (2001). *Intriguing Pendula: Founding Metaphors in the Analysis of Economic Fluctuations*. Cambridge Journal of Economics, 25: 25-55.

Louca, F. (2007). *The years of high econometrics .A short history of the generation that reinvented economics.* USA, Canada, Routledge.

Lucas, Robert E. (1981). *Studies in Business-Cycle Theory.* The MIT Press, Cambridge.

McCraw, Thomas K. (2006). *Prophet of Innovation: Joseph Schumpeter and Creative Destruction.* Cambridge: Harvard University Press.

Nelson, R. R. and Winter, S. G. (1982). *An Evolutionary Theory of Economic Change.* Harvard University Press.

Perez, Carlota. (2004). *The new techno-economic paradigm.* Conference "Looking into the future of ICT", Amsterdam.

Romer, P. (1990). *Endogenous Technical Change.* Journal of Political Economy, 98: 71-102.

Schumpeter, Joseph A. (1934). *The Theory of Economic Development*. Cambride: Harvard University Press. (New York: Oxford University Press, 1961.)

Schumpeter, Joseph A. (1939). *Business Cycles. A Theoretical, Historical and Statistical Analysis of the Capitalist Process.* New York Toronto London : McGraw-Hill Book Company.

Schumpeter, Joseph A. (1950). *Capitalism, Socialism and Democracy* (3rd edition). London: Allen and Unwin.

Schumpeter, Joseph A. (1954) *History of Economic Analysis*. London, George Allen & Unwin.

Smith, Adam (1776/1937) Smith. *An Inquiry into the Nature and Causes of the Wealth of Nations* (New York, Modern Library).

Solow, R. M. (1956). *A Contribution to the Theory of Economic Growth.* Quarterly Journal of Economics, 70: 65-94.

Sombart, Werner (1916/2001): *Economic Life in the Modern Age.* Reiner Grundmann, eds. New Brunswick.

Sullivan, Arthur*;* Sheffrin ,Steven M. (2006). *Economics: Principles in action.* Pearson Prentice Hall.

Tylecote, Andrew (1993). *The long wave in the world economy.* Routledge.

Verspagen, Bart. (2007). *The Spatial Hierarchy of Technological Change and Economic Development in Europe* UNU-MERIT Working Papers.

Verspagen, Bart. (2004). *Innovation and Economic Growth*. Oxford Handbook of Innovation. J. Fagerberg, D. C. Mowery and R. R. Nelson. Oxford.

Wilson, Daniel J. (2003). *Embodying Embodiment in a Structural, Macroeconomic Input-Output Model.* Federal Reserve Bank of San Francisco.

Woodbury, A.M. (1951). *Natural Philosophy.* Sydney, Aquinas Academy.

Woodford, M. (2003). *Interest and Prices: Foundations of a Theory of Monetary Policy.* Princeton University Press.

Young, John. (1997). *The Natural Economy.* London, Shepheard-Walwyn.