Kondratieff, N. and Schumpeter, Joseph A. long-waves theory

Analysis of long-cycles theory

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Summary

The goal of this thesis is to analyze Kondratieff, N. and Schumpeter, Joseph A. Long-waves. These waves are most noticeable in developed capitalist countries such as U.S., U.K., France and Germany. Therefore, Long-cycles analysis mostly used economic and historical data from countries mentioned above. By studying historical facts and economic data, we can conclude that the economy in the long term does not grow in steady linear curve, but grows in trend which has a sinusoidal form. These fluctuations, which consist of one full sinusoid cycle (2π), are particular to Kondratieff Long-cycles. The average of length of the Long-cycle is approximately 54 years but the depths of cycles are different, because each cycle has unique historical and economic environment. The depths of fluctuations are mainly affected by wars, which are divided into two major categories: the Peak wars and the Trough wars. The former occur on the peak point of the long-cycle and turn the cycle to the downswing period, however, it does not happen instantly because peak wars are followed by an era of good feelings – a plateau that lasts approx. 10 years. Trough wars occur at the bottom point when economy is at a standstill. Trough wars stir the stagnant economy and propel it into the upswing period. Therefore, these two types of wars help growth projection reach the turning points. These points affect the fluctuations, which from the lowest point to the following lowest point in sinusoid projection design one full Kondratieff's Long-cycle.

Schumpeter's contribution examining Long-cycles is obvious. His idea, that innovations to the economy appears in clusters, significantly strengthened the Long-cycles theory. He summarized that the first Long-cycle was mostly influenced by steam engine invention. The second long-cycle was the consequence of wild usage of locomotive and the third long-cycle was caused by electricity. The fourth long-cycle, which followed after WWII, would be possible to describe as oil system and cars caused cycle. Contemporary cycle, which is numbered as the fifth, is caused by IT technologies. We can understand that there are direct relationships between wars and innovations.

Definitely, the perceptions of Kondratieff were supplemented by other scholars as Mensch, Duijn, Barnett and others. Thus, the theory of the long cycles developed to a large aggregate cyclical-economic growth system. This system is a perfect combination of war theory, transport systems development path, population living and medical conditions change path, innovations aiming at producing technologies and changes of monetary system. However, to state the unequivocal existence of this cyclical system would not be appropriate, because some scholars, for example Maddison, A. and Solomou, S., state that the Long-cycles system suggested by Kondratieff is a very idealized historical overview. Nonetheless, the main result of this thesis shows that we can find cycles, every half century repeating economic and social upswing and downswing, phases.

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1 Introduction

Constantly increasing material production, consumption and human welfare levels are the goals of modern society. From the material production perspective, increased levels of quality of life are impossible to reach without increasing manufactured production levels, increasing consumption and new technological inventions. A critical role is played by innovations as they considerably influence human welfare. On the other hand, these same inventions are potential threats to human beings in the case innovations are meant for military purposes. In the broad sense technological innovations are treated as beneficial because they stimulate manufactured production for the increasing number of population.

Technological progress has a direct impact on international relationships between countries as different economic structures are spread within these countries. Furthermore, technological innovations and high receptivity to scientific levels are also reflected in the economic structures of each country. Countries that incorporate and apply technological advancements are able to produce higher output levels even though capital and human power levels stays constant. Countries cannot change their economic structures immediately and become global leaders when they are using less advanced technologies as it takes time and resources to create, apply and benefit from the creation of innovations. When taking historical perspective it appears that a lot of time is needed before the newly invented technology receive broad applicability levels in everyday life. At the final point, broadly spread innovations significantly revitalize countries manufacturing and economic growth levels. These rapid recoveries are called Long-waves. These Long-waves (cycles) were first noted and discussed by a researcher from Russia N. Kondratieff. His research was further continued by the Austrian economist J Schumpeter.

The Long-cycle is depicted as a sinusoidal-like cycle. Similarly to the econometric perspective, it is impossible to find a reliable trend without using currently available data and extrapolating past events. The use of long historical data is characteristic for the research by Kondratieff where the researcher surveyed cycles that on average lasted for fifty years. Currently there are no economic relevant or statistically significant suggestions regarding how to index these Long waves as more than technological advancements are reflected in these

waves. Furthermore, increasing human welfare levels are characteristic for these cycles. The drawback of using an economic growth rate index is that it does not reliably stand for the progress levels or for the general situation in the countries. Long-cycles introduced and discussed by Kondratieff are exclusive as they combine consumption levels, demographic and technological changes in societies. Furthermore, it is noticed that these changes potentially leads to occurrence of wars or financial depression.

Long-cycles constitute long time periods that may not be noticed in daily life. Historically it is proven that an average length of human life is only long enough to reflect two peaks or bottoms. Therefore, it is complicated to imagine that such long cyclical fluctuations are present without knowing the research of Kondratieff and Schumpeter.

To summarize the above the key purpose of my thesis can be stated as follows: *"To present and extensively discuss Long-cycles that are not always easily observed"*.

The following *sub-goals* aim to put additional weight to the relevance of the paper:
1. To show that Long-cycles are present based on different macro- and micro-economic indicators as well as broader scale of economic activity levels;
2. To show the reasons why the Long-waves occur;
3. To identify consequences of the Long-cycles;
4. To identify whether Long-waves are typical only for the European region.

This paper is relevant for researchers and practitioners who elaborate on stages of future developments as it is complicated to predict future trends without knowing and elaborating past events. Furthermore, this thesis is relevant when solving the problem of depleted resources as they have a direct relevance for advancement in the field of technological innovations. It is critically important to create and introduce new innovations that would reduce manufacturing costs and pollution levels as global population levels are increasing. Moreover, this thesis is relevant when analyzing demographic trends and developments of human welfare levels. A specific value of this analysis is added by cyclicality of Long-waves. This cyclicality supports that reasons and consequences tend to repeat themselves even though the circumstances might be different.

This thesis is potentially relevant as it covers issues and topics about science developments, environmental protection and economic growth. The thesis aims to highlight that our future is dependent on innovations, technological advancements and new inventions as global population is facing high growth rates. These growth rates are threatening global economies as more goods and services will need to be produced with fewer resources.

Theoretical basis for this paper comes from research and papers by Kondratieff, N., Schumpeter, J., Mensch, G., Tylecote, A., Maddison, A., van Duijn J.J., Reijnders, J., Barnett V.. Furthermore actual historical factors that are proven to have affected Long-cycles are extensively studied. Based on these papers it is shown that rapid economic developments occur when scientific advancements find support by societies and applicability by manufacturers, when new technologies and innovations are applied broadly. Furthermore, it is highlighted that economic growth is determined by technological developments and high levels of investment productivity.

This paper consists of 6 chapters. Firstly, two scientists who contributed most to the Long cycle's theory are discussed. Secondly, the structure of the Long cycle is examined. Thirdly, I further elaborate on the origins of the Long cycle theory. Fourthly, the four previously experienced Long waves and presentation of the current Long wave are discussed. Fifthly, I elaborate on dynamic theory of wars as having additional explanatory power towards the Long cycle theory. Sixthly, an opinion, opposing to the Long-wave theory, is presented.

2 Initiators and researchers of the Long cycles theory and their research

Two scientists who contributed most to the Long-cycles theory are presented in this chapter. Their research and value added to the economic theories as well as a brief overview of their biographies are presented in the following subchapters.

2.1 Nikolai Dmitrievich Kondratiev: biography, scientific projects and value added to the Long cycles' theory

Nikolai Dmitrievich Kondratiev (hereafter I follow English translation *Kondratieff*) was born in Russia in 1892. The precise location of his birth is still unknown. Kondratieff started his career in the Moscow Agricultural Academy in 1920 (Mager, 1987, p. 24). His famous paper "Long waves in economic life" was released in 1926. Kondratieff examined and confirmed in this publication the existence of extensive business cycles. Furthermore, it was evidenced that capitalist economies are constantly changing from spontaneous, recurrent depression to sustainable economic recovery. After inspecting his research by the dogma of communism, the researcher was sent to prison without any trial and deported to Siberia (Barnett, 1998, p. 189). Kondratieff was socialist, supporter of standpoints by Karl Marx and believed that market economy will collapse. He was exiled to Siberia, when he uncovered the concept about the collapse of market economy and made it publicly available in his publications. After spending thirteen years in Siberia, Kondratieff died in exile. Observations by Kondratieff have not received recognition as long as they were not translated into foreign languages and released publically.

Kondratieff believed that it was possible to forecast and foster future economic growth and the tendency of development based on social, cultural and, economic factors, reflecting the social welfare. In order to justify his forecasts, Kondratieff studied price level statistics of the US, German, British and French economies (Barnett, 1998, p. 113). Data used in his studies included prices of raw materials and output products, interest rates, foreign trade, wages, bank deposits and other data reflecting supply and demand changes.

Data used in the empirical research by Kondratieff has shown some trends of repeated changes in the economy. He identified the growth and decay stages while employing a high number of years between the beginning and the end of the decline. Three long-waves are found by Kondratieff (Duijn, 1983, p. 79):

- The first cycle is identified to last from 1789 to 1849 (Length 60 years).
- The second cycle is approximated to continue in the period from 1849 to 1896 (Length 47 years).
- A third cycle started at 1896 and reached the peak in 1920.

Kondratieff analyzed industrial behavior at the stage of wave's decline. He remarked that new technologies and innovations foster the decline period of the economies to switch to the development stage. These waves support that capitalism leads to the existence of periodically repeated cycles in the economy. Furthermore, these cycles are found to consist of growth and decay phases. Specifically, it is identified that every half-century market economies go into the development cycle where new technological inventions are employed. These new technological inventions are the key to turn the capitalist society in the way of progress.

2.2 **Joseph A. Schumpeter:** biography, scientific projects and value added to the Long cycles' theory

Joseph A. Schumpeter was born in Austro-Hungarian Empire, Trieste (now Italy) in 1883. He studied at the Vienna University. Afterwards he continued his studies at a higher degree at Harvard University. After graduating, Joseph A. Schumpeter started teaching at universities of Graz and Chernovtsy. He served as a president of the Biederman bank during the period 1921-1924 (Allen, 1990, p. 186). Later he was working as a professor at the University of Bonn for seven years and spent eighteen years at Harvard University. Schumpeter published following publications (Keklik, 2003, p. 12):

1. The Theory of Economic Development (1934);
2. Business Cycles, (1939);
3. Capitalism, Socialism and Democracy (1942)
4. Ten Great Economists (1951),
5. History of Economic Analysis (1954).

Schumpeter examined both the economic challenges as well as chronology of past events. Furthermore, strong focus was put on the analysis of the research by Kondratieff. Schumpeter supported the findings by Kondratieff. Similarly to Kondratieff, Schumpeter argued that half-a century cycles exist. Schumpeter referred to these cycles as Kondratieff's long waves (Neumann, 1997, p. 13).

Through further investigation of Kondratieff's research and follow-up analysis, Schumpeter identified the end of the third wave, which occurred around 1945. More recently, other researchers have identified a fourth wave, which started in 1945 and peaked before 1973 (Mager, 1987, p. 220). The last wave peaked when several OPEC members instigated an oil embargo, which caused a rise in oil prices worldwide which subsequently led to significantly increased inflation in the developing and developed countries.

Considering that previous researchers did not explain the reasons of long waves, Schumpeter was one of the first to explain the existence Kondratieff's long-wave. Schumpeter said that significant technological changes are the real causes of long waves. These massive technological changes foster developments of global economic structure much better than others. For example, Schumpeter showed that the second wave was caused by railway constructions. These inventions influenced the creation around them, when the modern mining industry promoted urban development in different areas.

It must be noted that not all economists agree with N. Kondratieff's and Joseph A. Schumpeter's long-wave theory and call it call astrology. However, Forrester (1981) incorporating computer technology, found empirical support to the existence of the long cycles in the global economy.

3   The structure of the long wave

The purpose of this chapter is to examine the structure of the Long cycle. A conceptual model that visualizes variation phases of the Long cycle follows firstly. Afterwards there follows a discussion regarding factors that are found to explain the dynamics of the Long wave.

3.1   The various phases of long cycle

The conceptual model of a long-wave cycle consists of four phases (see Figure 1. Idealized long cycle (created by the author): recovery (AB segment), elevation (BC), loss (CD) and recession (DA). One life-cycle of the long-wave is measured to last on average 54 years.
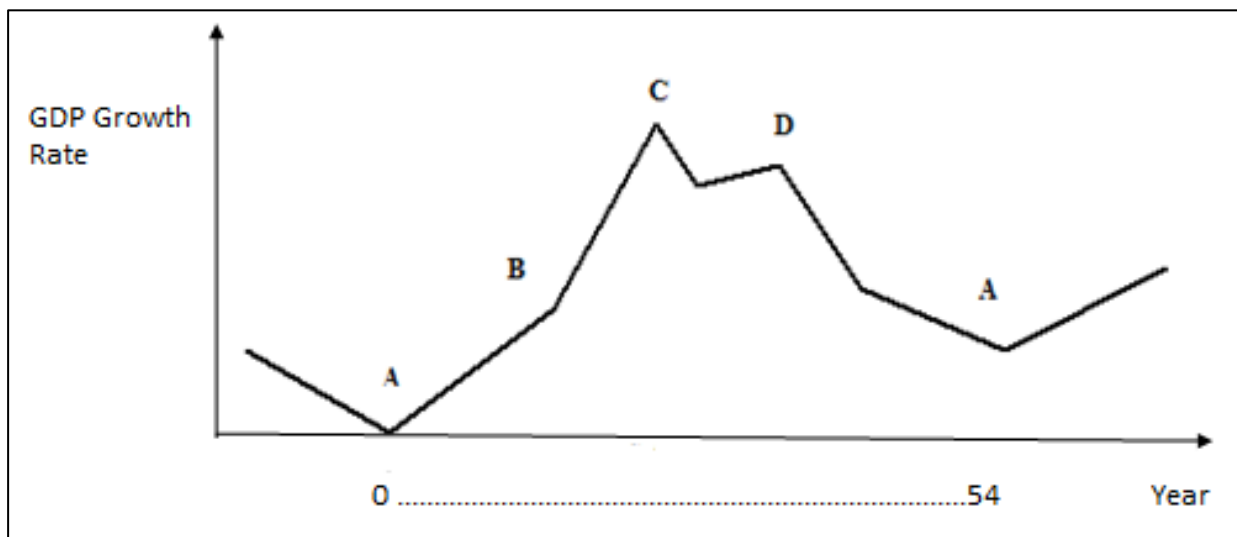
Figure 1. Idealized long cycle (created by the author)

According to the conceptual theoretical long-wave model, the cycle begins with a climbing wave. Recovery of a wave (AB) and elevation of the same wave (BC) follows firstly. The graph shows that the waves grow in a rapidly expanding economy and leads to an undesirable increase in costs. These costs are highly influenced by the increasing degree of inflation. The growth wave continues for about 20-25 years. However the growth rate is not constant and the first "growth" phase (AB) lasts about 10 years. At the end of the recovery period, the wave is "outgrown" into immediate take-off phase. Extremely high inflation is reflected in this period. High inflation has a negative effect on consumption levels. Furthermore, it fosters occurrence of serious recession where economies are faced with several shocks.

The fall of the stage (CD) leads to a turning point. Medium-term prices are stabilizing and economies begin to recover in this phase. This "economic revival" lasts about a decade. However previous growth rates are not reached. Due to its fragile nature which causes panic in the financial markets and deflation in the economy, the "economic revival" period turns into recession phase. A sudden drop lasts on average 10 years. Finally it reaches pre-crisis levels in the recovery stage. This way new wave starts to grow up and forms the next continuous and periodically changing long-wave's range.

3.2   Factors influencing the long-wave

Kondratieff discovered long waves by investigating the level of prices in different countries. Therefore, inflation (deflation) is one of the most prominent factors when monitoring the long-wave interface with statistical indicators. Deflation is more significant at the long-wave upswing phase as the declining prices influence considerably all economic sectors. Different economic segments just started to recover after the stagnation that has forced competitors into bankruptcy at this stage. Therefore only the strongest players have survived in the market. They are trying to get back to the old position by reviewing innovative projects or searching for new ideas, which could help to increase profits and turnovers.

Even though total debt is not as high as it should be at the recovery period, people are still afraid to borrow because of their optimism that disappeared due to the experienced business bankruptcies and massive poverty times in the previous long-runs. Citizens have lost their faith in the government and other administrative institutions. Public companies are exhausted and not able to recover as fast as the private enterprises.

The economy becomes active again when long-wave moves from recovery phase to the elevation phase. The amount of investment needed increases as new projects require continuous crediting (increases banks' profits). Increase in lending and establishment of new businesses enables to reduce country unemployment. In this period individual incomes increase. Subsequently increased consumption occurs which leads to increasing inflation. To summarize, it is evidenced that global economy is facing the threat of overheat and following recession once again.

At the time, when the long-wave reaches its peak, the overheating of the economy is inevitable. Governments might try to stimulate the economy by reducing taxes. However, it

has no positive impact for investment and business growth. Therefore unemployment increases and recession begins. The economy enters the monetary and credit crisis which is characterized by increased unemployment and bankruptcy levels. The short-term decline periods are extended in the recession case in comparison with the same periods at the stage when trend of the cycle is growing. Agriculture and manufacturing industries are extremely hindered by these short term shocks because not all output is consumed. Furthermore, recession hits the service sector where layoffs of employees, shorting their working hours and reducing payrolls start to occur. Declining income and consumption lead to reduced levels of production in manufacturing. This creates a closed circle of economic slowdown which keeps going as long as new innovations are not implemented. New technology innovation facilitates and accelerates the production of goods in the market. Therefore, the depression wave switches to recovery phase.

4 Further analysis of Long cycles theory. Advancements by Kondradieff, Schumpeter and Mensch.

This section of the thesis further elaborates on the origins of the Long cycle theory. Furthermore, research by Kondratieff, Schumpeter and Mensch are examined as they build the foundation for this theory.

4.1 Possible origins of long-cycle theory

The concept of long-cycles was introduced and first mentioned by Kondratieff in *The World Economy and its Conjuncture* in 1922, 4 years after WWI. Two full economic cycles - identified for the periods 1789-1809-1849 and 1849-1873-1896 - and one incomplete cycle are the essential and most influential parts of this two-hundred pages monograph on economic analysis. Furthermore, Kondratieff has also dated three shorter cycles: 1) Economic and social crises were spread across the whole Europe during the period between 1896-1903 with the peak in 1900; 2) The period 1903-1910 with the prosperity's turning point in 1907; 3) The third short cycle, as identified by Kondratieff, started in 1910, peaked in 1913 and was suppressed by the actions of WWI. Kondratieff elaborated on the short-term loans strength of London and Berlin's interest rates during the period 1896-1913 when illustrating, supporting and motivating the existence of previously described shorter cycles. (Barnett, 1998, p. 108)

Dr Hyde Clarke mentioned the corresponding long-cycle before Kondratieff in 1847 in his article published in *The British Railway Register*. Dr Hyde Clarke identified in this paper a 54-years length period that is found to last from 1793 till 1847 (Duijn, 1983, p. 59). He noticed that this period consisted of five 10-11-years cycles that later derived a name of Juglar's cycles. These shorter-cycles pointed four internal crises (1804, 1815, 1826 and 1837) of the Clarke's long-period (Duijn, 1983, p. 59). However, Clarke did not think that 10-11 years length periods could be cyclical as his foresights were based on comparisons of dearth emergencies. These physical forces could not affect the economy cyclically as inter-temporal unfavorable weather conditions caused the dearth (Mager, 1987, p. 15). The dearth threat has

always increased food production prices while growing survival panic decreased prices of industrial production as it had happened in 1847 (Barnett, 1998, p. 116).

Source: Mulhall, *History of Prices*, pp. 130–1 (the graph) and p. 178 (the data).
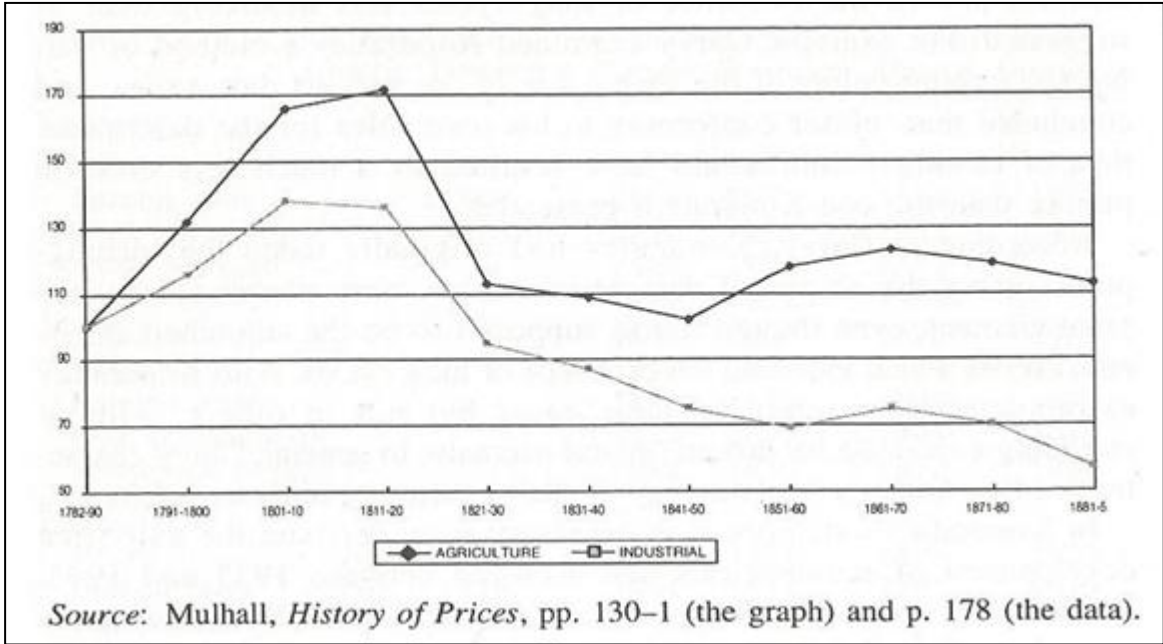
Figure 2. Mulhall's price level, 1782-1885

This picture was published by Michael Mulhall in 1885 when he released his paper *History of Prices Since the Year 1850.* Kondratieff used this data in his later research. When using Mulhall's price levels, Kondratieff could detect the end of the first long-cycle. Specifically, prices of agricultural production increased approximately by 10 percent during 1841-1851, whereas prices of industrial products decreased by 10 percent at the same time. Furthermore, dynamics of the graph led Kondratieff to formulate initial assumptions about the peak of the first long-cycle. Specifically, Kondratieff's first long-cycle turning point matches the highest price level proxied by Mulhall's methodology and calculations that was reached in 1811.

Jevon's paper *Investigations in Currency and Finance* published in 1884 was another important source for Kondratieff's research. Jevon noticed in this paper that the price variation curve is highly influential and sensitive. This curve is subject to change and could come back to the original level in over the years:

"An enormous and long-continued elevation presents itself after the year 1790. When prices had reached their highest in 1809, a still more surprising fall commences, reaching its lowest point in 1849" (Jevons, 1865, p. 302).

Jevons was interested in trends of economic crisis. However, his investigation was only based on Clarke's work that elaborated on dearth and its treats. Jevons did not recognize solid relationship between prices changes in the long period. He concluded his *Investigations in Currency and Finance* (1984) as follows: *"No single cause that I know, can be sufficient enough to account for such a singular event"* (Duijn, 1983, p. 59).

Some people believe that the first discoverers of long-waves were Dutch investigators - Van Gelderen and De Wolff. Both scientists worked independently. Only German translation of De Wolff study (1926) was available to Kondratieff, because Van Gelderen wrote only in Dutch[1] and his works were not translated to any other language. Van Gelderen identified prices changes and remarked strong upswing period from 1850 to 1873 and semi-strong phase from 1873 to 1890s in European and U.S. economies. Van Gelderen pointed, to 1896 as the new 'springtide'; thus he named the phase of upswing. However, Van Gelderen could not confirm the existence of repeated long-cycle as his latter series of data were too short (Duijn, 1983, p. 61). He saw two powerful explanatory developments that could increase production level:

- Expansion to the new territories;
- New industrial technologies.

However, Van Gelderen had difficulties in explaining the decline of the long-wave as ceaseless expansion of production did not seem to be harmful[2]. Van Gelderen was not the only to elaborate on long-period prices changes and its social effects. In addition to Van Gelderen, three authors published their books in 1896 (Duijn, 1983, p. 62):

- Albert Aftalion, *Les crises périodiques de surproduction*[3], 1913.

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[1] Very few people knew this language at this time in Russia.

[2] Nobody believed that long-term cycles exist in 1913. Therefore, reduced production rates were hard to believe during the rise of the third wave and the corresponding production growth coverage. People lived in euphoria from 1896 to WWI.

[3] In English: Periodic crises of overproduction. In this work Aftalion used prices changes causing crisis. The crisis in his paper was as a point where prices stopped to increase. Obviously there followed the fall of prices and decreased supply in an economy after this point. Thus, there was a need to meet the demand because marginal utility and prices of common goods started to increase at the lowest economic levels of economic activities. Aftalion suggested another idea: in order to satisfy the increased demand, society needs to install the modernized system into production. It is evident that this modernization process increases prices of machineries and stimulates the trades. However, this leads to overproduction and modern machines become redundant. Thus, it leads to general trouble when different factories become insolvent, and the crisis cover whole economy. It can be seen that his ideas are similar to Shumpeter's opinion. However, Aftalion made his calculations based by Juglar's 7-11-years length cycles.

- Marcel Lenoir, *Etudes sur la formation et le mouvement des prix*[4] *(*Doctoral Dissertation), 1913.

- Von Tugan-Baranowsky, *L'Évolution historique du socialisme moderne*[5]

The work by Van Gelderen was continued by De Wolff. He released his book in 1924 and 1929 (Duijn, 1983, p. 62) when Kondratieff had already mentioned the cyclical variation of long-cycles in *The World Economy and its Condition During and After the War* (1922).

Kondratieff explained that his own hypothesis of long-cycle he devised from 1919 to 1921 (Barnett, 1998, p. 105). Therefore Kondratieff could not include the already mentioned papers by Dutch researchers into his investigation. It would not be obvious to say that Kondratieff made the hypothesis only by himself, because he footnoted Jevons. He also thanked for others Conjuncture's Institute members for their help when searching for long-cycles. As Vincent Barnett wrote: "…it is clear that Kondratieff's research on long cycles was at least a collective effort" (Barnett, 1998, p. 106). Kondratieff stated his own hypothesis in 1924, when his study "Notion of Economic Statics, Dynamics and Fluctuations"[6] was released. The conclusions of this paper were as follows:

1. *Prosperity years were most common in the capitalist economies during price upswings periods.*

2. *Agriculture suffered more and long depressions than did industry during price downswings*

3. *Major technological innovations were conceived in downswing periods but were developed during upswing periods.[7]*

4. *Gold supply increased and new markets were opened at the beginning of an upswing.[8]*

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[4] In English: *Studies of the Formation and Movement of Prices.* Little is known about Marcel Lenoir, because he died during WWI (Sandmo, 2011, p. 370). Lenoir analyzed the markets of four goods - cotton, coffee, corn and coal - it this doctorial dissertation. He made the cyclical trending factors correlation analysis and examined the statistical relationships between quantities of these four commodities and their prices (production/consumption). He concluded the doctorial dissertation with the introduction of the concept: short-term variation of prices shifts the demand curve, whereas long-run variations indicative the shifts on the supply curve and the effect on monetary factors (Morgan, 1990, p. 140).

[5] In English: The Historical Evolution of Modern Socialism

[6] Original paper: *On the Notion of Economic Statics, Dynamics and Fluctuations*. Moscow. Translated and published in *Problems of Economic Fluctuations* (1936)

[7] Read more about this hypothesis at chapter 5 (Existence of the long-cycle and their relative changes in time)

[8] The table from Vincent Barnett book. (see Table 2, Production of gold, 1810-1930, (Barnett, 1998, p. 111))

5. *The most extensive and devastating wars occurred during the periods of an upswing.*[9]
(Mager, 1987, p. 27)

4.2 Insights and calculations by Kondratieff during the Long cycles' research

Kondratieff publicly announced his conception about Long cycles in *The World Economy* in 1922, whereas empirical support for the hypotheses followed three years later in 1925. Through the incorporation of statistical data from US, English and French economies, Kondratieff created an index of commodity prices.

Sharp price increase was observed in US and England[10] during the period of 1790-1815 which coincides with the growth of the first[11] Kondratieff's wave (Mager, 1987, p. 73). The second Kondratieff wave coincides with price increase observed from 1849 till 1873[12] while price decline lasted from 1815 till 1849. Kondratieff claims that differences in price variation during these two periods are an outcome of an American Civil War (Barnett, 1998, p. 112). The index of commodity prices fell in the second wave starting in 1843, whereas roots of the third Long cycle are observed in 1896. The third Long wave peaked in 1917[13] due to the lack of mass production. This situation was brought up by the First World War. Kondratieff eliminated 7-11 years length business cycles (Juglar cycles) in order to more accurately observe cyclical wave dynamics. He used nine-years length moving average and left the turning points untouched in order to make the turning points more visible (Duijn, 1983, p. 73). This methodology was used by Kondratieff in order to show clearly the dynamics and trends of the changes. English fixed-income bonds regression based on ordinary least square approach was employed by Kondratieff. Equation $y=122.57+0.26x-0.012x^2-0.0002x^3$ (see Figure 11, The course of English consols, 1816-1922 (Barnett, 1998, p. 119)) idealizes the incorporation of raw data into fixed-income bond regression (Barnett, 1998, p. 118). On the other hand, Kondratieff used the idealized (theoretical) curve that shows percentage changes

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[9] Read more about this phenomena at chapter 6 (Theory of Wars).

[10] Price levels from France are included in the regression starting with 1858.

[11] The first Long cycle started in 1789 and upswing period lasted till 1814. The first Long cycle turned to downswing phase (1814-1843) after Franco-Russian conflict in Europe as well as Anglo-American War (1812-1815) in North America (Mager, 1987, p. 73).

[12] Upswing period of the second Long wave started in 1843 and peaked in 1864. Construction of the Long wave identifies that the upswing period lasted for about 10 years (Mager, 1987, p. 85).

[13] Other researchers have shown that 1917 was not the peak of the third Long wave (see Table 5 (Duijn, 1983, p. 163)).

from the previously discussed equation (see Figure 12, Deviations of theoretical series from empirical (Barnett, 1998, p. 119)) when he aimed to present more critical and outlying shifts. According to Jan Reijnders, Kondratieff incorporated nine-years length moving average into his research in order to remove irregular elements and hide shorter fluctuations (Reijnders, 1990, p. 70). After eliminating shorter fluctuations, Kondratieff easily noticed turning points (though or peak points) (see Table 3, Kondratieff' troughs and peaks (Duijn, 1983, p. 76)), which he found when using US, English and French price indices (see Table 4, Kondratieff's index numbers of commodity prices (Duijn, 1983, p. 75)). Furthermore, Kondratieff remarks that these turning points are not just a trend of price changes. Rather they are found when incorporating interest rates, wages, bank deposits and foreign trade into regression consideration (Duijn, 1983, p. 77).

Van Dujin remarks that the turning points of Kondratieff's Long cycles[14] coincide with his calculations of price levels (Duijn, 1983, p. 79). However, Kondratieff's price level methodology is found not to confirm Long cycle wave when taking future perspective into consideration as Kondratieff published his first book about Long cycles in 1922. Prices were increasing worldwide till 1930s whereas the third Long wave peaked in 1920. Since prices have increased enormously starting with 1933, inflation has broken Kondratieff's methodology. Neither World War II, nor Korean War has stopped inflation even though previous trends have proven inflation to shrink after wars (e.g. Napoleonic Wars, World War I, see Figure 13, British prices, 1668-1977 (Duijn, 1983, p. 78)).

Kondratieff could not foresee neither that gold standard system will break down in the 20th century nor that the increased money supply will significantly increase financial reserves[15] of most of the countries. It was highlighted by Van Duijn that this situation was caused by unstoppable inflation, which was not considered during the research of Kondratieff :*"The relation between changes in the price level and changes in production volume has been broken in the 20th century, perhaps because price changes are now the result of conditions that were not operative in 130 years covered by Kondratieff."* (Duijn, 1983, p. 79)

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[14] Kondratieff has written four more books about Long cycles. His research stops in 1928 because of prohibition by Soviet regime. Kondratieff was arrested and deported to Kommunark firing range in 1930 (Barnett, 1998, p. 189).

[15] After rejection of Gold standard, countries that did not belong to any monetary unions were able to increase money supply worldwide without any disruptions.

According Van Duijn, there are 5 reasons that might have influenced price levels in the 19th century[16]:

1. Increased production demand during the upswing period always moves the demand curve towards the right which creates a new equilibrium with a higher price and higher production levels bought. This situation significantly increases consumption levels and leads the market to saturation and production oversupply. Manufacturers are forced to reduce prices in this situation which subsequently moves the supply curve to the right. Production vacuum occurs when it becomes unprofitable to sell production for low price. Low prices are dangerous as they reduce both supply level on the one hand and labor wage on the other side. This situation leads to lower consumption levels and decreased price levels compared with the upswing phase. Wave falling begins afterwards.

2. Gold supply and market are the other reasons which influenced price levels during the Gold standard. Paper money was directly exchanged to gold during the Gold standard era. After mining new spots, states were forced to increase money supply which subsequently triggered increase in production demand. This phenomenon occurred during the growth of the second Long wave. Gold supply increased yearly by 5.5 percent during 1847-1868 due to the discoveries of new gold concentrations in California and Australia. Discoveries of new gold pools in Alaska and South Africa are reflected in the trend of the third Long wave. Gold supply increased yearly by 4.1 percent on average (Barnett, 1998, p. 111). Dominance of the gold standard has led to the situation that gold hunters were financed by governments. This phenomenon was found later to increase prices in the whole economy.

3. Prices increased more rapidly as wage growth rates exceeded productivity growth rates. Strong labor unions conditioned the increasing wages. This phenomenon is explained by plants that were not threatened by bankruptcy during the growth phase of the Long wave. On the other hand, the increase in wages was impossible to sustain during the decline period of Kondratieff wave as most plants and whole economies were stagnating and shrinking.

4. Wage contracts and subsequently cost-of-living clauses are found to have impact to price levels. Wage levels are identified to change similarly to increase and decrease of price index levels. Specifically, wages decrease during the price level decline period

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[16] The first and the second Long cycles researched by Kondratieff occurred in the 19th century.

and wages increase during the incline period of price index that could continue into infinity.

5. Absence of competitive market or existence of oligopolies and monopolies are found to increase prices further. Direct disagreements and increased commodity prices have led to the occurrence of market power disposing cartels. Manufacturers are forced to increase their production price after the increase in commodity prices whereas after the decline in commodity prices they are willing to increase their profit margin rather than decrease production prices (Duijn, 1983, p. 80).

The highest shocking price increases occur during war periods when large parts of national economies are reoriented to military industry. The supply curve significantly moves to the left as lack of civil goods occurs. It appears as extremely complicated to restore pre-war market equilibrium levels for two key reasons:

1. Economies are impoverished during the post war periods as they lack resources, transportation infrastructures are destroyed, plants are modified and destroyed in most of the cities.

2. Manufacturing levels must increase together with population levels that are commonly increasing during the post-war era.

Nations must rebuild the destroyed national economies in order to eliminate the consequences of the first reason. Plants are modernized in order to increase their productivity levels which subsequently lead to the regain of market equilibrium that existed during the pre-war period. New technologies are implanted and new products occur. According to Schumpeter, these changes are essential to help for the Long wave to switch from stagnation to upswing period.

4.3   Schumpeter was the main developer of the Kondratieff's long cycle theory

Similarly to Kondratieff, Schumpeter did not start his theory with non-existent scientifically background. The research of Schumpeter was based on the previously announced findings by other scientists. For instance, Karl Marx has noticed that business cycles are influenced by the

endurance length of manufacturing machines. It was observed that operations of manufacturing machines usually last 7-11 years which conforms to the Juglar cycle. According this theory, De Wolff has identified that the Long cycle is influenced by long living fixed capital such as bridges, plants, coasts, railway materials, etc. De Wolff notified that the operating period of long living fixed capital is on average 38 years. This finding almost matches the period of the second Long wave (1873/1874-1913) (see Table 5 (Duijn, 1983, p. 163)). De Wolff has summarized his findings as follows: "The long wave is determined by the life of the long living fixed capital" (Keklik, 2003, p. 40). However, the theory by De Wolff is incomplete as it lacks further incorporation of innovative expansive concepts.

Rainoff is another scientist who did not find further support in the innovation field. Rainoff was a colleague of Kondratieff at the Conjuncture Institute. Rainoff analyzed wave dynamics of the 18th and 19th century through the incorporation of German, English and French findings in physics. Furthermore, Rainoff collected discovery data of these three countries, put the data into time series and showed how discovery number varies as the time passes. While using five year sums and introducing three-year moving average, Rainoff has proven that deviations of discovery number differ from country average (see Figure 3. Physical discoveries in England. 1651-1891, (Barnett, 1998, p. 131))

Source: Rainoff, 'Wave-like Fluctuations', p. 295 (the graph) and p. 309 (the data). Original data from the tables given by F. Auerbach, *Geschichtstafeln der Physik*, 1910.
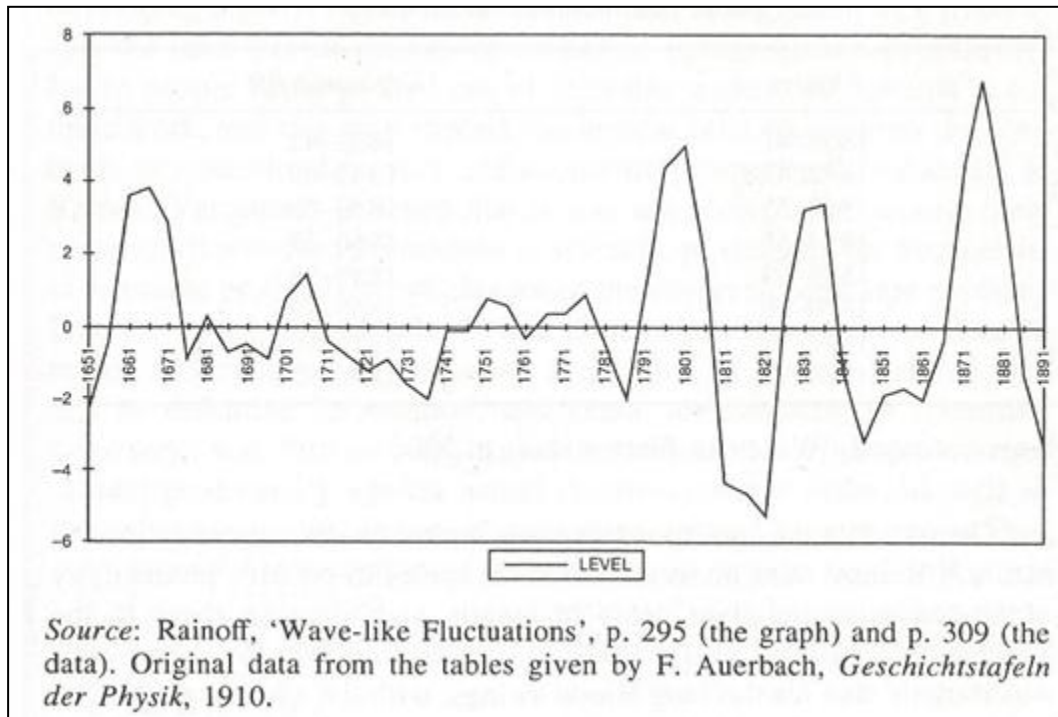
Figure 3. Physical discoveries in England. 1651-1891

Rainoff arrived at the following conclusions during his research:

1. Even though long swings are not always strictly periodic, they show cyclical characteristics.
2. The longs swings of discovery productivity existed in reality.
3. Discovery productivity levels were synchronized in Germany and UK, whereas it was not the case in France.

Rainoff did not compare his findings with Kondratieff Long waves that are in comparison more cyclical. Furthermore, Rainoff did not call his period as cycles. Rather he used a simple phrase of some or several decades. Rainoff wanted to continue his research in chemistry. However, criticism by Ignatiev[17] and Vainshtein[18] experienced in 1929 has stopped his intentions.

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[17] Ignatief stood for an opposite position, because Rainoff was not able to identify a direct relationship between invention of scientific idea and concept that occurred due to a chance. Furthermore, Ignatief stressed that time needed to invent an idea and to apply it in practice differs in industries and type of innovation (Barnett, 1998, p. 130).

[18] Vainsthein was not interested in the date of the innovation. Rather he was motivated by the growth of scientific fields. Vainsthein suggested that the total number of scientific inventions is increasing in the Prosperity period (Barnett, 1998, p. 133).

Kondratieff who highly appreciated reasoning by Marx was the key inspiration for Schumpeter (Mager, 1987, p. 54). Kondratieff remarked that high investments are needed when restoring manufacturing plants. Total production costs are significantly increased by these investments. Marginal production costs increase together with total costs. Due to this situation, investments into manufacturing were reduced significantly because product price margin could not be increased. Downswing period occurs in the short cycles (7-11 years) after manufacturing has started to stagnate due to reduced investments (see Figure 4. The schema of three cycles (Reijnders, 1990, p. 68)).

Schumpeter elaborated on innovations in *The Theory of Economic Development,* 1911. The author introduced five phases of the process lying in between inventing the product and broad consumption of it (Duijn, 1983, p. 98).

1. Inventing a new product;
2. Development of technology to be used in a mass manufacturing procedure of the new product.
3. Search of a new market and demand research.
4. Search for a reliable partners to deliver raw material.
5. Creating a company that will manufacture the new product.

This process was time consuming as collecting the data needed in the marketing research was much more complicated as it is nowadays. Historically this procedure is identified to last from several years to a couple of decades. These principles of production introduction into the market were used by Schumpeter for his 7-11 year length cycles. Later on these cycles were named Juglar because of their discoverer French economist Clement Juglar. Only 15 years later Schumpeter became familiar with Kondratieff Long waves and tried to implement the same production introduction principles for the case of Kondratieff Long cycles.

Schumpeter described the direct relationship between short and long cycles in his book *Business Cycles* (1939). Schumpeter introduced a chain of cycles where the longest Kondratieff's cycle consists of 6 Juglar cycles and one Juglar cycle is formed out of 3 Kitchin[19] cycles. Schumpeter linked true historical events with reasons and consequences of Kondratieff cycle in his analysis. Furthermore, Schumpeter also related factors that influence

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[19] These cycles are 38 month length and are found by English economist Joseph Kitchin.

Juglar and some of the Kitchin cycles (Mager, 1987, p. 56) (see also Figure 4. The schema of three cycles (Reijnders, 1990, p. 68))
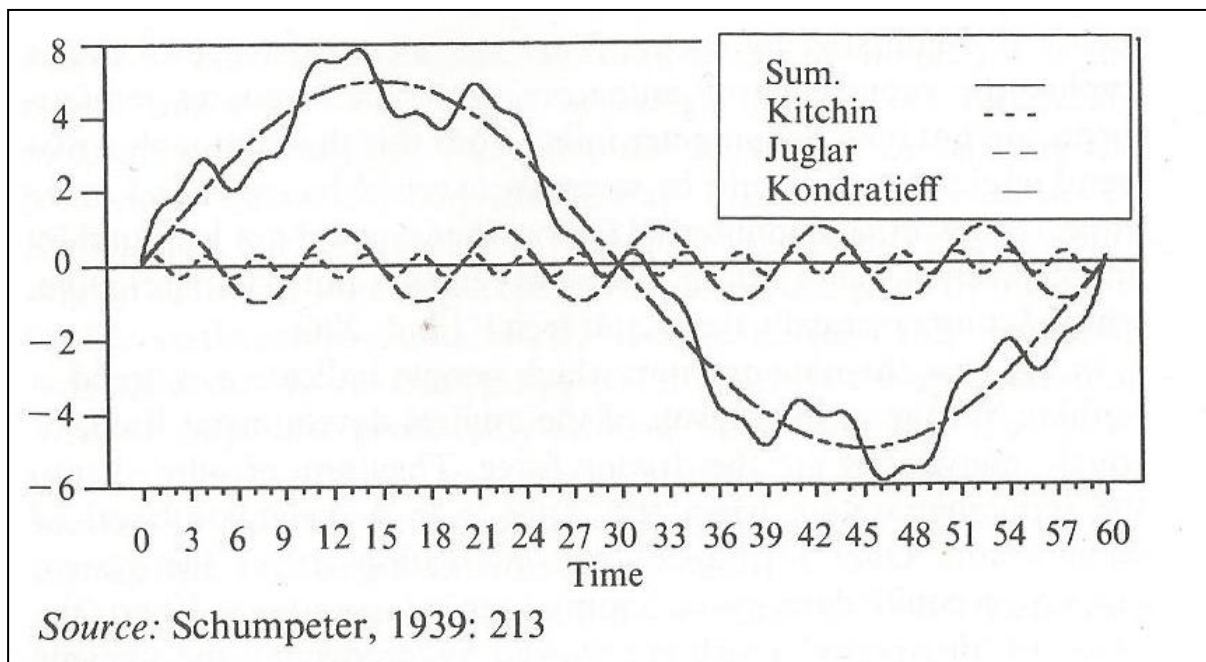
Figure 4. The schema of three cycles

Schumpeter has shown with this graph that all three cycles are interconnected and influence each other. He used a sinusoid in this graph with the aim to show stable amplitude of cycle dynamics. In other words, the researcher idealized cycles as volatile waves. Schumpeter provided error intervals and highlighted this way that:"If innovations are at the root of cyclical fluctuations, these cannot be expected to form a single wavelike movement, because the periods of gestation and of absorption of effects by economic system will not, in general, be equal for all the innovations that are undertaken at any time" (Duijn, 1983, p. 102).

Wave periods used by Kondratieff and Schumpeter differed only slightly. Initial years used in the cycle identification by Schumpeter were 1787, 1842 and 1898:

"Historically, the first Kondratieff covered by our materials means the industrial revolution, including the protraction process of its absorption. We date it from the eighties of the eighteenth century to 1842. The second stretches over what has been called the age of steam and steel. It ran its course between 1842 and 1897. And the third, the Kondratieff of

electricity, chemistry, and motors, we date it from 1898 on." (Young & Schuller, 1988, p. 41) (see also the Schumpeter's row (the fourth line) in Table 5 (Duijn, 1983, p. 163))

This way he distinguished between the two 55 year length waves and adjusted the new (the previous model included only prosperity and recession phases) model phase dynamics which consisted of 4 new stages: prosperity, recession, depression and recovery[20] (Duijn, 1983, p. 101).
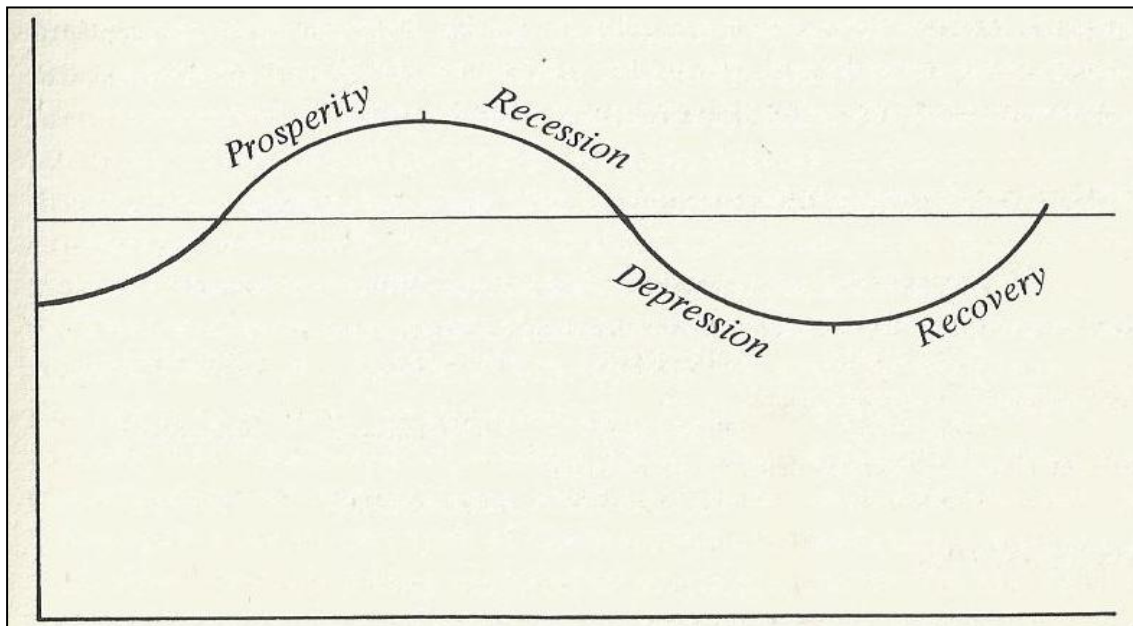
Figure 5, Schumpeter's Four-Phases Cycle

Schumpeter remarked that the key discoveries are made in the downswing period: depression and recovery stages (see Table 6, Major innovations by Kondratieff' phases and by single countries (Duijn, 1983, p. 101)).

This phenomenon is explained as follows. Key and most interesting event occurs when economies are real and outbalanced. Schumpeter took the position that each increase in Long cycle is caused by sharp increased activity levels in one or several industries. These sectors that stimulate economic expansion are called leading sectors because these industries are developed through incorporation of major innovations. Schumpeter stated following questions in order to create these assumptions: What are the driving forces of moving forward? What are the conditions to open the potential of creative human energy? Why the economy doesn't

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[20] Kuznets connected this curve with actual historical facts. Starting with 1953, Kuznets started to research Schumpeter's projects (see Table 7, Schumpeter's long-wave chronology (Duijn, 1983, p. 102)).

stop moving? What is the key source of profits? Ability to discover and embrace unused or improperly used natural, capital and labor resources in order to make new and unexpected solutions is according Schumpeter business the essence and the key to profit source. According to Schumpeter, an entrepreneur stands firstly for innovativeness and routine breaking. Innovators and first in-steppers see what others missed, correct their mistakes and subsequently receive the highest profits. Because of the largest profits, the people stands as benchmarks that must be followed and imitated. Hundreds of thousands of other people imitate them and this way depression stage in the Long cycle switches to recovery phase. Several industries deteriorate during this switch as new products, more efficient technologies and more effective organizational forms are introduced. These changes allow to reduce costs and price levels subsequently. According Schumpeter, the so-called business (economic) cycles are related with the previously discussed developments. Furthermore, the author infers that business cycles are represented by an undulating wave that represents an eternally increasing wealth of capitalist countries. First movers always become an imitation objects. Therefore innovation spreads as a specific avalanche and marks the Prosperity phase (Duijn, 1983, p. 103). Low economic growth, bankruptcies – the so called recession stage – occur when the whole economy starts to adjust to new changes brought by innovation. These cyclical developments expand in a manner of a increasing line (see Figure 14 (Duijn, 1983, p. 135)) through the elimination of inefficient industries, cost reduction, decreased production price levels and increased social wealth (see Figure 15 (Duijn, 1983, p. 26)).

The essence of business does not occur during the times of equal circumstances when companies are competing with large number of similar firms and aim to provide same products/services with lower price or higher quality. The essence of business is to provide a new, more effective and efficient product/service that fills the position of previously undefined demand. These innovations are essential in the process when depression switches to recovery. Innovative businesses are destroying the statistics of current businesses. Innovations bring new solutions that cannot be anticipated by any statistical demand-supply analysis. Schumpeter suggests that the highest and most real profit always arise from innovations that are not reflected in traditional economic theories (Duijn, 1983, p. 103)

Van Duijn has summarized Schumpeters' analysis about long economic cycles (the whole Schumpeters' analysis consists of 1040 pages (Maddison, 1982, p. 78)) with four key aspects (Duijn, 1983, p. 103).

1. Innovations are natural events that help to avoid stagnation and foster progress in modern capitalistic society.

2. Innovations do not occur singly. Rather they tend to spread in groups and foster cyclical dynamics of Long waves this way.

3. Economic expansion is a cyclical process where Long waves (cycles) can spread only in a capitalistic and competitive free market economies.

4. Innovations have different effects to Kitchin's, Juglar's and Kondratieff's cycles. Furthermore innovation explains why cycles with different length exist. Historically long cycles stand out with following innovations: motorization, electrification and railroadization.

When generalizing the conclusions retrieved by van Duijn, the key conclusion of the Schumpeter's work motivates the existence of Long cycles and is stated as follows. Innovations occur initially in the leading industries in groups, get support from the capitalistic society and lead later into the growth of the whole economies. On the other hand, this hypothesis is questioned by Angus Maddison. He highlighted that the hypothesis by Schumpeter does not explain why innovation cannot be installed in manufacturing in regular and unbreakable manner (Maddison, 1982, p. 79). Furthermore, Schumpeter did not explain the reasons behind innovational vacuums. The so-called Neo-Schumpeterians elaborated later on this aspect.

4.4   Mensch – an economist who supported and protected ideas by Schumpeter

One of the most well-known J. Schumpeter's proponents' and Neo-Schumpeterians' was Gerhard Mensch. He published *Stalemate in Technology* in 1975 where his key arguments supporting Schumpeter's theory are presented. Arguing that stagnation occurs due to the lack of basic innovations was the key topic in this book. Mensch distinguishes between 3 key innovation types that influence economic expansion (Duijn, 1983, p. 106):

1. Basic innovations are defined as innovations that create totally new products or production processes. These inventions create new industries that expand the current market into more specialized niches and attract consumption from elder industries.

The newly developed industries transform the existing consumption routines and change money streams.

2. Improved innovations refine the existing product or production processes. These inventions reduce production costs and increase productivity levels. After implementing these innovations consumption levels increase sharply because products' supply level curve is moved towards the right which leads to an increasing demand in the longer perspective. New equilibrium of consumption levels and price is created. These innovations are often divided into important and less important ones. The important innovations are attributed by Mensch to basic innovations.

3. Pseudo innovations are the third class innovations in the rankings by Mensch. These innovations are assumed to increase consumers' wealth even though these inventions neither move the demand nor supply side curves. Pseudo innovations occurs often in the form of changed color or original form and do not increase significantly the final consumer satisfaction levels[21]. Overall, basic innovations are found to have large impact on Long waves. Basic inventions occur after going a long road as they are entirely new and must develop into a fundamental science level. The other disturbance factor is a non-existing demand for a new product (see Figure 16 (Keklik, 2003, p. 44)). Additional complications come from the fact that the existing customer expectations and habits need to be adjusted when implementing a basic innovation. It is impossible to achieve this just with a single product. Rather the whole industry trend needs to be changed. This way Mensch takes the position that basic innovations are driving forces of new industries just when they occur in groups rather than individually. Furthermore, basic innovations are identified as a key of depression phase to proceed into recovery phase.

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[21] When looking from today's perspective and taking developments in marketing field into account we cannot unambiguous state that changes in mode and taste do not influence products' demand and consumption levels. However, these changes are too minor to be able to affect Long waves and theory by Mensch.
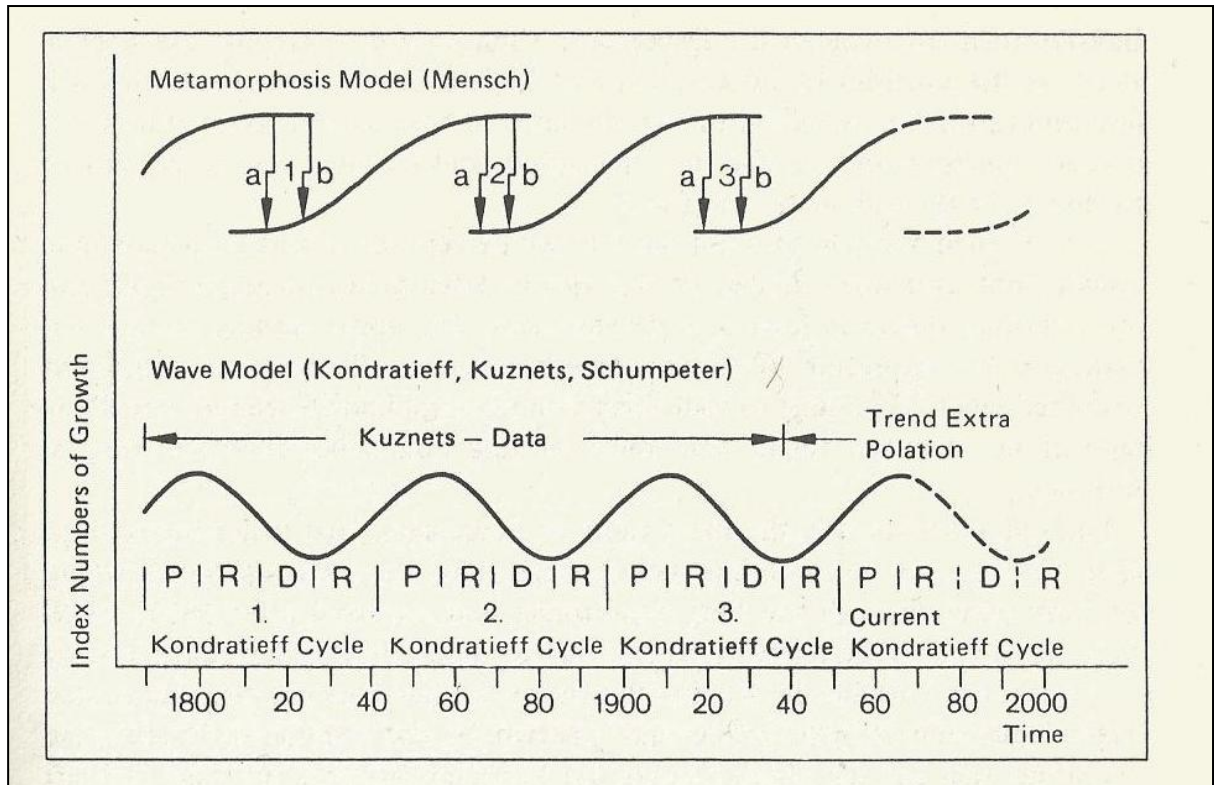
Figure 6. Mensch's metamorphosis model of industrial evolution

The process visualized in Figure 6 is called by Mensch *the industrial metamorphosis of industrial evolution* (Duijn, 1983, p. 107). S-shaped curves[22] are characteristic for the visualization of this process that stands for increases in welfare when time passes by. Each S-shaped curve stands for expansion of new industry. Following this approach, dynamics of each industry starting with its creation and finishing with stagnation is shown. These curves

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[22] Theodore Levitt suggested in 1965 a new conception of a product life cycle. This concept is built upon 4 phases (Duijn, 1983, p. 22)(also see Figure 17 (Duijn, 1983, p. 23))

1. Market introduction stage. This the first stage of the life cycle. High manufacturing costs, low sales number, weak competition and low profits is characteristic for this stage. The key corporate goal is in this stadium to make consumers familiar with new product and create a demand for it.
2. Growth stage. Demand starts to increase rapidly in this stage. Due to economies of scale manufacturing costs starts to shrink. Corporate profits increase. However, competitive environment becomes more severe and more firms aim to steal part of profit from industry leader. Increasing competition reduce the price consumer has to pay.
3. Maturity stage. Sales peak and market saturation is reached in this stage. Production costs are minimized due to corporate experience, high turnover levels and economies of scale. Due to the sharply increased competition price levels are reduced significantly what subsequently leads to reduced corporate profits. In order to increase market share companies start to incorporate pseudo innovations.
4. Decline stage. Product loses its consumers and turnover shrinks dramatically. Costs become counter-optimal in this stage. A newer and more efficient product substitutes the old item.

It goes without saying that this life cycle is different for each product. For instance, life cycle of mode product cannot last longer than a year. When analyzing Long waves we consider S-shaped production life cycle and only basic innovations which's life cycle exceeds 50 years.

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show that industry is stable for a while during the maturity period. Afterwards it proceeds into stagnation when other industries change the existing market habits. New innovations help to grow for the other industry more rapidly than old industry, because latter ones are frozen due to lack of innovations. According this model we can claim that new industries are more innovation receptive than the old industries. This situation leads to old industries staying in the stagnation phase and lastly their market share is taken over by new industries (Duijn, 1983, p. 107). It goes without saying that old industries do not disappear. They exist together with new industries even though their role in the consumption habits is significantly reduced. (see Figure 15)

During the recession phase the largest industries are broadly spread. However they lose the position of leading sectors. It occurs because new inventions are released in the market in groups. This event was proven by Mensch when incorporating actual historical facts about basic innovations into his research (see Figure 7. Swarms of basic innovations, according to Mensch (Duijn, 1983, p. 109)).

Figure 7. Swarms of basic innovations, according to Mensch
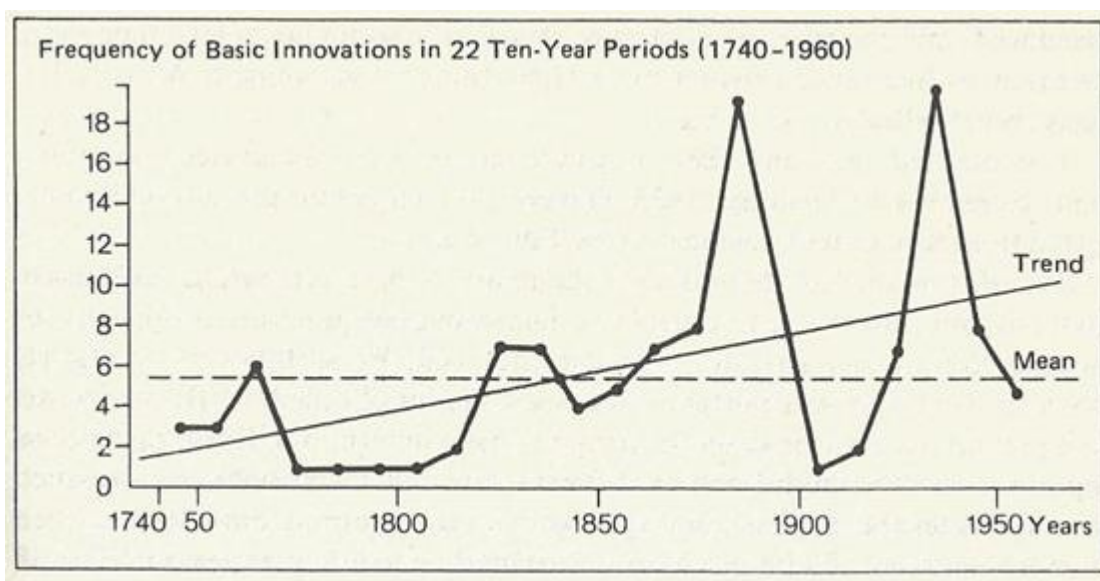
Mensch noticed when using this graph that the key reason of depressions in the Long cycles are the missing innovations. He took the position that if the world initiated and explored innovations in a steady rate, world economies would have avoided deep depressions that were experienced in 1825, 1873, 1929 or 1973 (Duijn, 1983, p. 109). It is visible that the first crisis

incorporated by Mensch was experienced in 1825. Furthermore, a boom of basic innovation occurred 5 years later in 1830s. The other innovation boom followed after depression of 1873 and is experienced in 1880s. The last peak of the graph infers stands for booming innovations in 1930s (after depression in 1929). To summarize, it becomes evident that the largest innovations occur in crisis and these inventions are the key to tilt economic developments into the direction of boom. The following citation by Mensch is essential when showing how his research about innovation applicability to Long wave theory supplements the research by Schumpeter (Keklik, 2003, p. 49):

"The cycle begins with a technological stalemate resulting from stagnation in the formerly most highly developed industrial areas. This situation engenders the cultural, political, social, economic, and technological conditions required for the emergence of a cluster of basic innovations. These innovations establish numerous new manufacturing and service industries, which through successive improvement innovations then become increasingly useful for ever larger segments of population. These branch cycles run in tandem over the long term, exhausting themselves at approximately the same time in a new technological stalemate as the series of improvement innovations governed by the law of diminishing returns produces progressively less significant improvements. These improvements eventually become pseudo innovations, as process that manifests itself in the overall economic system" (Mensh 1975, 68)

It comes without saying that the research by Mensch is not critique free. Mensch is often cited as an economist who aimed to fill the gaps left by Schumpeter's' research of Long cycles existence. Finally, Mensch is criticized because of lacking empirical support and therefore is often called a theorist (Duijn, 1983, p. 108).

5 Existence of the long-cycles and their relative changes in time

This section continues the thesis with the description of the four previously experienced Long waves and presentation of the current Long wave. Furthermore, there follows an overview of actual historical facts that are found to influence Long cycles.

5.1 The first long cycle (1789-1849)

Below I consider industrial revolution and social changes in Europe as having significant impact on the occurrence and dynamics of the first Long wave. The first Long wave is most prominent in England and France.

5.1.1 Industrial revolution and its influence on the first long cycle

Despite the fact, that the beginning of the first long cycle consists with date of Bastille, the origins of this wave started in 1769 when the steam engine was invented by James Watt in England (Klooster, 2009, p. 36). This technology was the key element of the industrial revolution experienced at the end of the 18th century. The highest achievement of this wave is that living conditions of broad society have significantly improved.

"Industrial revolution" is the process when country's internal economic system develops from farming approach to factory based economic system. In other words, the former farming lands are transformed into developed industrial countries. This process has affected the entire Western Europe and North America even though in different time periods. This revolution was a starting point of the research by Kondratieff considering the fact that agricultural commonwealth could not provide neither reliable knowledge nor solid propositions regarding how economic and social levels must be interpreted.
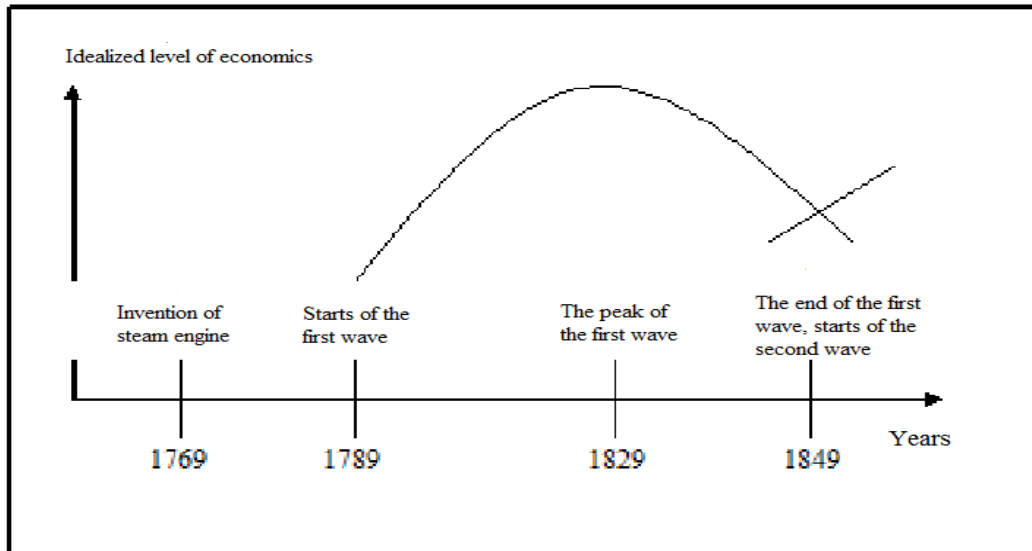
Figure 8. The first Long wave was caused by the steam engine (created by author)

The artisans were left until 18th century in charge to produce the needed industrial items at manufactories. Tremendously significant changes global economy wide occurred in the 18th century. First of all, the changes happened in England where weaving (was invented the flying shuttle by John Kay in 1733 (Klooster, 2009, p. 49)) and spinning machines[23] were invented. These machines, which were powered by the steam engine[24], caused the first symptoms of overturn from old and slow textile's manufactories to modern factory. Specifically, mechanical handwork was replaced by mass production. Later on metallurgical industry that started to produce metal machines boomed as wooden weaving machines were not strong enough for increasing business. More solid iron was required to facilitate the growth in steel and cast iron production (see Figure 18, (Mack, 2012)). Changing technologies relocated industrial concentration in industrial areas. As innovative technologies were transferred and adjusted to practical utilization, steam engines power could be transmitted by belts or shafts. Therefore, different factories were concentrated close to each other. The factories were built near ports or iron and coal mines as close geographical

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[23] Spinning machine was invented by James Hargreaves in 1766. This machine reduced the number of workers in textile factories. It was innovative in that one worker using wheels and shafts could work as few staffs, but the wheel was still turned by hand (Klooster, 2009, p. 49). Later this process has been improved by Richard Arkwright, in 1770, when he invented and patented the water-driven spinning machine (Klooster, 2009, p. 50).

[24] Richard Arkwright in 1790 for water-powered spinning machine applied steam engine, which had been invented by James Watt (Klooster, 2009, p. 52). This new innovation significantly speeded up the output path and abolished the seasonality problem, where in case of seasons changes the rivers could not provide continuous amount of energy. This innovation allowed transfers of production from the coastal to the wider land areas. Thus, reduced the entrance cost to the production, what brightened the economy.

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distances made it easier to import raw materials. Factories did not spare the suburbs, because it was easier to find employees and sell the output to the same workers.

The factories provided many jobs for blue-collars in the UK. Therefore, unemployment was reduced and consumption was increased significantly. Workers moved from villages and settled in new homes. Factories were required to produce as much as possible with the lowest possible cost and this way maximize the owners' profits. The owners of factories began to look for newer and more progressive production opportunities. This situation increased investments into research and development of industrial branches. A desire to penetrate into the market, achieve the greatest part of it and maximize profit gave birth to a new concept which is known as competition.

England produced almost one-third of the world's manufactured goods by 1830, and worked harder than its competitors in continental Europe (France, Spain, etc.) (Maddison, 1982, p. 37) in order not to lose leader position in manufacturing (see Figure 19 (China C. U. G., 2004)). Technological, financial and commercial knowledge, and the "brain drain" from England to the rest of European countries enabled Europe to become the strongest continent in the world (Kreis, 2012). China which was known before industrial revolution as a leading country in innovations, was outperformed by Europe in the 19th century. Newly established trade relations with other continents enabled that European manufacturers to deal successfully with increased need for raw materials and market demand. Furthermore, European firms started to use its technological advantages when exporting capital embedded and colonized in a new and undiscovered world's remaining lands. This system laid foundations for imperialism.

However, sustainable growth and prosperity were not the only features of the first Long wave. Climate changes led to poor harvests and increased prices of agricultural products. Buying agricultural products absorbed almost all savings of population. When unfavorable weather conditions were experienced, industrial production was bought by nobody. The unemployment rate grew significantly in the factories. Large number of workers who had no other livelihood had lost their jobs. The governments of Western Europe assigned large sums for modernization and search of more efficient agricultural technologies. Specifically, the use of mowers, threshing, reapers and many new inventions increasing the level of food production was initiated. This led to improved living standards of broad society which was often forgotten by factories owners during the stage of "industrial revolution".

5.1.2 Social changes in Europe, 1789-1849

More agricultural and food production was needed to feed the growing population in the cities. The relationship between urban and rural had been strengthening during the industrial revolution as large number citizens in urban areas could not survive without agricultural production. On the other hand, residents in the rural areas could not imagine their life without factories produced goods - craftsmen were no longer competitive. Towns and villages in forging closer commercial ties brought a wider road network. This allowed faster realization of production growth in the villages. Better roads fostered developments in provinces too: post offices, schools or even the mayor's office with his employees and officials were established. These changes enabled farmers to study and most importantly to read. Subsequently, books and newspapers became immensely popular. The number of researchers has grown together with the literacy levels. However, to reach all these developments, which followed with the first Kondratieff's long-wave, the public had to master innovations which were invented before 1789 (Duijn, 1983, s. 176). The inventions alone could not lead to the long-cycle it was that they would be absorbed by society as clusters. Therefore, the origins of life quality improvement during the first long-cycle started at least since the early 18th century. The primary energy sources (coal) were found in Western Europe, especially England.

English faith and Puritanism implied that English people were interested into saving money for investments, own businesses or trading. They were working hard and intensively in order to reach financial success. London and other large English cities began to set up the Academy of Sciences. These stimulated a variety of research. Western European countries followed this model. At these academies new inventions were created that helped to establish the medicine, the chemistry, physics and other sciences. At the chemistry field, Frenchman Lavoisier split and synthesized water. The physicist I. Newton described the principle of universal attraction, whereas other physicists N. Fahrenheit and G. Celsius found a way to determine the temperature. Swedish scholar N. Linnaeus created the classification system of animals and plants. Marquis d'Abana built steamer for the first time and tried it at the Seine River, France. Steam was for the first time used as a power for traveling.

Perhaps the greatest discovery was found in the medical field. Since the beginning of the 19th century new treatments of hygiene instructions have been developed. Such research was the center of discussions at the newly founded Academy of Medicine in Paris. Clinical

observation of patients when temperature, disease symptoms and various body ailments were recorded was introduced. Furthermore, a vaccine and anesthesia that have significantly contributed to the rapid progress in the medical field were invented in the Academy of Medicine in Paris.

Medical progress and changes in household habits (e.g. healthy diet and strictly hygiene rules) increased life expectancy at the Old Continent. Furthermore, vaccination has significantly reduced mortality of infants (see Figure 20, Death rates per 1000 over time (Pluijm, 2006)).

Numbers of populations began to grow rapidly when the labor demand increased significantly in factors. Therefore it became a standard that more than 10 children were raised in a singular family of labor workers[25] (School History). Originally, it was feared that not enough food for people would create a global hunger. A new famine and plague flood, which was about to occur, was also feared. Land drainage systems as well as construction of embankments were started in order to win valuable arable land. Fallows were reduced or have been fully waived through the use of chemical fertilizers[26] that were able to increase fertility without exhausted soil. Multidisciplinary subsistence economy was abandoned in agricultural areas in order to suite crop production and animal husbandry to local conditions. These induced changes resulted into specialized agriculture. This agriculture was significantly more efficient than family natural farms that were dominating from middle Ages till industrial revolution. Developments of commercial properties were present since most of the production of specialized farms has been for sale. These developments were severe in North America and Western Europe as these regions disposed prodigious technical potential.

This technological and global elevation that started in 1789 lasted for about 40 years. There are no longer significant innovations or inventions which could give "steam" for the

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[25] Europe Population from 1800 to 1850 increased from 143.3 million to 208.3 million, which is 45.3% growth. Whereas from 1750 to 1800 the growth was 26.4%, and from 1850 to 1900 the growth was 39.6%. North America's citizens population from 1800 to 1850 increased more than twice, a largely influenced by immigration. The immigration significantly affected and South America, where from 1800 to 1850 population grew by 56%. It should be noted that, due to then being not widespread hygiene norms in Africa population growth from 1800 to 1850 is only 4.9%, that is, from 93.1 million to 97.7 million. At the above-mentioned half-century Asia's population grew by 28.6%. (data from (Goldewijk, 2005, p. 354))

[26] It is notified that it was started to employ natural fertilizers (e.g. ash, salt, bones, etc.) in 16th century after notifying that these natural materials increase soil productivity levels. The broad use of commercial fertilizers began in 1840. It was started to export sodium nitrate worldwide especially to North America from where it was mined (Chile and Peru). To summarize, natural as well as commercial fertilizers were employed as providing nitrogen to field crops.

following long wave since 1829. George Stefenson built the first locomotive in 1815. However it took almost 35 years till this idea was used publicly and implied in production.

5.2 The second long cycle (1849-1896)

The sub-sections below consider invention of locomotive and demographic explosion as having significant impact to the occurrence and dynamics of the second Long wave. The second Long wave is most prominent in U.S., England, Germany and France.

5.2.1 The initiator of the second long wave was locomotive

The 19th century is regarded as the capitalist prosperity age. The recession phase of the first wave started at the beginning of this century while the second wave began to rise. The world had gone through the first long-term decline which was observed by Kondratieff in the 19th century. The roots of the second wave occurred during the decline phase. The first steam engine line that was built in Great Britain in 1825 gave birth to the second Long wave (Tylecote, 1992, p. 46).
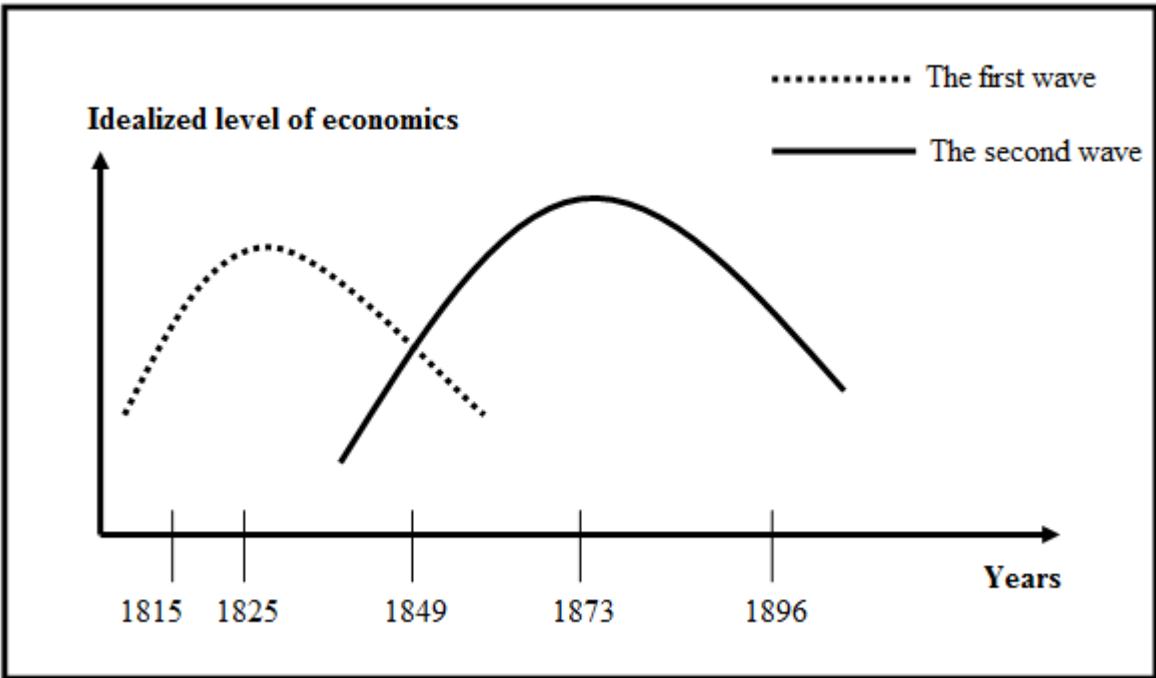

Figure 9. The second wave was caused by usage of the locomotive (created by author)

Even though the locomotive was invented in the mid-term of the first wave (1815), it is treated as the "initiator" of the second long-wave. It took a couple of decades for practical implications of the locomotive to be taken into extensive use. Time was needed to build new rail lines, mine tunnels and construct bridges. New jobs were given for skilled workers as railway constructions revived the metallurgy and metal processing industries[27].

The railway line length had already exceeded 9 thousand kilometers in the USA in 1850(see Figure 21, U.S. Railways 1830-1850 (Cooper, 2004)). It was significantly speeded up as the white colonization was experienced in large residence areas of North America prior to 19th century (see Figure 22, U.S. Railways 1880 (Cooper, 2004)). The settlers from Europe were searching for work in industry as their expected incomes were much higher than in the home country. Additionally, farming land which was missing in Europe and the gold deposits stretching in rocky-west attracted more Europeans. New settlers brought technical knowledge and equipment from Great Britain to the U.S. Therefore, the second Long wave that started in the US is highly affected by the global leadership from Great Britain.

The railroads were under construction in Prussia, France, Russia, India and South America in the 19th century. These railroads transformed the land transport - made it much more convenient and faster. Furthermore, it reduced the transportation costs and boosted the exchanges of goods. It abolished the regional isolation and contributed to the development of domestic markets.

A steamer invented in 1807 was the other technical invention that had helped to develop a wave. The steamboats began to outperform other freight carriers (e.g. sailing vessels and clips) in 1870s as they were cheaper to operate and faster (Lambert, 2011). However, harmful to steamship traffic was its high consumption of coal. This drawback was present until the steel hull and the propeller of the boat were started to be placed instead of the wheel. These vehicles had been widely applied at the internal waters of the United States of America. Together with massive capital flows, further channels were harvested and stimulated the U.S. economy.

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[27] Duijn said that locomotive became as innovation in 1830 (Duijn, 1983, p. 176), so it will take approximately 20 years that this innovation would affect the second cycle.

More and more technological innovations had been invented in Europe, North America and Japan. The technological progress was constantly being introduced into production, which promoted rapid economic growth.

5.2.2 The impact of demographic explosion to the second wave

Gross national product was constantly increasing as industrialization of national economies occurred. The increasing national product was also a result of the wide range interaction between political, demographic, economic and social factors.
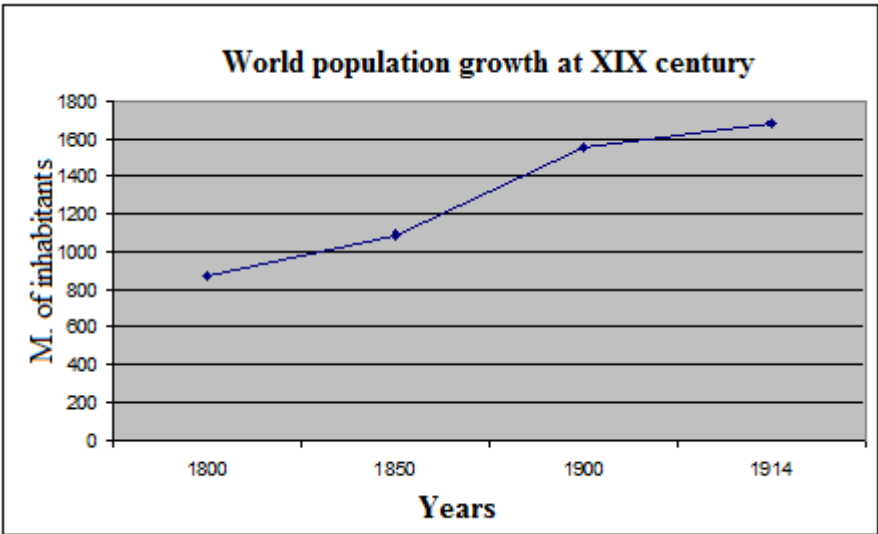
Figure 10. Beginnings of demographic explosion in the 19th century (created by author*)*

The special role in this period is assigned to the demographic explosion. As population grows, wider markets and higher profit potentials opens up for businesses. The growing population encouraged firms to invest capital as well developing their businesses. Construction industry had to meet the growing needs of the residential areas and build hospitals, schools and roads. Innovations have helped to meet the needs raised by the growing population and purchasing power. Entrepreneurs began to effectively use the available capital. To summarize, progress was achieved when large financial resources were formed. Compounded resources are essential as they surpass significantly the majority of individuals available personal capital. Banks started to accumulate the company's stock, take deposits and invest them into areas offering highest profits and dividends.

Companies began to organize themselves into larger companies with the aim of greater control and market power. Oligopolies such as German concerns, Americans trusts or Japanese zaibatsu were created that contributed to the anti-competitive agreements and led to the consumer losses.

Agreements between large corporation and the lack of a well-functioning market economy was a dominating character during the over-production crisis. Speed of industrial production was growing faster than demand. Production demand started to decline in 1870 which led to accumulation of inventories. Not surprisingly, business owners were forced to cut production or to lay off workers.

According to Kondratieff, the turning point of the second wave was reached in 1873 as countries decreased their trades after the economic crisis experienced in 1870 (see Table 5, Long-cycle chronologies according to various authors). The curve of the second wave was dropping till 1896 when new technological inventions were introduced.

5.3 The third cycle (1896 – 1945)

Electricity which was discovered during the peak times of the second wave was the initiator of the third long-wave. Electrical energy could not foster the second wave as it was not widely used till 1886. Joseph A. Schumpeter observed the global beginning of electrification, which most influenced take-off period by the third wave[28]. Electrification changed the manufacturing systems employed in the production factors as previously the energy needed was transferred through belts. Transferring energy through belts is less efficient and therefore lower energy levels could be changed during the manufacturing process into kinetic energy. To summarize, electricity enabled both the prevalence of innovative lighting systems as well as roots of a conveyer. The employment of a conveyer increased significantly manufacturing capabilities, reduced financial resources needed as well as increased manufacturing effectiveness levels. Lower levels of labor and materials were needed for manufacturers. Subsequently this has led to lower manufacturing losses and pollution. Therefore, it goes

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[28] The third Long wave is most prominent in U.S., England, and France.

without saying that occurrence of a conveyer has increased manufacturing effectiveness significantly.

Rise time was the start of conveyors, which fully mechanized industrial production. Conveyor invented by H. Ford, production of cars, engines, motorcycles, tractors, airplanes characterize the third wave. These mass-production techniques significantly facilitated the work in agriculture (Tylecote, 1992, p. 54). Widespread use of tractors as well as combination of harvesters and other agricultural machineries are characteristic for agricultural changes. The fertilizers used have further reduced the risk of famine in the world and provided stimulus for sustainable population growth.

Realities and consequences of the World War I and the Russian October Revolution left a significant impact for capitalist countries during the take-off period. Industries were producing militaristic production during the wars. However, industries failed to adapt to the peace conditions during post-war years. It took several decades till industries were reconstructed into the civilian needs satisfying industries.

Kondratieff treats 1920s as the upper turning point of the third wave. At the end of chaos, the wave turned into an "economic renaissance" stage. However, weak nature of the economy led to the fact that previously experienced growth rates are no longer reachable. For instance, the total Britain's industrial output just reached prewar levels at 1929.

The world economy faced collapse at the beginning of Great crisis (1929-1933 years). This event remarks the beginning of the third wave recession. Many Americans realized the importance of state regulation which was missing in the US during the crisis. The government did not interference much in the economy. It has mostly taken care of public safety and played "night guard" role. In contrast, European governments were actively involved in economic activities. As the United States followed the European model, it introduced the New Deal policies, which established the state's role in economic life.

Germany was the first to recover from the crisis in Europe. Hitler initiated considerable investments to reduce unemployment. However, these investments were mainly devoted to the military industry. It raised tensions in the world political and economic life. Even before the World War II, Roosevelt, F. remarks in his radio speech in 1938 that Great crisis has not only caused recession but also laid the groundwork for the war. To cite Roosevelt, F.: "Democracy has disappeared in several other great nations -- disappeared not because the

people of those nations disliked democracy, but because they had grown tired of unemployment and insecurity, of seeing their children hungry while they sat helpless in the face of government confusion and government weakness through lack of leadership …" (Kennedy, 1999, p. 362)

The third wave experienced its lowest point during Second World War 1939-1945. WW II has caused much greater losses for the whole world than the WW I (1914-1918). WW II claimed 50 million people. Half of them were civilians. The people were extremely intimidated after the Second World War. Almost all economic output had militaristic origins: tanks, planes, guns, trucks, war ships. The war required the mobilization of the entire economy. Therefore prices have continually risen and food products were starting to be rationed. The threat of famine was present as sometimes it was not enough food for all people. The end of the World War II could only cause a rise, during which the third wave was replaced by the fourth long-wave. This wave is thoroughly analyzed by Schumpeter.

5.4   The fourth wave (1945 – 1995)

Many millions were killed during the World War II. Besides that, world's geopolitical and social environment was radically transformed. As no direct war acts were experienced in the US, this country became a "donor" to rebuild the destroyed Europe even though the Americans got the best return for military supplies for war purposes. Government of the US made donations worth 97 million dollars for the rest of the world during the two decades after the World War II. Furthermore, dollar developed into international currency.

France, Germany, Great Britain and Japan have increased the value of foreign capital (U.S. dollars). Powerful transnational corporations that controlled the massive money flow were developed in these countries. It placed the power era of the US because it was rich in natural resources also it had good markets at countries, which were affected by WWII. In order to maintain a steady demand for home production abroad, US provided loans to countries hindered during the WW II.

The centerpiece of this trade was the car – it became exceedingly popular after the Second World War. Industry of car production was most receptive to new technologies in manufacturing industry. It was possible to successfully develop this economic sector only

together with the implementations of the technological and scientific. This industry required educated and qualified advanced professionals. European countries had gone through post-war turmoil better than after the First World War, because the public was strictly controlled by circulation of money and products prices. Developments occurred during the post-war period did not result in high inflation that was potential threat due to significant cash flow from the U.S.. This economic growth continued almost 25 years. OPEC countries temporarily stopped oil supply in 1974-1975 which subsequently led to significantly increased oil prices. The current crisis in the US was the second largest after WWII. Industrial production felt on average by 13.8% due to increased unemployment and inflation (Mager, 1987, p. 153). This crisis reduced significantly the role of the US economy in the global trade.

After the highest levels of the fourth long wave were achieved during this period, a sharp decline that lasted for several years began. US firms have lost the competitive fight against Japans and European enterprises in steel, machine tools and automotive industries. Japans enterprises have surpassed the car production levels of counterparts in the US for the first time in 1979. The U.S. had only sought to protect competition in the domestic market through the increasing duties on imported steel from other countries. The Government of the US banned for public sector to purchase the energies and telecommunications equipment from European countries. International traffic was subsequently decreased and had further fostered the global economic slowdown.

Slowed industrial growth did not mean that there was no technical progress. In contrast, it has particularly accelerated after the crisis faced in 1974 – 1975. Rising oil and other commodity prices forced industrialists to reduce the value of products materials and energy intensity. Less oil consuming cars were started to be produced. Capitalist countries have substantially transformed their industrial structure. Innovative and advanced computing technologies, automatic lines, micro-computers and robots were often applied in these countries. Computing technology was also put into use in the service sector.

Significant impact on the fourth wave had the dreadful development between two superpowers - "Cold War". It further accelerated technological progress. Unfortunately these improvements could cause damage to the whole world. The war ended together with the collapse of Soviet Union in 1991. This date almost coincides with the end of the fourth wave. New markets previously governed by communists have been opened for the global economy and started the currently ongoing fifth Long wave.

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5.5   The fifth long wave (1995 – 2030?)

We are currently witnessing fifth long-wave, which due to the high abundance of innovations might be shorter than previous Long waves. We can clearly see that the tide began to take shape after the widespread use of IT and communications technologies. This period is called the transition from the industrial age to the information age. Nowadays economies are based on the amount of information available. Therefore, we are going through the most destructive economic changes that are caused by the telecommunications and information technology as a response to the globalization processes.

Technology proponents argue that the IT revolution is more important than any previous economic transformation when considering changes broad by the latest technological inventions and absorption rates in the society. It is calculated that little over 50 million people[29] used radio in 38 years after its invention (United Nations) whereas more than 2 billion people were using internet in 2011 (Toure, 2011). This supports the view that the integration of information and the exchange rate develops at rates of geometric progression. Previously business forecasts could be been made for decades. In contrast, currently it is extremely difficult to predict changes even for several because market and the economy had become highly dynamic. Therefore it is possible to predict only the key developments of the economy.

Future projections that are calculated based on the past results are suggesting that a peak turning point of the fifth wave has already been experienced. Economic take-off has stopped in the current financial crisis and is highly triggered by the collapse of US banking industry. The growth period of the fifth wave was shorter than growth rates of the previous waves due to the quickly adopted technological innovation. The intensification of new inventions can lead to get some new regular long-waves. Such an invention which caused the current wave was the computer. Perfection of this appliance evolved over time and reduced its production costs significantly. The scope of computer applications have broadened from military, scientific and public affairs too much more functional applications used in daily life.

A new generation of computers promises revolution. It is predicted that these computers will not only handle data but also knowledge. For instance, expert systems have been already developed. Computers begin to learn from their experience and are operating based on the

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[29]Number of 50 million users of internet was reached in four years after its invention (United Nations).

previous results. The artificial intelligence is already under construction. Computers start to be able to think like a person with logical conclusion.

Furthermore, significant progress is happening in the field of genetic modification. However, the biggest changes are forecasted to take place when biochemistry will integrate with IT technologies. The new devices will be produced biologically and not captured at the factories which were previously the case. These innovations will lead to a new - the sixth long wave.

5.6   The sixth long wave (2030? - ?)

It is difficult to predict how the world will look like in twenty years especially during the high pace of technological developments. Several future prospects of the sixth long wave are presented in this subsection.

According to the trend the sixth wave is expected to begin after twenty years. As people increasingly will take more care of their health and well-being, continual exploration of longer life age is predicted to be the driving force of the sixth wave. Developments in neurology will enable brains transplantation with available memory (skills). Therefore people minds are expected to remain active for longer periods. There will be attempts to explore the parts of the brain that are in charge of emotion determination, cognition, and sensation. The cells are expected to be examined in the nano-molecular level (The sixth Kondratieff − long waves of prosperity). Findings retrieved will be implemented in the innovative industries. Neuron technologies have potential to create new industries as well as new forms of social organizations. Nano-technologies will be essential at this period.

The sixth wave will be replaced by the seventh. Furthermore, it might be possible to break each of the long-cycle observed by Kondratieff. However, it is not possible predict future scenarios accurately.

6 Theory of wars

This part of the paper elaborates on dynamic of wars as having additional explanatory power to the Long cycle theory. Peak- and through- wars, post-war periods and war chains in Europe are discussed extensively. Finally, cycles of post-war demographic boom are examined.

6.1 Dynamic of wars

The dynamic of wars and postwar depressions is being broadly realized in the history of North America. The existence of war centered cycles occurring every fifty to sixty years is undisputed. Besides that, it is clear that several postwar depressions which could be separated by eras of good feelings follow after each war. Kondratieff established the causes and consequences of wars as the phenomenon of economic life[30]. The periodic nature of wars was one of elements in his calculation when searching for the evidence of long waves (Barnett, 1998, p. 107).

Kondratieff came to the conclusion that wars and postwar depressions serve not only as components of long wave. Besides that they might be a consequence which keeps the Long wave moving. He called that wars are natural product caused by capitalist countries:

"Wars and revolutions influence the course of economic development very strongly. However wars and revolutions do not come out of a clear sky. Rather they are not caused by arbitrary acts of individual personalities and originate from real economic circumstances. The assumption that wars and revolutions occurs as a response to outside circumstances that cause the evoked long waves raise the question why do economies themselves follow each other with regularity and solely during the upswing of long waves. Much more probable is the assumption that wars originate in the acceleration of the pace and the increased tension of economic life, heightened economic struggle for markets and raw materials. Social shocks happen most easily under the pressure of new economic forces.

Therefore, wars and revolutions can be fitted in the rhythm of the long waves and do not prove to be the forces from which these movements originate. Rather they are proven to be

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[30] Kondratieff published two-hundred pages length economic analysis called "*The World Economy and its Conjuncture During and After the War"* in 1922.

one of their symptoms. Once they are present, they naturally exercise a potential influence on the phase and direction of economic dynamics." (Kondratieff)

Moreover, the relationship between wars and long cycles is supported by the theory of technological innovation. It is obvious that during wartime the government seeks for new inventions that could help to overtake the positions of war leader. Military planes that started to be extensively used during WWI would be a primarily example of this. Booming motor industry followed after the war. It caused new military innovations (e.g. tanks and whippets) that were started to be operated also during WWI. On the other hand, these inventions contributed to the economic growth in the pre-war era too. However, this information could not be able to be widely used due to the military secrets issue. At the age of prosperity, countries consume a large amount of resources that would be used to satisfy civilian needs in the peace periods. During the peace periods several countries dispose the surplus of material resources. The excess resources and over-capacity manufacturing levels are appointed by some countries for defense equipment while other countries invest it into armament. Subsequently the war threat arises as it is not possible to fully control the arms market. The point that supply of armaments increases during the prosperity time is suggested by Gerhand Mensch:

"One cannot predict that a period is particularly threatened by war simply because nations possess large defensive stockpiles. Rather the danger of war arises when one or more nations actively begin to increase its arms supplies. These sudden increases in armament levels have always occurred in our economic history at times when the era of prosperity in the most highly developed industrial nations has given way to an era of stagnation. Defense contracts had to be substituted for sluggish private demands. According to the Kuznets model, these inflection points in the past growth trends occurred in 1801, 1858, and 1912. These dates provide us with the guess for the hindsight prediction of which years were particularly vulnerable to an outbreak of war. Since the economy-boosting defense contracts that a state in a critical situation would suddenly promote would need to be justified domestically by the engagement in war-threatening behavior abroad."

6.1.1 The peak wars

The analysts discovered two types of wars that occur repeatedly in regular intervals. These types are called "peak wars" and "trough wars". The anterior (peak wars) type primarily

consists of wars series in the U.S. Peak wars are mainly spread in the continent of North America.

Anglo-American War experienced during 1812-1815 took lives of more than thirty thousand people. The second peak war - American Civil War (1861–1865) - occurred in the US 49 years later and required lives of more than half of million people. The third "peak war" participated by US was WWI (1914-1918). This war took lives of over 16.5 million people. The duration between second and third "peak wars" is 56 years. Vietnam War (1965-1973/1974) is treated as the fourth "peak war" experienced by the US. More than three million people died during this war which is treated as the biggest militaristic event after the World War II. The period between World War I (1914-1918) and World War II (1939-1945) is a little more than twenty years. According Mensch, G., World War II cannot be treated as "peak war" as it does not fit into the chronological intervals between peaks:

"The timetable of major wars fits into the stagnation scheme too well not to cause us some alarm. The economic preconditions for war include defense contracts used as therapy for a stagnating economy. This pattern was repeated before every large-scale war until World War I. World War II does not fit into the economic framework. However, the contention that the United States became involved in Vietnam for primarily economic reasons has been discussed too thoroughly to require more elaboration."

The period between third and fourth "peak wars" is 48 years. It would be difficult to think about the fifth "peak war", because we count only thirty nine years after Vietnam War. Therefore, Afghanistan and Iraq conflicts are not powerful enough to be described as "peak wars".

The peak wars affect the society through increasing inflation and long years of the budget deficit. According to Kondratieff, the peak wars consume all recourses which could be used to improve citizens' quality of life. This consumption of material goods and human resources satisfied the needs of the peak war. However, previous exploitation of the economies has led to postwar depression consisting of two episodes. The first phase of postwar collapse is called "the primary postwar depression". This stage takes on average a period from five to ten years. To visualize, it looks like a plane that was rebuilt after the experienced crashing fall. This plane exists until the government decides decisive action as it desperately tries to revitalize the pre-war boom. Being motivated by this purpose, economies involve into "the secondary

postwar depression". This stage arrives on average after six to nine years later and initiates the final liquidation process. This process lasts on average for about twenty years. Furthermore, from the visual perspective it appears that this period is a decreasing long wave. The most difficult financial circumstances occur during the end of the secondary postwar depression. These circumstances are usually present during the third decade after peak war. To summarize, peak wars are often characterized with considerable tension, heavy costs, significant casualties and rapid inflation. In addition to this, decreased public effectiveness in politics and increased public tension are the other drawbacks of the peak war realities. Mensch, G. treated economic stagnations as occurring unavoidable after peak wars:

"History teaches that a certain type of economic crisis follows the war. After the armistice, people are still suffering from the horrors of war. Governments will no longer be able to countering the prevailing stagnation in private industry with defense spending. Therefore, the economic problem of stagnation will revive in the postwar period in a more aggravated form. The so-called peace economy that was already stagnating before the war must now supply the returning soldiers with jobs. But why should these stagnating industries be more capable to create jobs in the postwar poverty than they are in the prewar prosperity?"

6.1.2 The trough wars

In contrast to the peak wars, the trough wars occur in the beginning of Long wave's expansion period and do not cause economic recession as the size of the trough war is not as extensive. The trough wars can benefit economic growth as it empowers the unused manufacturing and human resources that occur during peaceful economic life. The inflation effects of trough wars that occur during the postwar periods are usually minimal. Surprisingly, it may happen that economies do not perceive inflation threat. The trough war is treated as a catalyst of economic growth and is responsible for stimulation of the beginning of a recovery period. For instance, this generalizing finding is in the time line of United States war story.

American Revolutionary War (1775-1783) is the first war that is described as the first trough war in North America. This war occurred between thirteen British colonies in North America and the Kingdom of Great Britain. Moreover, countries as Spain, France and Dutch Republic supported the Americans side, whereas native Indians joined the forces of Great Britain. This war required lives of more than a hundred thousand people. Despite the fact that the death

rates of American Revolutionary war (through war) are higher than death rates of Anglo-American war (peak war), this war hindered economic at lower paces. War actions took place not in North America territory as well as in European coastal waters, Atlantic and Indian Oceans. Naturally it could seem inadequate fact that this war was not concentrated in one region. However must take into account the fact that Europe was exhausted and still recovering from the wave of Napoleonic wars (1803–1815). It was easier to keep economic growth rates steady than after Anglo-American War, when markets were destroyed.

The second trough war in North America occurred sixty three years after first trough war. It was Mexican–American War (1846–1848). The war that tried to solve the conflict between US and Mexico realized into deaths of twenty seven thousand people. Unlike the first trough war, this war was less spread from the territory perspective- region between US and Mexico border - California, New Mexico and Texas inside of United States, whereas, in Mexico, it was Northern, Central, and Eastern Mexico including Mexico City. This war did not make meaningful repercussions for U.S. economy, obviously it did not affect World' trade balance.

The third trough war, which was held between US and Spain (1898) occurred fifty years after the second trough war (1846–1848). Independence of Cuba and thirteen thousand deaths are the results of Spanish–American War. This war did not make a significant impact for United States Government as only 16 soldiers out of 300.000 were killed. However, this war is treated in literature as a strong catalyst of a boom that followed this war as US was the main supplier of armament. Consequently satisfaction of the military needs revitalized industrial development in the United States and it became profitable to produce more armament. There are different opinions whether Philippine–American War (1899-1902) is ascribed as a trough war. Kondratieff does not treat this war as a driving force of the Long-wave. However, it is remarkable that 4,165 American soldiers (about 75% from disease), up to 12.000 Philippine soldiers and up to 200.000 Philippine civilians died as war actions took physical action place in Philippines.

Korean War (1950-1953) is treated in economic literature as the fourth trough war. This war revitalized industrial developments and leveraged up the fourth long-wave. This war took more than two million lives. However, high number of deaths did not make a negative effect for the fourth wave as war actions were only in the Peninsula, Korea. The rest of the world just produced and supplied armament even though we cannot ignore the fact that more than one million soldiers from around the world were sent to this region.

The Persian Gulf War (1990–1991), The Iraq War (2003 –2011); War in Afghanistan (2001–present) and War on terrorism (2001-?) fits into definition of the trough wars. However, currently there is neither scientific nor empirical support existing that verifies these wars as fostering economic growth of the Long wave.

6.1.3 Periodic war chain in Europe

It is clear that relationship between economic crisis and war as described by Kondratieff waves and supported for the case of US, is not highly valid and unquestioned for the case of the rest of the world. Each country has unique chronology of conflicts that are often interrelated in the prospect of time. Nathan H. Mager identified three leading nations in Europe: England, France and Germany. Military activities occurred in these countries on average every forty to sixty years.

England had a position of world leader at 18th century. As the result of this leadership, Nathan H. Mager remarks the military activities experienced in 1789. Anglo-Spanish War (1789-1793) was initiated by English government in order to maintain leadership position in economics. Fifty seven years (1846) England had problems to its colonies in South Africa and New Zealand. As a consequence of this, Seventh Xhosa War (1846-1847) and New Zealand wars (1845-1872) occurred. The third part of England's wars, according Nathan H. Mager, occurred at 1896. It was a chain of military events in Afro-British colonies: Second Matabele War (1896-1897), Benin Expedition (1897), Second Anglo-Boer War (1899-1902).

War history in France differs from English history as each country has unique context and play unique role in the history. Military activities took action in France in following years: 1756-1763, 1803-1815, 1870-1871, and 1914-1918. The chain of France's war actions is remarkably similar to Germany's chain of military activities: 1806-1815, 1870-1871, and 1914-1918. It is clear that Germany and France were conflicting countries for a long time. These countries fought against each other during hundred days of Napoleon war in 1815. Fifty-five years later in Franco-Prussian War (1870-1871) occurred between these two parties. The periodic series of wars stopped taking place in Europe with the end of WWI   (1914-1918).

6.1.4 Postwar period

From the social aspect point of view, it is possible to conclude that wars result into immeasurable social damage. Furthermore, the governments have to cover military expenses and rebuild the structure of industry to civilian needs during post war period. It requires a large amount of money. Hence, the governments could borrow money from foreign countries or increases the supply of cash in the home market using a printing machine. Despite the fact which path is taken, countries are exposed to inflation problems. In order to avoid this, governments of war winners usually requires contributions from the countries that lost the war. These contributions are expected to help to rebuild the devastated industries and economies. Trophies come often together with contributions and help potentially to improve level of innovations in the countries that won.

Inventions that were widely used during prosperity stage become less important after the wars. A tremendous amount of innovations that had been extensively used for military purposes were invented during the period of war. These innovations must be adapted for civilian purposes during each postwar period. Furthermore, civil industries are noticed to grow during post war era as cheap and demobilized labor forces are present. Furthermore, industries are strengthened by the increasing demand for common goods. Therefore additional investment and capital is needed to renew the equipment base. Innovations enable the economies not to be exhausted after producing for military needs. Therefore, rapid economic expansion is often experienced after the first postwar recession. This growth is enabled by hasty postwar demobilization. As the economies get exhausted, the prospecting long-wave turns into recession phase. To summarize, economic growth and stabilization faced in the postwar were caused by the needs to replace capital goods and production lines.

Deflationary forces together and reduced government expenses occur in conjunction with the first postwar recession. Budget deficits are replaced by surpluses when governments start to save their income. This situation keeps being present until a reduction in revenues and budget deficit disappears, national balance increases. This postwar turmoil was present after each major war: 1814, 1873, 1921, and 1972. These dates are being described as the peaks of Kondratieff waves. Furthermore, they are followed by two periods of postwar recession.

The second postwar depressions are more severe, more stubborn, and more precipitous than the first postwar depression.

Economists assume that economic crises are inevitable consequences of the long peace period in the competitive markets. The fact is that wars slow down the economy during the economic prospering phase. Kondratieff describes the wars as culmination points of the prosperity phases. Wars occur when governments start to search for the new markets where they potentially could realize their oversupply. Thereupon it causes the political disagreements. According to the Marxist the war is the consequence of oversupply production in the capitalist society. Others say that war is the cause of tremendous defense spending, which also follows by a huge increase of Governments expenditures in the prosperity phase.

6.2   The cycles of postwar demographic booms

Kondratieff did not mention demographic changes that influence long waves. However, these cyclical processes follow the waves in prosperity and decay phases. When investigating cyclical rhythms and consequences of wars, it is necessary to keep in mind that additional cyclical process - the postwar baby boom – is present during the postwar period.

It is clear that during war-time the number of births decreases as poor living conditions are experienced in the countries involved in the wars. War forces cannot stop the human need to continue its generation. Military actions can only delay this need for a while. Consequently each postwar period is followed by increased birth rate which is highly influenced by the birth "vacuum" experienced during war times. The increased birth rates during postwar periods tend to be cyclical. According to calculations by Mager, baby boom periods occur each 22 years after the end of the wars. It is obvious that many postwar baby boomers are simultaneously mature and have initiated birth of their own children.

These baby booms ideally consist of 50-60-years length cycles. Population of each nation changes due to many aspects. However, military and economic forces are treated as the key driving forces of the changes. Population changes make an immediate impact on Kondratieff waves. Forces of economic depression reduce the fertility. Therefore the number of productive people decreases. Otherwise, victims of war, epidemic, and mobilization spread the belief of improving future prosperity and subsequently birth rate grows. This situation increases changes in the age proportion. More rapid economic growth is experienced as new born grows up after 16-20 years. Subsequently, the phenomenon of unemployment appears. Subsequently the increasing unemployment and reducing wages lead to depressing

atmosphere in society. The same phenomena occur in the postwar period, when the postwar demobilization starts. The soldiers (the surplus labor force) come back to home country, increase the unemployment and lower wages in the postwar period economy. These are the persons that were born during the postwar baby boom period.

Baby boom period that occurred after WWII is identified by Nathan H. Mager as the most significant. Consequences of this baby boom peaked during the fourth wave (the mid-1960's). At this time many young adults - which were born immediately after the WWII - have started to look for a job. However, industries were not able to hire new labor as the end of prosperity era was felt. Industrial developments were slowing down - lack of progress in production rate was present. Furthermore, 7.1 million additional workers came into labor market in the United States of America as the result of baby boom of WWII. The situation was further worsened by the migration. On average 100.000 working age people moved from the countryside to cities during this wave.

76 million babies were born during 1945-1963 in the US. This constitutes a yearly birth rate of 4 million (Mager, 1987, p. 184). Furthermore, this group of people built one third of Americans population even though it was produced in 17 years. The fertility rate exceeded 3.7 births per women lifetime during the year of the postwar baby boom peak. However, this rate has dropped to 1.8 in 1975.

The US economy managed to employ only 1.1 million of workers per year which stood in contrast to 19 million that were searching for jobs in 1963. Subsequently, the unemployment rate of the youth reached a level of 16 percent during the 1970's. Furthermore, the number of young people (16-19-years) increased by 46 percent, whereas young adults (20-24-years) grew by 60 percent (Mager, 1987, p. 188). The labor market was oversaturated with new job-seekers. The government was forced to look for new and sometimes radical decisions in order to employ baby boomer of the WWII.

Landon Y. Jones wrote in his study about of the baby boom generation in 1980. Actions of Lyndon B. Johnson[31] were described as follows:

"Strictly in the sense of manpower alone, Lyndon B. Johnson has decided to go to Vietnam during the best of times. Parents had just presented the military with the largest supply of potential soldiers ever. So massive was the generation that it looked as if he could train and

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[31] 36th President of the United States (1963–1969)

field an army with a minimum of domestic dislocation. Fathers could be spared. So could graduate students and undergraduates." (Mager, 1987, p. 186)

The Vietnam War helped to cover the unemployed youth and to decrease unemployment in the internal US economy. The unemployment dropped from 4.5 percent in 1965 to 3.4 percent in 1969 (U.S. Department of Labor, 2012). Necessary to mention that Vietnam War was like a sponge, that absorbed the evident proportion of potentially unemployed youth (Mager, 1987, p. 186).

19 years after the WWII (1964) there were 2 million with the age of 18 in US. In contrast this group was around 1 million in 1963. Even though 1 million new workplaces were created annually in the US, this growth rate was too low. Economic developments reaching the annual level of 2.2 percent were needed in order to provide employment for WWII baby-boomers. However, the economic realities - unemployment level of 5.2 percent and constantly increasing military expenses – made impossible to reach the required growth rate (U.S. Department of Labor, 2012).

Many young people joined universities or colleges as it allowed to avoid war. Other baby boomers spent few years in mobilization. Thus, war years provided a large supply of young adults without children. Subsequently, the World War II baby-boomers started to create their own baby-boom after demobilization followed in 1974.

To summarize, the baby boom follows the trough wars and turns the Kondratieff wave to prosperity phase. Twenty years after the trough war the government faces problems of youth employment. Mager noticed that these problems are solved by Peak Wars (Mager, 1987, p. 188):

1. The Peak War of the first wave was the Anglo-American War of 1812. This war took War of Independence (1776-1783) baby-boomers. Accordingly, people who were born in War of Independence postwar generation were matured enough for war of 1812.
2. The Civil War (1861-1865) absorbed the baby-boomers who born at the beginnings of the second long wave (1843).
3. World War I (1914-1918) is the Peak War of the third wave. This war absorbed people who were born at the beginnings of the third long wave (1896) and people who could be described as Spanish-American War (1898) baby-boomers.

Obviously not all wars are repeated in a exact manner. Currently, the synchrony of baby-boom can be distorted. However, there are several baby-booms that are typical for almost all nations at the same time. The people who were born just after the WWI aged 18-24-years were fully involved into WWII war actions. It is clear that WWI postwar baby-boom created the oversupply labor in 1939 (beginnings of the WWII). Similarly, baby boomers of WWII constituted labor oversupply in 1960s.

7 Critique of the Long-cycle theory

Research and findings that oppose the Long-cycle theory are presented in this section of my thesis. However, the essence of this section is neither to prove nor to neglect the existence of the Long-waves. Rather it is aimed to provide additional relevant information.

The Long-cycles extensively analyzed by Kondratieff are often cited, surveyed and elaborated on by economists, politician and innovators. Most critiques take the positions that Kondratieff's Long-cycle theory lacks a detailed cyclicality from the geographical standpoint because the Long-waves tend to change development location between major countries, such as U.S., England, France and Germany. Another critique argues that Long-cycle theory lacks more detailed empirical support. Research by Solomou and Maddison are often treated as most reliable and trusted. The following citation summarize the criticism wave towards the Kondratieff's position: "My basic conclusion on long-wave analysis is that the case for believing that there are regular long-term rhythmic movements in economic activity has not been proven, although many fascinating hypotheses have been developed in looking for them" (Maddison, 1982, p. 83).

Maddison agrees with Kondratieff and argues that the occurring systemic shocks are changing capitalistic expansion. In contrast to Kondratieff, Maddison argues that these shocks are occurring due to a chance. It is essential according to Maddison that events or innovations that cause economic instability occur once in a while. Maddison links the break-down of Bretton Woods as an example. Furthermore, the researcher specifies that political- and institutional decisions rather than economic theories influence developments of capitalistic society. His argumentation seems as valid because it is impossible for capitalist countries to develop based only on the economic scenario. Maddison identifies Long-wave changes since 1820 and claims that capitalistic developments are endless processes. This standpoint is empirically supported considering the changes that occurred in 1820. Firstly, a large part of employees moved from agriculture to manufacturing. Later, service industry has expanded considerably. Maddison specifies that price fluctuations have been reduced due to a expansion of the service industry on the one hand and reduced governmental usage of fiscal instruments on the other hand. Maddison takes the position that the governmental possibility to implement fiscal changes is a significant tool to reduce economic fluctuations. According to Maddison, several phases that are not influenced by cycles are present. These phases are present specific for each moment and development stage (see Table 1. System Characteristics of Different Phases (Maddison, 1982, p. 92).

Governmental policy stance on unemployment/price price stability trade-off	Nature of international payments system	Labour market behaviour	Degree of freedom for international trade	Degree of freedom for international factor movements
I 1820-1913 'The Liberal Phase'				
No concern with unemployment	Gold (sterling) standard with rigid exchange rates exerts somewhat deflationary influence cushioned by wage flexibility	Weak unions; wages have some downward flexibility	Very free. No QRs but tariffs rise in second half of period	More or less complete freedom
II 1913-50 'The Beggar-Your-Neighbour' Phase				
Concern with price and exchange stability leads to conscious acceptance of large scale unemployment	Gold standard restored at nostalgic parities, and quarrels over government debt exert extreme deflationary influence and induce 1931 system collapse followed by move to moveable peg	Governments enforce downward flexibility involving a good deal of social conflict	QRs and tariffs raise very substantial barriers	Severe controls on both capital and labour
III 1950-73 'The Golden Age'				
Priority given to full employment	Fixed (but not rigid) exchange rate (dollar-based) system, international credit arrangements soften potential deflationary effects	Strong unions, no downward wage flexibility, social climate relaxed for most of period	Very strong move towards freer trade and customs unions	Gradual and substantial freeing of both labour and capital movement
IV 1973 onwards 'The Phase of Blurred Objectives'				
Lessened concern with full employment, more with price stability	System collapse followed by floating rates	Strong unions, strong upward bias in wage price expectations	Free trade maintained	Free capital movements remain, labour movement restricted

Table 1. System Characteristics of Different Phases

These growth stages are clear, dispose specific boundaries and driving force. Growth phases are inevitable and commonly economic activity levels increase in different industries during these growth phases. Transition between the phases is influenced by political- and institutional- powers as well as strong systemic shocks. Furthermore, transition within industries occurs as the existing development stage cannot expand further. It is almost impossible to forecast these shocks as they are reflected by different external factors that are unique for each stage. For instance, transition from the third to the fourth phase was highly influenced by following factors: switch from fixed to fluctuating exchange rates, expectations in the job market, autonomic shocks stemming from OPEC, governmental incentives to reduce unemployment levels.

The fourth stage that is dated to start in 1973 is according to Maddison similar to the third wave. However, this stage is separate and is treated as most advanced and challenging. Even though performance level is in his lowest, the economies fluctuate less and are more stable than prior to 1950s. Furthermore, manufacturing per capita levels are at their highest. Two characteristics of the current wave are identified as threatening. Firstly, manufacturing production level are low considering the relatively high and still growing positions of capital resources. Secondly, price levels are high in comparison with previous period and are often discussed by politics.

Maddison has created his stage model to explain the perspectives of the Long-wave. Solomou was another researcher that criticize Kondratieff's long cycles[32]. Solomou used 'shocked Gerschenkron catching-up waves'. These G-waves are irregular, dispose different length and depth. Data used in the research by Solomou dates back to 1850. One full G-wave is

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[32] "*The strongest case against the Kondratieff wave phasing of economic growth is to be found in an examination of the production and investment trends of Britain, France, Germany and America*" Solomos Solomou (Solomou, 1990, p. 169)

identified for the period 1850-1937. According Solomou, Long-waves discussed by Kondratieff misrepresent the history because G-wave, which growth phase lasts from 1856 to 1913/1929, shows real economic growth followed by 1930's crisis. Therefore, the second and third Kondratieff waves do not comply with the reality. Solomou relying on econometrics calculations by Maddison does not agree that after second long-cycle followed economic stagnation period, which, according to Kondratieff reached the lowest level at 1896. Also Solomou does not accept the Wars theory, which, according to Solomou, are not only post-war high-growth boom but he describes these booms as unique historic eras. Solomou also disagrees with methodic used by Kondratieff, which includes few countries' growth paths calculating world's development path. (Solomou, 1990, p. 61). Similarly, other authors, such as Kenwood and Lougheed criticize research and findings by Solomou as he misses to provide list of the G-wave expansion and developments conditions.

To summarize, we can argue that studies and insights by Solomou and Maddison are similar from differing perspectives even though the boundaries of the periods are different. Surprisingly there are skeptics who argue: "What both studies serve to do, however, is to draw our attention away from the cyclical fluctuations that had characterized developments within international economy and to focus it on the underlying growth paths along which the international economic system has moved over the past 170 years." (Kenwood & Lougheed, 1999, p. 160).

8   Concluding remarks

The following concluding insights can be drawn up based on the theoretical framework and analysis performed in my thesis:

1. Any main essential innovations or broad scope economic changes occurred worldwide during the period between Romanian empire (5th century) and Long wave's epoch (18th century). Therefore gathering historical data and elaborating on it does not provide sufficient information to conclude that the roots of the first Long-wave are found in this period (5th-18th century).

2. Economies develop more rapidly and more sustainable as new scientific inventions and innovations occur and are implemented in practice.   Rates of technological and economic growth reduce as time passes. Historically it has been shown that new innovations are needed for a new growth period to occur.

3. Economic growth rates depend highly on technological developments and productivity levels of the investments made. Equity protecting laws are essential for the processes of raising capital and implementing innovations. Therefore economic growth occurs commonly in developed capitalistic countries which dispose these laws.

4. Innovations and scientific inventions enable to create and sustain social welfare. However, historically it has been shown that these innovations may be a reason and tool for international conflicts.

5. Innovations are treated as the main reason of improving public health levels, prolonging life length, shrinking average working day and improving working conditions.

6. Travel length and transportation prices have been reduced due to significant developments in the transportation industry.

7. Radio, television, press, travelling as well as internet have reduced international boundaries and increased the speed of globalization.

8. The scope of technologies available forces to use natural resources wisely, protect them and take care of nature in the broad sense. Furthermore, new industries that are natural resource friendly occur and are developed.

9. Worldwide population grows rapidly which highlights the need to feed, educate and create regular living conditions for the increasing number of people. Therefore, human future is highly dependent on innovations and science developments.

Based on the current trends it is impossible to analyze reliably the existing wave or to predict unfailingly the upcoming cycle. We cannot predict when the fifth wave will grow into the sixth based on the war theory as the dates of the future wars are unpredictable. On the other hand it is feasible that the next wave will occur due to economic innovations rather than due to the reason of war. Furthermore, I take the position that the peak of the fifth wave matches the US real estate and financial crisis which started in 2008. Based on the theoretical framework and literature review, it may be predicted that the next 10 years may be in

recovery stage whereas downswing period will follow afterwards. It goes without saying that politic pressure puts additional uncertainty to my forecasts. For instance, the influence and end of the future wars are still unknown and immeasurable. Today we can analyze the Long-waves prior to 1989 as broad scope of actual and relevant information is available. Similarly, in my opinion the current wave will be subject to detailed investigation after 20-40 years after all the economic and politic developments can be taken into account. Based on the extrapolation of the historical data and trends retrieved we can argue that economic cycles will not disappear and will be subject to investigation as initiated by Kondratieff. From my perspective it is impossible that broad scope of rapid developments that are currently occurring will destroy the Long-cycle theory as there is still plenty of room to improve social welfare.

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Appendix 1. Figures used to support the Long cycle theory.

Figure 11, The course of English consols, 1816-1922
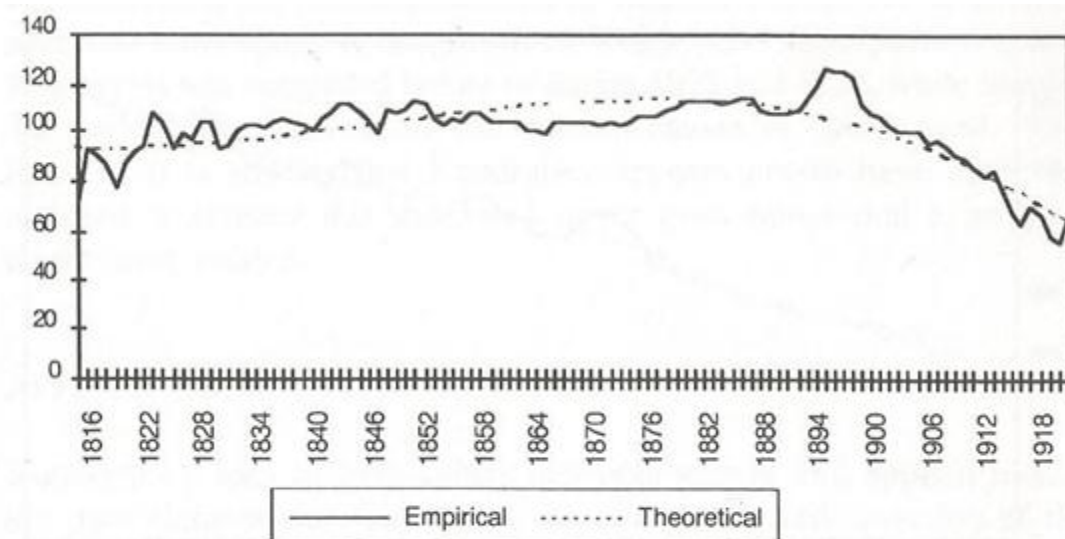
Source: Kondratiev, *Bol'shie tsikly kon"yunktury*, pp. 246–7.

Figure 12, Deviations of theoretical series from empirical
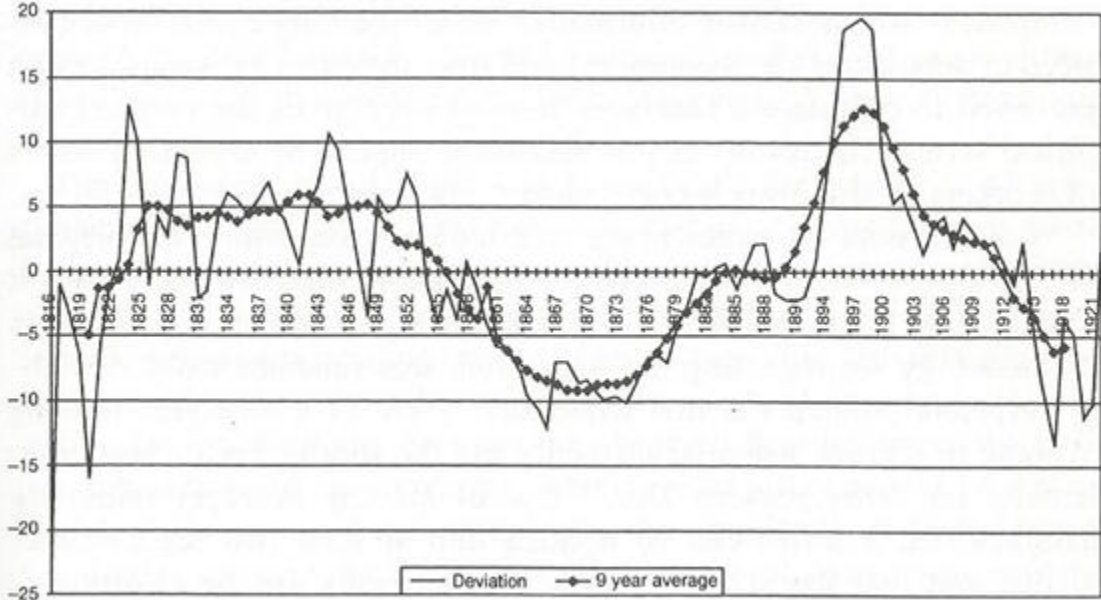
Source: Kondratiev, *Bol'shie tsikly kon"yunktury*, pp. 246–7.

Figure 13, British prices, 1668-1977

Source: *The Economist* (June 1978)
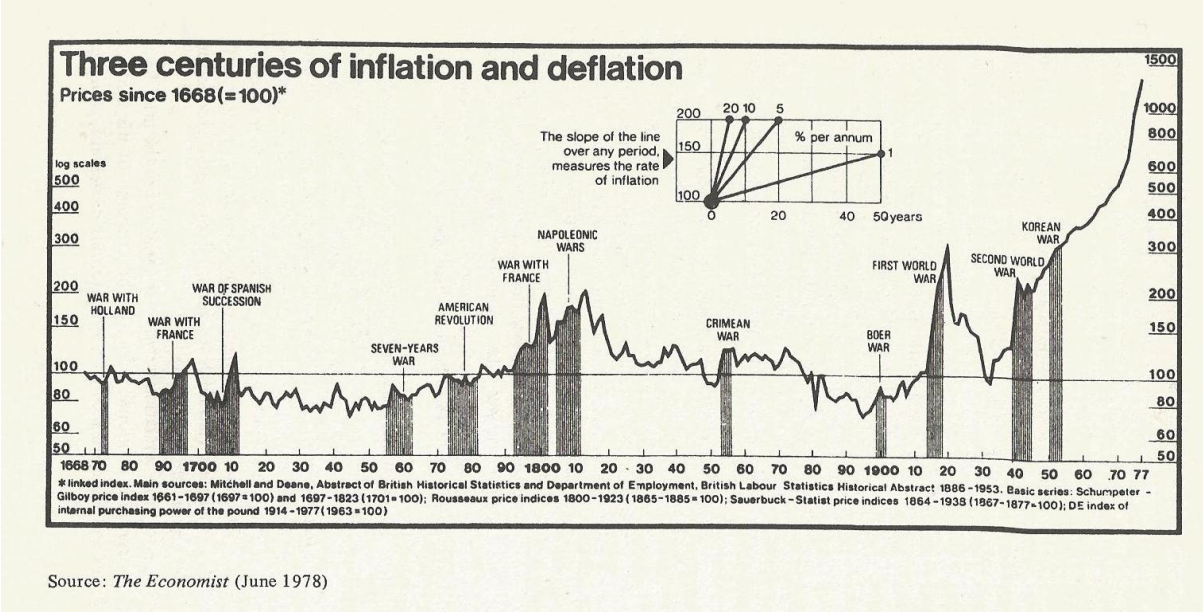
Figure 14, A four-phase long wave with upward trend

A four-phase long wave with upward trend
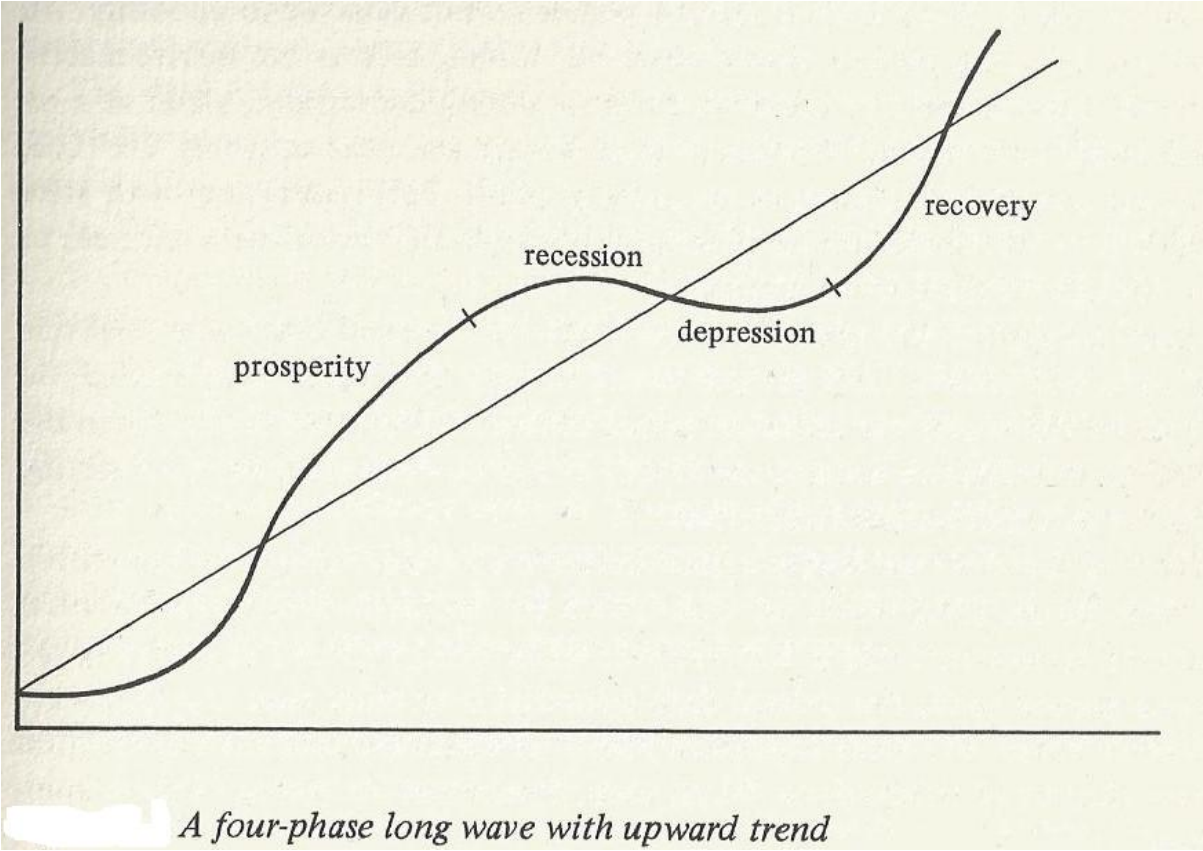
Figure 15, Succession of technologies

Source: E. Jantsch, *Technological forecasting in perspective*, OECD, 1967.

Figure 16, Generation of an innovation

Figure 17, The product life cycle: four-phase model

Figure 18, Iron in the Industrial Revolution

Figure 19, Relative Share of World Manufacturing Output, 1750-1900
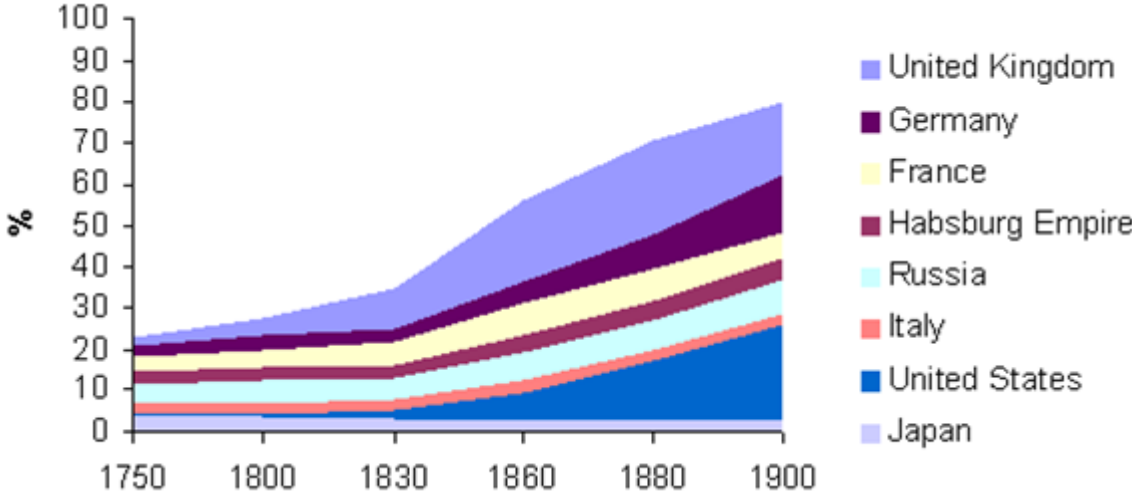
Figure 20, Death rates per 1000 over time
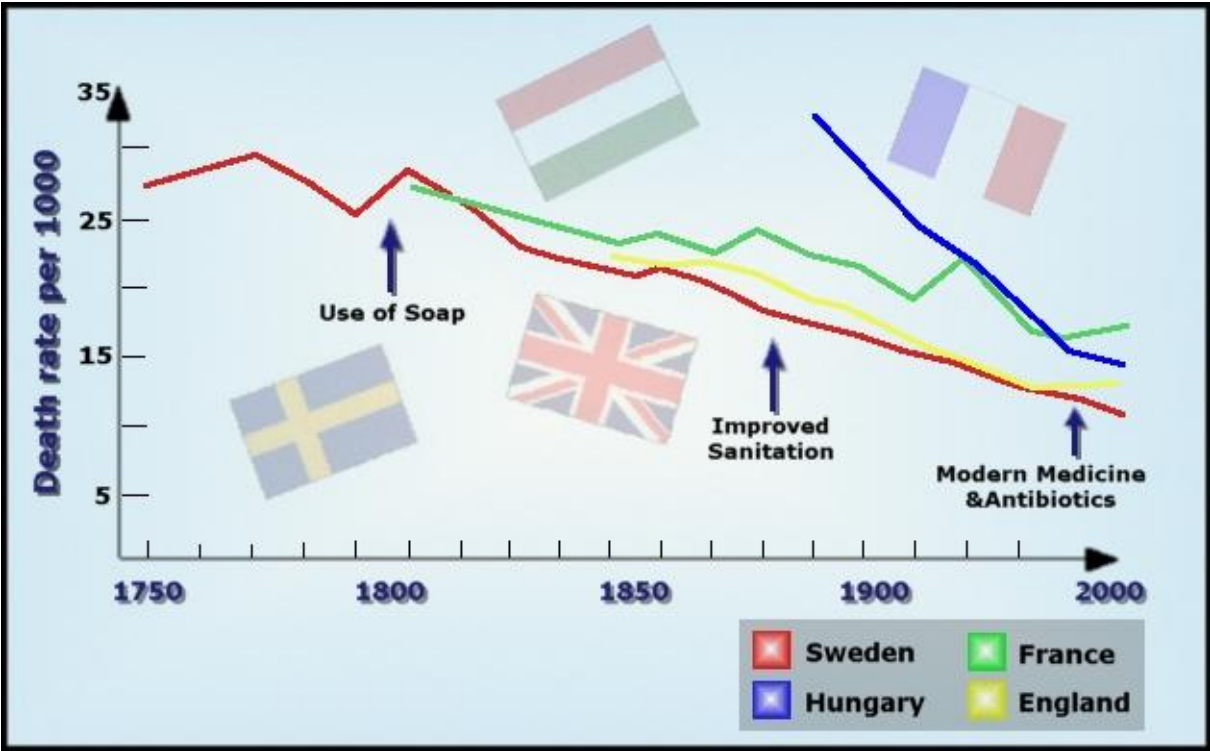
Figure 21, U.S. Railways 1830-1850

1830   1840   1850
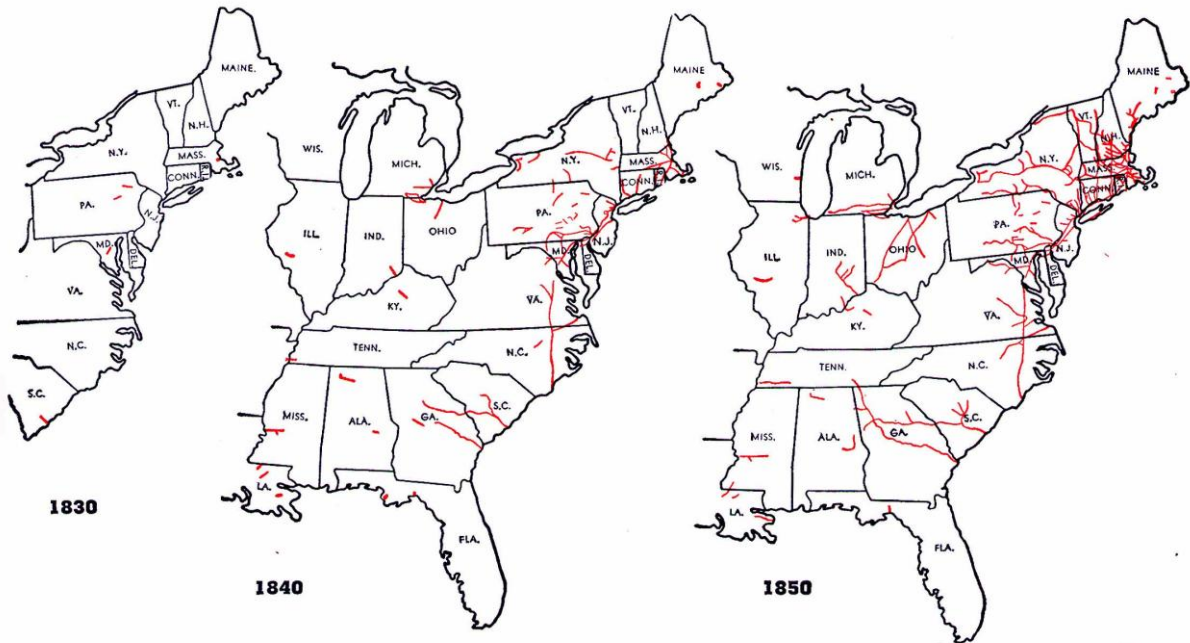
The early stages of railway development in America are shown by this set of maps. During the decade 1830-1840, the total length of completed railroad lines increased from 23 to 2,808 m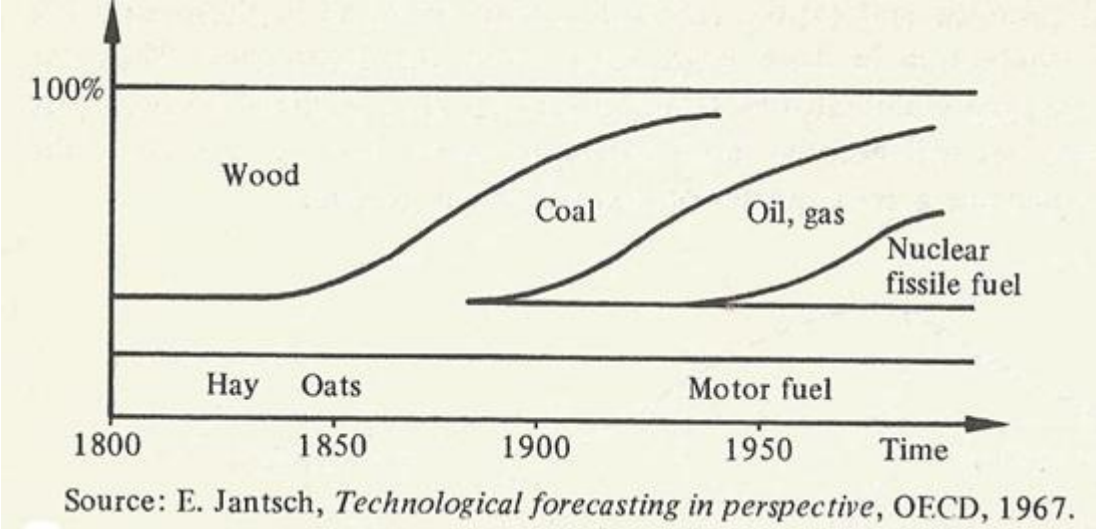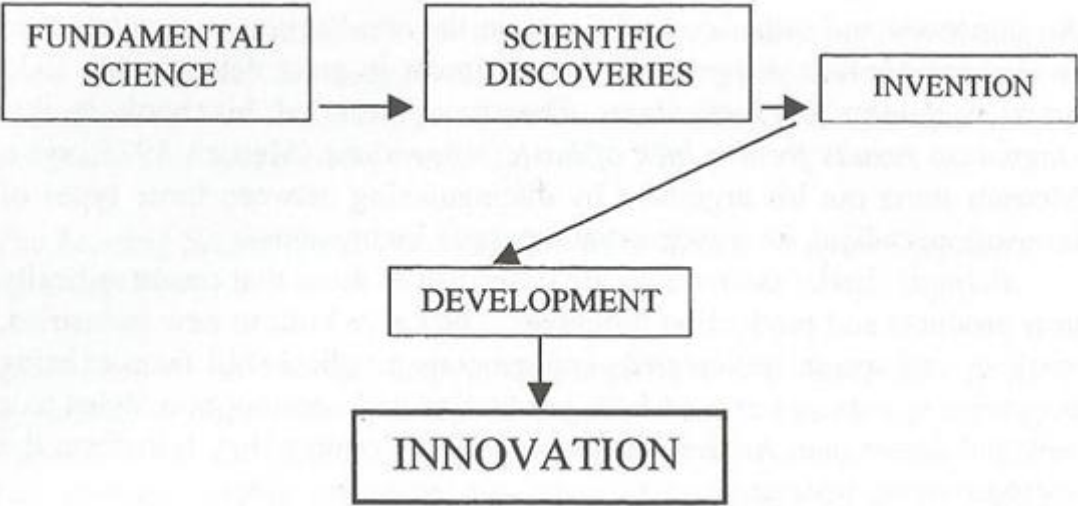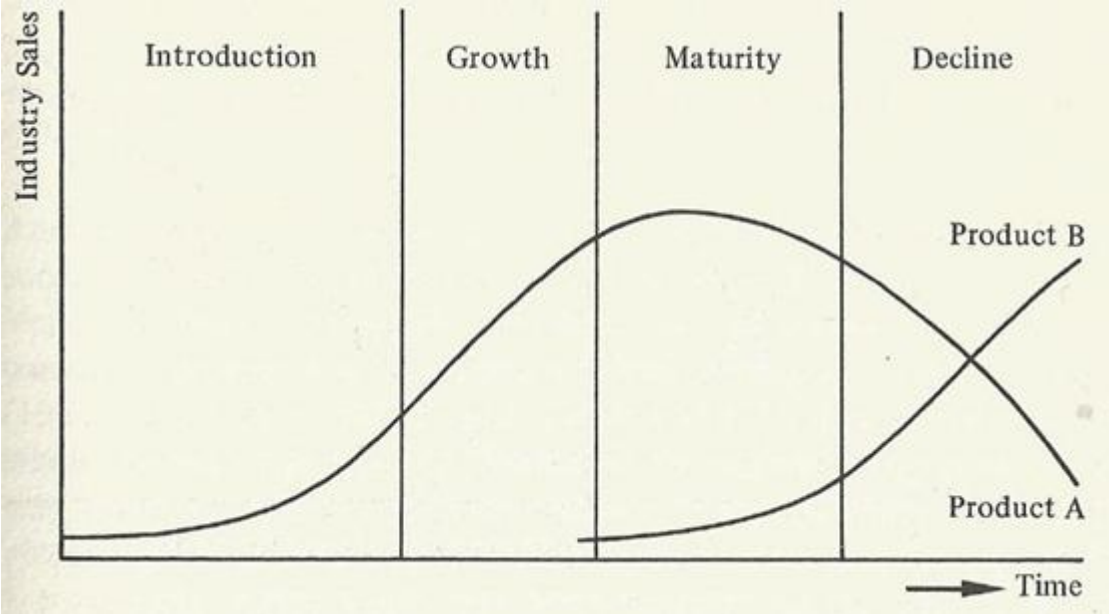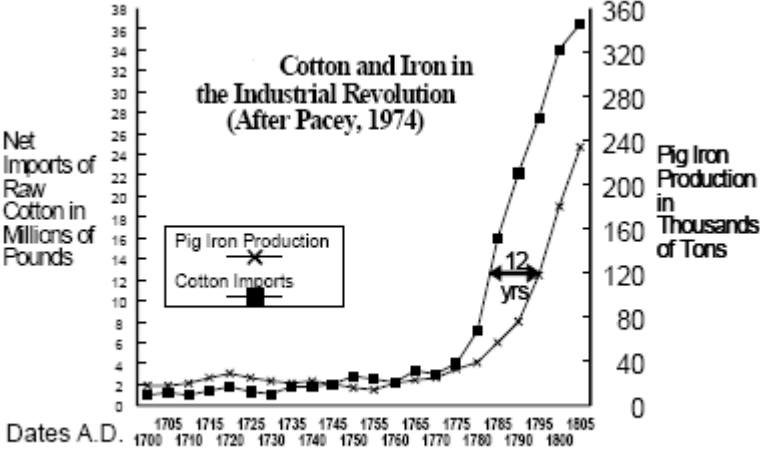iles, and during the next ten years, more than 6,200 miles of railroad were opened, bringing the total network up to 9,021 miles in 1850. The most intensive growth during this period was in the Atlantic and Seaboard states. In 1850, a trip from Boston or New York to Chicago was made by rail and lake steamers or by stagecoaches, and required several days. One could travel all the way from Boston to Wilmington, North Carolina, by rail, with several changes of cars and a few ferry trips en route. During the first twenty years of railway development, covered by these maps, the population of the United States nearly doubled.

Figure 22, U.S. Railways 1880
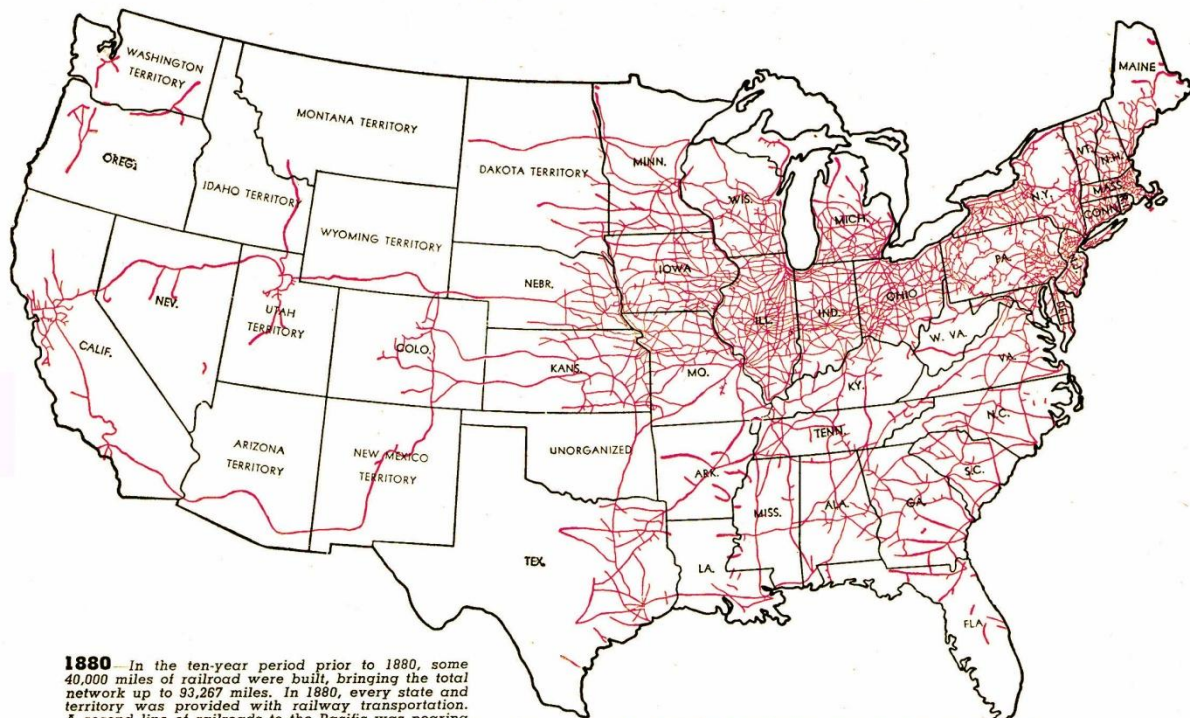
1880—In the ten-year period prior to 1880, some 40,000 miles of railroad were built, bringing the total network up to 93,267 miles. In 1880, every state and territory was provided with railway transportation. A second line of railroads to the Pacific was nearing completion, and other transcontinental railroads were under construction. Railway development was exerting a powerful influence upon immigration and agricultural and industrial growth throughout the country.

Appendix 2. Tables used to support the Long cycle theory.

Table 2, Production of gold, 1810-1930

Date	Total mining of gold (millions of pounds sterling)	Average yearly percentage growth in recent period
1810	160	0.1
1847	207	5.5
1868	531	0.5
1891	733	4.1
1918	1916	0.7
1930	2277	–

Source: Kondratiev, *Mirovoe khozyaistvo*, p. 256.

Table 3, Kondratieff' troughs and peaks

	England	France	United States
trough	1789		
peak	1814		1814
trough	1849		1849
peak	1873	1873	1866
trough	1896	1896	1896
peak	1920	1920	1920

Table 4, Kondratieff's index numbers of commodity prices

Year	England	France	USA	Year	England	France	USA
1780	142	—	—	1832	124	—	117
1781	154	—	—	1833	127	—	114
1782	155	—	—	1834	127	—	103
1783	135	—	—	1835	131	—	116
1784	130	—	—	1836	147	—	106
1785	126	—	—	1837	134	—	124
1786	129	—	—	1838	137	—	120
1787	134	—	—	1839	146	—	123
1788	129	—	—	1840	142	—	115
1789	125	—	—	1841	135	—	124
1790	131	—	—	1842	124	—	106
1791	130	—	121	1843	113	—	100
1792	134	—	128	1844	114	—	101
1793	143	—	136	1845	116	—	102
1794	141	—	—	1846	122	—	105
1795	166	—	179	1847	130	—	105
1796	179	—	—	1848	107	—	100
1797	185	—	193	1849	101	—	97
1798	196	—	190	1850	105	—	101
1799	205	—	181	1851	102	—	105
1800	191	—	—	1852	107	—	101
1801	202	—	192	1853	130	—	107
1802	176	—	158	1854	139	—	111
1803	199	—	162	1855	138	—	111
1804	195	—	174	1856	138	—	111
1805	204	—	179	1857	143	—	110
1806	—	—	175	1858	124	137	100
1807	—	—	165	1859	128	137	99
1808	—	—	162	1860	135	144	99
1809	199	—	174	1861	132	142	99
1810	199	—	186	1862	138	142	140
1811	169	—	180	1863	141	143	125
1812	175	—	183	1864	143	141	149
1813	187	—	214	1865	138	132	122
1814	203	—	265	1866	139	134	166
1815	190	—	208	1867	137	131	156
1816	170	—	178	1868	135	132	141
1817	184	—	180	1869	134	130	138
1818	191	—	172	1870	131	133	143
1819	175	—	164	1871	137	138	125
1820	163	—	132	1872	149	144	129
1821	154	—	127	1873	152	144	124
1822	150	—	130	1874	139	132	122
1823	148	—	124	1875	131	129	115
1824	139	—	122	1876	130	130	107
1825	155	—	124	1877	128	131	106
1826	135	—	119	1878	119	120	102
1827	133	—	119	1879	113	117	95
1828	127	—	116	1880	120	120	106
1829	124	—	116	1881	116	117	104
1830	122	—	107	1882	115	114	106
1831	125	—	117	1883	112	110	105

Year	England	France	USA	Year	England	France	USA
1884	104	101	98	1904	96	94	96
1885	98	99	92	1905	98	98	96
1886	94	95	90	1906	105	104	100
1887	93	92	91	1907	109	109	105
1888	96	96	93	1908	100	101	101
1889	98	100	93	1909	101	101	109
1890	98	100	91	1910	107	108	113
1891	98	98	90	1911	109	113	104
1892	93	95	84	1912	116	118	111
1893	93	94	86	1913	116	116	112
1894	86	87	77	1914	116	118	110
1895	85	85	78	1915	144	149	113
1896	83	82	75	1916	182	192	142
1897	85	83	75	1917	234	273	198
1898	87	86	78	1918	256	364	217
1899	93	93	84	1919	259	288	231
1900	102	99	91	1920	258	214	253
1901	96	95	89	1921	167	154	165
1902	94	94	94	1922	163	161	167
1903	94	96	96				

Table 5, Long-cycle chronologies according to various authors

	1st Kondratieff		2nd Kondratieff		3rd Kondratieff		4th Kondratieff	
	lower	upper	lower	upper	lower	upper	lower	upper
1. Kondratieff (1926)	ca. 1790	1810/17	1844/51	1870/75	1890/96	1914/20		
2. De Wolff (1929)	–	1825	1849/50	1873/74	1896	1913		
3. Von Ciriacy-Wantrup (1936)	1792	1815	1842	1873	1895	1913		
4. Schumpeter (1939)	1787	1813/14	1842/43	1869/70	1897/98	1924/25		
5. Clark (1944)	–	–	1850	1875	1900	1929		
6. Dupriez (1947; 1978)	1789/92	1808/14	1846/51	1872/73	1895/96	1920	1939/46	1974
7. Rostow (1978)	1790	1815	1848	1873	1896	1920	1935	1951
8. Mandel (1980)	–	1826	1847	1873	1893	1913	1939/48	1967
9. Van Duijn	–	–	1845	1872	1892	1929	1948	1973

Table 6, Major innovations by Kondratieff' phases and by single countries

	UK	Germany	France	US	Other	Total
1st K Upswing 1787-1812			1			1
1st K Downswing 1813-1842	8	1	3	2		14
2nd K Upswing 1843-1868		4	2	6	3	15
2nd K Downswing 1869-1897	6	7	1	16	2	32
3rd K Upswing 1898-1923	3	5	1	13	1	23
3rd K Downswing 1924-1953	6	13	1	28	3	51
4th K Upswing 1954-1979	3	2		12	2	19

Source: (Young & Schuller, 1988, p. 47)

Table 7, Schumpeter's long-wave chronology

	prosperity	recession	depression	recovery
1. Industrial Revolution Kondratieff: cotton textile, iron, steam power	1787-1800	1801-1813	1814-1827	1828-1842
2. Bourgeois Kondratieff: railroadization	1843-1857	1858-1869	1870-1884/5	1886-1897
3. Neo-Mercantilist Kondratieff: electricity, automobile	1898-1911	1912-1924/5	1925/6-1939	

Source: Kuznets (1953: 109).