ANALYSIS OF LONG-TERM TENDENCIES IN THE WORLD ECONOMY AND HUNGARY*

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This study tries to prove the fact, that not the national features are characteristic in the Kondratev cycles. Kondratev cycles are global; they are the cycles of the entire world economy.

Economic development realized through introduction of new innovations that means introduction of new products and production-organization methods, opening new markets and finally exploiting new raw materials, therefore we studied the role of basic innovations. The relationship between innovations and long-term cycles has been investigated and the long-term tendencies have been analysed with some empirical results: at first the industrial series then the long waves of plant cultivation. The results of empirical investigations proved the existence of long-term cycles.

KEYWORDS: Kondratev cycle; Century trends; Innovation.

The research of market conditions and the theory of business cycles seem to be arisen in crisis periods. Computations concerning the basic economic factors proved the existence of Kondratev waves. The author carries out a wide scope empirical research in this field being sponsored by the Hungarian Academy of Sciences. The investigation covers the Hungarian industry and agriculture. Processing the data measured in natural units supported by the fact that the currency had been changed during the examined period in Hungary and that makes the data expressed in value terms unreliable. Data collection was limited by the fact that gathering long-term data series is difficult from 1920 because during the period of Second World War the system of data collection was not always formed.

The data set processed in this research consists of some 1000 data.[2] The author improved Kondratev's method and evolved with his collaborators a computer program (for PC computer SPSS 10, Excel and PC with software REGAL) which, following data input, carries out a series of computations. After having tested the computational results, the author

* This research was carried out with the support of Hungarian Scientific Research Fund (OTKA), theme number T 34101, the research is led by the author.

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[2] Data source: Time series of world economics 1860–1960 (1965). 157. p. Data for the period 1961–1999 are from: International Statistical Yearbook. 1965, 1970, 1974, 1981, 1985, 1994, 1996, 1999. Statistical Yearbook of Hungary. 1964, 1971, 1976, 1979/80, 1982, 1983, 1994, 1995, 1996, 1997, 1998, 1999, 2000. Hungarian Central Statistical Office, Budapest.

selects the appropriate secular trend, then makes estimates of the long cycles and delineates them using moving averages. The innovation theories resulting in long cycles are reviewed. The research is focused on empirical investigation and statistical induction. The author's results prove the existence of Kondratev cycles in the investigated fields.

Some members of the economic school of *Farkas Heller* (*Heller*; 1928, 1934) were interested in the work of Kondratev for the first time in Hungary in the 1930s and 1940s. After a long pause historians published studies about Kondratev in the 1980s, and then Kondratev's cycles aroused the interest of economists.

Results of international and Hungarian researches confirm that the causes of Kondratev cycles are not in the ownership of the means of production. Scholars have found the existence of long-term cycles even in the Middle Ages.[3] Based on the experiences gathered till now it seems that there are several equilibrium points around which the economy fluctuates (*Kövér*; 1988). The reason of cyclical fluctuation is the different adaptability of the economic factors, and their different reaction speed. When a course is started then, caused by the effects of different factors on each other, it becomes a self-strengthening mechanism. The turning point is the fact that the longer the distance of economy from the equilibrium is the stronger counter-forces are also getting started, their effects become more and more manifest, and they force the economy to return to and over the equilibrium state again. At what intervals the cycle repeated itself, this is a substantial aspect. Thus cycles can be classified by their duration, that is the returning intervals of the cycle, i. e. the interval within the cycle runs its course. This time interval is called period. The existence of cycles of various periods in economic life means that there are different equilibrium points caused by the fact that commodities and goods perform their own economic functions during very different periods, so their production requires different lengths of time and various sorts of resources.

THE KONDRATEV CYCLES

Kondratev (*Kondratev*; 1980) and *Kuznets* have distinguished equilibrium types of shorter and longer term. At first, Kondratev regards the market supply as constant. Some commodities and goods are consumed in the short term without reshaping and updating. In this category various consumer goods can be ranked, several sorts of raw materials and means of production. The replacement and supplement of stock of these goods can take place within short (1–4 year) periods. In the second, already longer stage Kondratev regards the machinery stock of fixed assets as constant. Large part of means of production (machinery, equipment), are classified among these. *Marx* has found that the material basis of crisis or middle-term cycles returning at ten year interval is the material deterioration, replacement and supplement of means of production because it happens impulse-like (*Kondratev*; 1989).

The Nobel prize winner Kuznets, who is also of Russian birth, discovered the so-called 'secondary secular movements' mainly on the basis of the data of the United

[3] *F. Simiand* investigated the long-term fluctuations of prices and wages from 16th century and has showed that fluctuations lasted several decades. See *Simiand* (1932) p. 16–18. *C. E. Labrousse* has showed long-term cycles using prices of cereals in France and Europe. 1668-[1698]-1732-[1817]-1835-[1871]-1895. The data in brackets mark the culmination of the process i. e. the rising branch turns into declining branch at this time. See *Labrousse* (1933) p. 139–142.

States. He did not regard these movements as cycles but regarded them as ‘waves’ like other contemporary economists. In his opinion this period lasts for 21–23 years. These waves shape a middle-term equilibrium type. Material base of the fourth equilibrium type, the long-term cycle, according to Kondratev is created by depreciation, replacement and increasing of the stock of basic capital goods functioning for many decades. In this category such capital goods as enormous buildings, considerable railways, canal building, soil amelioration equipments, training of qualified workforce etc. can be classified.

The international nature of cycles are showed by *Artis-Kontolemis-Osborn* (1997) analysing the economy of the highly developed G7 group and other European countries as well as the United States and Canada. The cycle is usually asymmetrical, i. e. the duration of the declining branch is longer and deeper than that of the rising branch.[4] The results show that the cyclic behaviour of European countries is closely associated with each other and through Germany with the economies of the United States, Canada and Japan.

The following grouping of business cycles is recognized (*Sipos*; 1997. p. 119–128.).

1. Kitchin cycle (Kitchin; 1923. p. 10–16): 3-4 year short-term cycles concerning the movements of stocks.

2. Juglar cycle (*Juglar*;1862): 6-8 year middle-term cycle (2 Kitchin cycles) which, according to *C. Juglar's* work is called ‘commercial cycle’.

3. Labrousse cycle: 10-12 year middle term cycles (Juglar and Labrousse cycles), these can be explained with the changes in investments.

4. Kuznets cycle (*Kuznets*; 1930): middle term, 20-23 year hyper-cycle (doubled Labrousse cycle).

5. Kondratev cycle (*Kondratev*; 1935. p. 105–115.): 40-60 year long-term cycle (2 Kuznets cycles). Theories clarifying Kondratev cycles have not explained the reason for the appearance of these cycles yet. There are interpretations based on facts related to monetary, agricultural and production (see innovative, demographic, and investment cycles) (*Schumpeter*; 1939), as well as other factors. Since the first oil-crisis in 1973, we were in the declining of the Kondratev cycle, and the rising branch of the Kondratev cycle began at 1995.

6. Changes in secular trends: Historians draw distinctions between 100 (2 Kondratev cycles) and 200-400 year cycles, which may be called century-trend changes. Since the first oil-crisis in 1973, we are in the declining of the secular trends. Secular trends are long-term movements that lasted for more than hundred years in the last thousand years and their nature have been showed on the example of wage and price movements (see Figures 1, 2).

During the last hundred years Kuznets cycles have preceded Kondratev cycles and there were three-three Kuznets cycles during the last two Kondratev cycles. After Word War II the through of Juglar cycles meet the through of Kitchin cycles (*van Duijn*; 1983). According to other views the effects of four cycles are independent (e.g. *Forrester*; 1982). Based on scientific knowledge, at present, it can not be decided which one of

[4] The reason for this is that both century-trend and long-term cycle are in declining branch since 1973.

these theories approaches better the reality. The fluctuation of investments often seems to be as the engine of economic cycle. As mentioned previously the cycles with different duration can be connected with individual type of investments: the Kitchin cycle with investments in stocks, the Juglar cycle with investments in machines and assets, the Kuznets cycle with construction investments and the Kondratev cycle with production of basic capital goods. Naturally other factors may also play a role in causing cycles with different periods (e. g. basic innovation in creating long-term cycles).

When elaborating his procedure Kondratev assumed that he could distinguish the previous components in the time series and random changes.

The 20-30 year long Kuznets cycles were founded later by Kondratev. He fitted polynomial trends to the data and removed the random fluctuations of the residuals by using 9-element moving averages. The details of his method are given in (*Sipos*; 1997).

In this research we followed Kondratev's method. In the first stage we eliminated the trend-effect, and then we used moving averages. For cutting out the shorter cycles we used a nine-element-moving averages.

Kondratev has found four empirical regularities; these are the following.

1. Before or at the beginning of increasing branch of long-term cycles fundamental changes occur in economic life: discoveries and implementations of new inventions; changes in relations of production, widening of world economic relations, changes of circulation of money, increasing of gold production etc.

2. During the increasing branch of long-term cycles social convulsions and changes (revolutions, wars) are more frequent.

3. During the declining branch of long-term cycles the agriculture is also in a long-lasted crisis.

4. During the declining branch of long-term cycles depressions of 8-11 year middle-term cycles are longer and deeper while prosperity phases are short and weak.

On the basis of national and international results in the following we summarize the features of century- and long-term cycles[5]

The century-cycles:

	trough		peak		trough
I.	1250	–	[1350]	–	1510
II.	1510	–	[1650]	–	1743
III.	1743	–	[1817]	–	1896
IV.	1896	–	[1973]	–	2030?

The long-term-cycles:

	trough		peak		trough
I.	1780	–	[1815]	–	1848
II.	1848	–	[1873]	–	1896
III.	1896	–	[1929]	–	1945
IV.	1945	–	[1973]	–	1995?

[5] *Braudel F*. (1980): A tér és idő felosztása Európában. Anyagi civilizáció, gazdaság és kapitalizmus a XV–XVII. században. A világ ideje. In: *Világtörténet*, No 4. p. 3–39.

Nevertheless, the cycles with different periods occur simultaneously, mixing together, and their movements increase or decrease the amplitude of the whole vibration. It is obvious from the illustration that the length of the period of the century trend shortens, which can be explained by the shortening of the length of doubling periods. In *Braudel's* opinion the world is a closed entity so doubling of cycle periods is caused by interference. In a declining branch of century trend in the Middle Ages there was also a demographic ebb and wars occurred more frequently. In contradiction between 1896–1974 (during a rising branch) there were two world wars and several local wars, while doubling time of the population of the world shortened further. Investigating rising branches we can find that firstly the feudal representative monarchies succeeded feudal anarchy (1250–1350), then the absolute monarchy was born in the 16th century in France, the next rising branch (1740–1817) resulted the establishing of national states (constitutional monarchies), the victory of the French Revolution, which was followed by the period of restoration. The rising branch of the last secular trend (1896–1973) brought the birth of the developed capitalist systems and the shaping of welfare states, the victory of socialism in the Soviet Union, Mongolia, then, after 1945, in the East European and in the developing countries (e. g. Cuba, Vietnam, Kampuchea, Ethiopia, Angola etc.). While after 1973 the so-called socialist countries were not able to respond to the challenges caused by turning and declining Kondratev cycle (e. g. restructuring production).

Rising branch of the secular trends is characterized by new intellectual movements such as the Reformation in the first half of 16th century (Luther 1517, Calvin 1541), the Enlightenment in the 18th century and the Marxism in the mid XIXth –XXth century.

Investigation of long cycles has also resulted in that the traditional models cannot describe the development of economy when the cycle is turning. Recent research findings of chaos theory are encouraging on this field. (*Nováky*; 1992. p. 223., *Nováky*; 1993, *Nováky*; 1995. p. 156.)

Relationships between the Kondratev cycles and basic innovations are as follows:

	The basic innovations	The long-term-cycles trough – peak – trough
I.	steam engine (1790–1842)	1780 – [1815] – 1848
II.	railway (1843–1997)	1848 – [1873] – 1896
III.	electricity and car (1898–1949)	1896 – [1929] – 1945
IV.	atomic energy, electronics, aircraft, plastics, PC and biotechnics (1950–2000)	1945 – [1973] – 2000?

Kondratev[6] elaborated his procedure for demonstrating and separating the long waves at the beginning of the 1920s. Globalization proved that the Kondratev theory is not only a hypothesis.

One can see from the following the tendency of the shortening of the length of the period of the century cycles. The lengths of century-cycles were as follows: the first was 260, the second was 233 and the third was only about 153 year long. One can follow the shortening character of the long-term cycles. The first lasted for approximately 68, the second for 48, and the third one for 49 years. The switches of the Kondratev and the

[6] See Kondratev's more important publications in the References.

shorter cycles caused the changes in the ratio of the length of the rising and declining branches. The declining branches of the fourth cycles started with the first oil-crisis in 1973.

The match of the declining branch of the century-trend and the declining trend of the Kondratev cycle caused serious crises in the early 1920s. The example of the two cycles strengthening each other is the convergence of the rising branch of the Kondratev cycle after 1945 and the rising branch of the century-trend cycle. Almost similar procedures of the restoration periods encouraged prosperity.

RELATIONSHIP BETWEEN LONG WAVES AND INNOVATION CYCLES

All components required to the theory of inner dynamics of long waves were at hand for Kondratev. He realised the importance of technical and technological innovations and he was aware of the timing and clustering of innovations. He knew that the inventions have arisen during depression, they were introduced in wide-range at the beginning of the next recovery, and he also recognized that the rising branch of long waves was in line with the increasing production of basic capital goods. But he did not relate one with another, he was not aware that they require their own infrastructure. There is no simple match between long waves and innovation cycles. Long waves are also caused by fluctuations in infrastructural investments.

Van Duijn (1983. p. 129–144.) accomplished the synthesis. He classified the innovations into four categories:

1. major product innovations which create new industries;
2. major product innovations in existing industries;
3.process innovations in existing industries; and
4. process innovations in basic sectors.

On the experiences obtained about introduction of innovations he summarized the propensity to innovate during the four stages of the long wave. Table 1 shows the propensity to innovate for each category of innovations. Major product innovations, which create new industries, will be introduced mostly during the recovery when increasing demand for replacement investment will turn the pessimism of the depression into a more optimistic economic outlook. In existing industries the majority of innovation will be introduced during periods of the depression and recovery since these industries can respond more quickly to the declining branch of a long wave and they are more aware of the life cycle phases of their own products. Changing the technological base of a product is less risky when it is continuously serving the same market, to meet the same need. As soon as the new generation of products (e. g. CDs, DVDs and their players) has gained public acceptance then instead of the need of further and more radical product innovations the improving of technological process comes to the front. Innovations in basic sectors usually can be interpreted as responses to final demand increases. Process innovations induced by demand in producer goods sectors will be introduced mainly during the rising branch of long waves.

Table 1

The propensity to innovate during different phases of the long wave

Type of innovation	Depression	Recovery	Prosperity	Recession
Product innovations (new industries)	+	++++	++	+
Product innovations (existing industries)	+++	+++	+	+
Process innovations (existing industries)	+++	+	++	++
Process innovations (basic sectors)	+	++	+++	++

Note: Number of + signs denote the strength of the innovation propensity.

As Table 1 shows, the overall propensity to innovate is highest during the recovery and lowest during the recession. It also illustrates the contradiction that appears in different opinions about innovation. On the one hand some emphasize the lack of innovations, and on the other hand such expressions as 'chip revolution' and 'information revolution' suggest an abundance of innovations. There is indeed the lack of employment creating product innovations in new industries but there is equally no lack of labour-saving innovations in existing industries. In the field of innovation only the recovery, of which origin can be estimated at turn of the century or millennium can bring breakthrough. The engine of long-term development is the rapid growth of the basic sectors including several basic innovations.

Two kinds of infrastructural investments can be distinguished: one which serves more directly the growth of leading sectors, industrial complexes, harbours and others, and another which provides transportation and communication infrastructure for the economy as a whole. When innovations enter their growing phase, demand for both categories of infrastructural investment will increase, output in the first responding rather more quickly than output in the second one. Long wave prosperity will be therefore characterized by rapid growth in leading sectors as well as rapid growth of infrastructural investment. Overall output growth will be slowed only by productive capacity constraint. During the recession the infrastructure of the economy will approach completion, but multiple lags that are characteristic in investment projects of long duration will possibly make overshooting.

Projection of future demand for infrastructure will be based on extrapolation of prosperity. It is not recognized that the growth in this phase is much higher than the average growth over a complete long wave. The seeds of depression are sown during recession. If firms become engaged in a competition to increase their market share by being the first to reduce unit cost, the outcome of that will be excess capacity. Investment behaviour is basically determined by expectation. Once expectations change (e.g. it becomes abundantly clear that overcapacity is in the making) it is difficult to turn around. The ensuing depression will tend to prolong itself. Initially it is visible that the economy can work out this situation very quickly, but gradually it will become evident that time is necessary in which the excess capacity disposes. It will also become obvious that the former group of growing industries has too limited potential for the future. In such an unfavourable economic environment the propensity to innovate will be low. In the same way that prosperity was extrapolated to give a prosperous future, depression will now be extrapolated to make the economic outlook unnecessarily gloomy. In the absence of any aggressive innovation-promotion government strategy the day will also come when excess capacity

will be eliminated, and even if new growing industries are lacking, the existing infrastructure will need to be renewed. The basic industries may lead to the 'technical recovery'. In itself this cannot sustain prolonged macroeconomic growth, but the important function of investment surge is that it will change the overall economic outlook, thus removing hindrances to innovation and paving the way for a new cluster of growing industries.

Cycles of great innovations, modernizations and technical-economic changes prove the relationship between innovation cycles and long waves as follows. There were five great periods of modernizations[7] and five technical-economical changes in history. The great innovations are:

1. textile steam engine between 1805–1810,
2. railway between 1848–1850,
3. electricity, chemical industry between 1896–1900,
4. flying in air and space, radio, TV between 1946–1950,
5. electronic computer, biogenetics, information revolution in 2000.

It can be seen that the epoch-making inventions have arisen in the declining branch of the Kondratev cycles and in the rising branch basic innovations give a rise to the following considerable technical-economic changes:

– mechanization of sector B (light industry) from 1775–1780 to 1815–1820,
– modernization of material infrastructure from 1815–1820 to 1871–1876,
– mechanization of heavy industry from 1871–1876 to 1928–1933,
– modernization of communication, nuclear technology from 1928–1933 to 1973–1976,
– information processing, automatization, biotechnic systems from 1973–1976 to nowadays.

ANALYSING THE LONG-TERM TENDENCIES

Long-term forecasting requires different approach since in the long term many things may and do change which modify substantially the created, established patterns and/or existing relationships. This makes our prediction inaccurate and misleading and the identification and extrapolation of megatrends becoming essentially confusing. Successful strategy and effective long range planning (e. g. capital budgeting) require calculating the implications of long-term trends and the distinction of such trends from cycles linked with them. Although long-term economic trends can also change, it is not probable to do so since by definition they lasted for a very long time and therefore they would be regarded as the implications of the free market economic systems. Thus this kind of trends can be extrapolated with acceptable confidence, if we have a reason to suppose that the present economic system will change in some basic manner.

In the following we try to characterize the changes of century trend with some long-term time series.[8] Figure 1. shows the estimated real daily wages in England from 1264.

[7] Based on *Szabó* (1983. p. 461.).
[8] Data source: *Makridakis–Wheelwright–Hyndman* (1998. p. 642.) figures are prepared by the author.

It indicates clearly that real wages increase exponentially, at first about from 1625 to 1725 as a consequence of the effect of first agricultural revolution (*Makridakis–Wheelwright–Hyndman*; 1998), secondly from about 1800 due to the impact of industrial revolution. Since real wages are increasing, also real GNP and wealth do so, which rise exponentially at least from 1800. Real wages have increased from 4.41 pounds/day in 1260 to 45 pounds/day by 1994 so during 735 years the growth is greater than tenfold, this means average 0.2 percent annually.

To the original series which show the change of real daily wages in pounds, England between 1260–1994, second degree parabolic and exponential trends were fitted. The second degree parabolic (R^2 = 0.7614) trend fits better than the exponential one (R^2 = 0.4921). Since there are difficulties in comparing data so they can regard as estimations.

Figure 1. Changes of real wages in England, 1260–1994

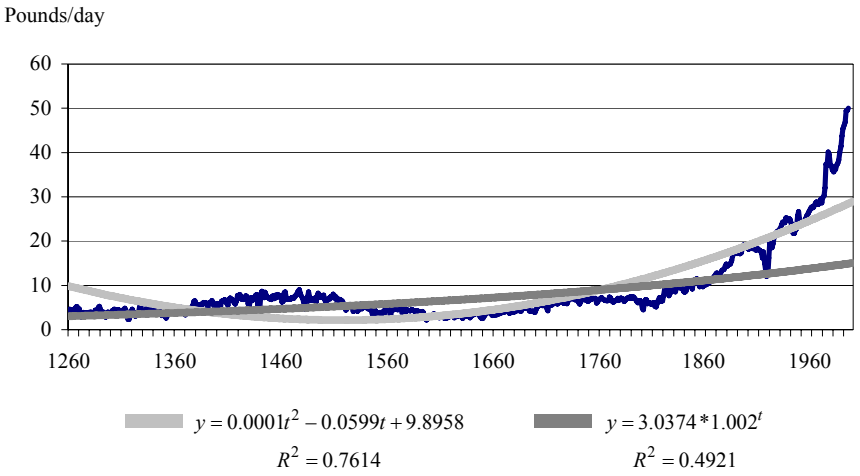


Figure 2. Wheat prices in constant 1996 pounds, 1264–1996

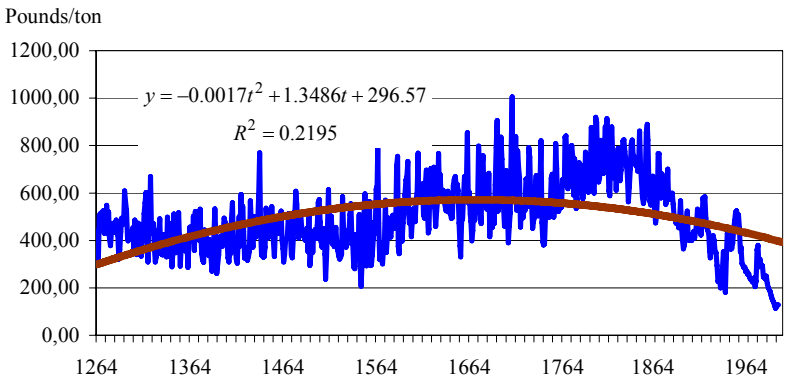


Figure 2. presents real wheat prices since 1264. A significant decrease can be seen from about 1800 when the industrial revolution have started and exerted its effects on agriculture. Since then wheat prices have decreased exponentially since supply exceed demand (although population have risen sixfold between 1800 and 1997 increasing demand considerably) so forcing real prices to decrease. The starting price was 385 pounds/ton in 1234, the highest price in 1710 was 1006 pounds/ton, in 1993 and the lowest wheat price was 113 pounds/ton. The original data show a considered fluctuation around the parabolic trend of the second degree.

Figure 3. illustrates the prices of crude oil (USD/barrel) between 1870 and 1997. The starting price of 49 (USD/barrel) in 1870 decreases to 21 (USD/barrel) by 1997. Oil crisis can be seen well since the unit price per barrel increased in 1974 by 57 percent compared to the previous year, while in 1980 it increased by 50 percent compared to the previous year. The second degree parabolic trend forecasts increase in 2000 and the real price reaches the forecasted price of 30 (USD/barrel).

Figure 3. Changes of crude oil prices in world market, 1870–1997
(in constant 1997 USD)

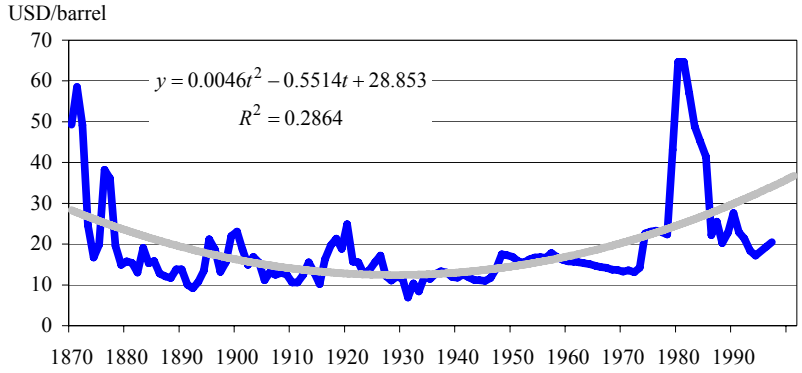
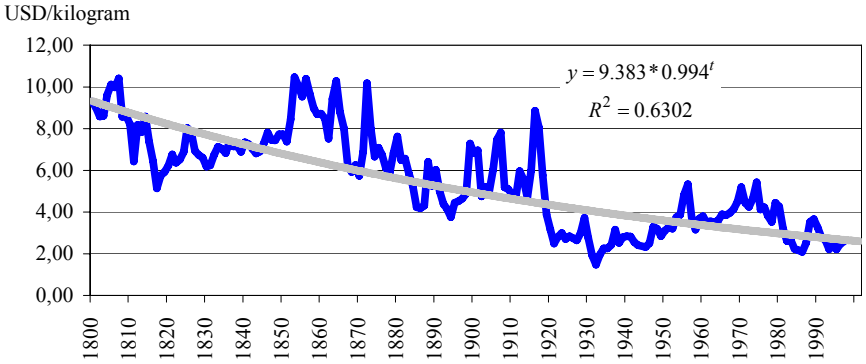


Figure 4. shows the decreasing tendency of copper price in the long-term.

Figure 4. Copper price, 1800–1997
(in constant price level in 1997 USD)



The tendency of copper price changes is shown in Figure 4. in constant price level in 1997 USD from 1800 (which is a proper starting point since the implications of Industrial Revolution have started around this time). It displays the exponentially decreasing trend and a lot of cycles with different duration and length ($R^2 = 0.6302$).

Although long-term economic trends can also be changed it is not likely that it happens as by definition, they have lasted for a very long time, being the outcome of the economic system of free competition. Such trends can, therefore, be extrapolated with a reasonable degree of certainty unless we have reasons to believe that the present economic system will change in the future.

These examples and further investigations (*Makridakis-Wheelwright-Hyndman*; 1983, p. 459.) show that the price, excluding inflation, of most standardized (commodity type) products or services decreases. The implication of decreasing behaviour of real prices in the long run is that the firms have to improve their productivity continuously through technological and/or organizational innovation in order to be able to reduce their costs and real prices permanently. That is true at least for the companies producing standardized goods. Moreover it is possible that such decreasing behaviour will keep on in the future. Even it can accelerate as a consequence of the recent information revolution. Since the beginning of information revolution real income increases in countries of free market economy (EU, United States, Canada) although this increase is characterized by cyclical volatility. Long-term forecasting must accept the great consistency of long-term trends and the substantial degree of uncertainty (as we cannot forecast their turning points statistically), accompanied by considerable fluctuation around these trends. Success and high profits must come from the technological and other innovations and the use of these innovations for opening new markets and meeting new customer needs since almost all existing needs have already been satisfied.

KONDRATEV CYCLES IN THE HUNGARIAN ECONOMY

In the following we introduce some empirical results for the Hungarian economy. Extrapolation of long-time trends is limited by the fact that little or no historical information are available, much less data series go back to 1800. In such cases analogies can be used for making possible that the forecasters prepare prognoses based on similar situation on which past data or gathered experiences are available. Short-term analogies are used to forecast implications of special events or competitive actions based on past examples. In the medium term for example they are applied to the evaluation of length and depth of recessions, comparing current recession with all the recession occurred after the Second World War. Similarly in the long run the sales of such new products or services which are based on past demand of similar products are used for prediction. World-wide interest towards research of market conditions and in the theory of business cycles is usually arisen during crisis periods. Computations concerning the basic economic factors proved the existence of Kondratev-waves.

Evaluating the empirical results for Hungary[9] the following factors are to be taken into account. Hungary has lost 71.3 percent of its original territory and 63.3 percent of its

[9] Data source: Time series of world economics 1860–1960 and Statistical Yearbook of Hungary 1960–1999. *K. Brenkus*, student of Budapest University of Economic Sciences and Public Administration have also contributed to the data collecting.

inhabitants after the Trianon peace-treaty (4th June 1920).[10] This differences are so considerable that they cannot be corrected by computing per capita data. Hungary became a new economic unit from the 1920s.[11] That is why we accomplished the empirical investigations again considering the period between 1920 and 1999 except for natural gas production since data are available only from 1945. We have applied only data measured in natural units since the value and mixed measures contain high uncertainty as the currency in Hungary has changed several times between 1920 and 1946.[12] The empirical study covered the field of industry (including the production of steel,[13] brown coal, lignite, coal and natural gas) and agriculture (including the production of wheat, maize, sugar and potato and livestock of pigs). For the better comparison *per capita* data were used. The dimensions of per capita data were ton/capita and after multiplying by thousand it became kilogram/capita. This paper analyses the Hungarian steel production in details while some results of production of other goods can be seen in Table 2.

At first we fitted an analytical trend to the data series, namely a second-degree parabolic trend, since there was a turning point in time series. In the next step we computed the estimated values and the difference between original and estimated data. That is the way how we eliminate the change of secular trends. Considering that century trend was in the rising branch in world economy between 1896 and 1973 (in our study it happened between 1920 and 1973) and after 1973 it turned its declining branch, fitting the second-degree parabolic trend was reasonable. In the last step we presented the long-term cycles by using a 9-element moving average. So the effect of random changes as well as 3 and 9 year cycles have been eliminated.

In Figure 6 the dark line shows the time series of steel production (kilogram/capita) between 1920 and 2000 and the bold line depicts the second-degree parabolic trend function. The equation of the second-degree parabola is the following:

$$y = -0.0721t^2 + 9.8628t - 66.518 ,$$

where t = time variable (t = 1,2,...).

Initially parabola shows increase then decrease since the coefficient of t is positive while that of t^2 is negative. The coefficient of multiple determination (R^2) demonstrates a rather good accuracy of fitting:

$$R^2 = 0.7267$$

Figure 7 illustrates the difference between the original data and the estimated trend function (dotted line) and its 9-element moving averages (the continuous line) showing Kondratev cycle. Accordingly, steel production was in the declining branch between 1932 and 1951 and it was in the rising branch between 1951 and 1983 in Hungary. Difference or delay from the world tendency is 3–10 years. In Hungary the rising branch started later (1951 versus 1948, 3 year lag) and the beginning of the declining branch shows greater delay during the oil-crisis (1983 versus 1973, 10 years lag).

[10] Új Magyar lexikon (1962). Akadémiai Kiadó, Volume S–Z, p. 504.
[11] Because of secession from Austro-Hungarian Monarchy, the territorial rearranging and the ravages of war difficulties.
[12] Korona existed from 1892 to 1926, pengő from 1927 to 1946 and forint from 1946 until now.
[13] Data are available up to the year 2000.

Figure 6. Changes in steel production, 1920–2000 in Hungary
(original data and trend line)

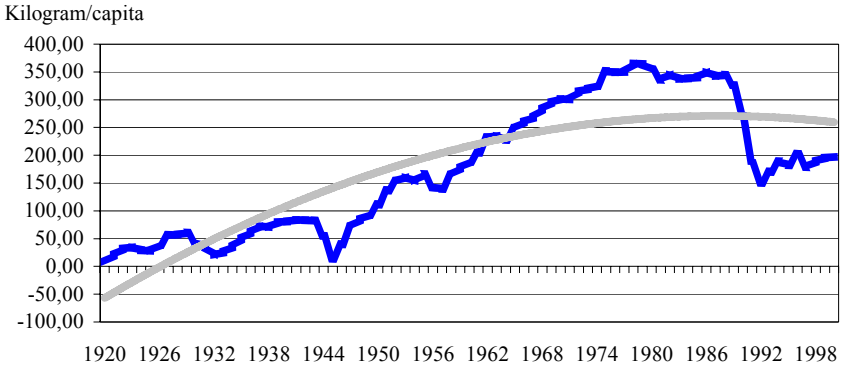
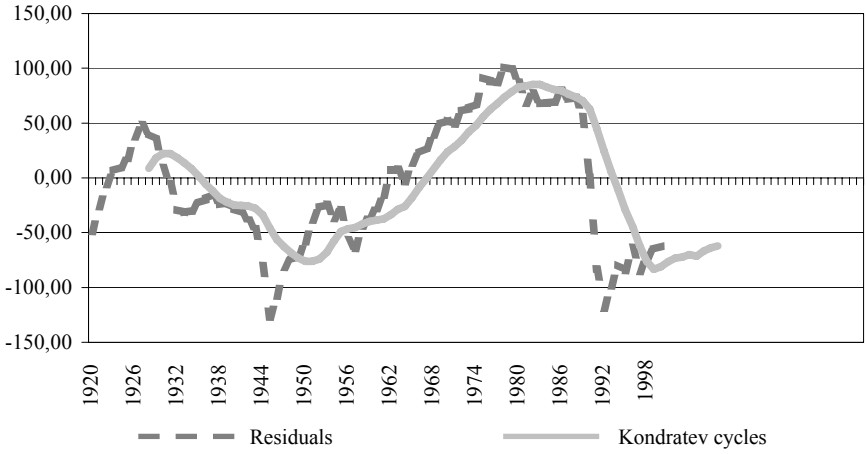


Figure 7. Residuals and 9-year moving average of steel production, 1920–2000



The lowest level of steel production was 7.8 kilogram/capita in 1920, and then it rose to 1929 reaching 59.89 kilogram /capita, trough of the declining branch was in 1945 (14.3 kilogram/capita), it reached the maximum in 1986 (350.38 kilogram /capita),[14] then its fluctuation decreases gradually to 195.7 kilogram/capita in 1999. As far as the historical background of the steel production is concerned, after 1920, the consolidation, initiated by *István Bethlen* the prime minister, created better conditions for coping economic difficulties and a slow growth begun. In steel production for example the Bessemerian process was considered obsolete and the electric steel production was introduced. Prosperity was broken by the Great Depression in 1929 that afflicted strongly the heavy industry including the steel production. Production was 514 thousand tons in 1929 in Hungary then it decreased to

[14] At the same time steel production decreased considerably, for example in Great-Britain the per capita steel production was significantly lower in 1986, 259 kilogram/capita than in Hungary (350.38 kilogram/capita)

180 thousand tons by 1932. The signs of prosperity became visible really in 1935, that can be accounted also for war preparations. After 1945 the forced development of heavy industry had effects also on steel production, which can also be seen in Figure 6. The reason is that the Communist party wanted to transform Hungary to the country of iron and steel. After a short decrease between 1956 and 1958, increase continued till 1986. Following the transition the decline was considerable, steel production decreased from 3700 thousand tons in 1986, to almost its half, 1980 thousand tons in 2000.

Table 2 supports the previous statements with some empirical results. It shows among others the long-term cycles of production of brown coal and lignite. Declining branch lasted from 1920 to 1951; a rising branch followed it till 1967 since then a declining branch can be seen again. Between the two world wars the exploitation of capacity of coalmines was low. There was no improvement in the technical equipment and further coal-pits were not opened. Following the Second World War the investments increased and production growth can be observed. This tendency lasted up to 1965, at this time production was the highest (2670 thousand tons), from this time coal production was limited in contrast to the cheaper carbo-hydrogene with higher calorific value. Similar tendency depicts the long-term cycles of hard coal production. Between 1920 and 1953 we have found a declining branch, between 1953 to 1973 a rising branch, after 1973 a declining branch began again.

Table 2. also illustrates the long waves of natural gas. Because of the shortness of time series, we can show only one rising branch between 1967 and 1986. This differs considerably from world tendencies. The domestic natural gas production began only during the Second World War, the rising branch lasted till the beginning of the 1980s.

Table 2. presents the production of some agricultural products as well. Among these we illustrate the long waves of plant cultivation. In the long waves of wheat production fluctuation is not considerable and it is opposite to the world tendency: 1920-[1940]-1966-[1990] (where the years in brackets mark the peaks). The great depression between 1929 and 1933 afflicts less the wheat production than heavy industry. In 1934 the average production was 198 kilogram/capita that reaches the maximum of 695 kilogram/capita in 1984 and decreased to 265 kilogram/capita in 1999. Table 2. also presents the long waves of domestic maize production. From 1920 to 1955 a declining and between 1955 and 1983 a rising branch could be observed. The long-term cycle approaches the world tendencies: from 1931 to 1947 a declining, from 1947 to 1968 a rising branch could be showed, after 1968 the movement is irregular but it was above the equilibrium axis to 1995 when it intersects the axis.

In the long-term cycles of potato production from 1920 to 1945 a rising, from 1945 to 1954 a declining then from 1954 to 1963 again a rising branch could be seen. The long-term cycles do not coincide with the world tendencies.

The long-term cycles of pig-breeding is characterised by a declining, from 1920 to 1953, a rising branch from 1953 to 1988. The long-term cycles move partly along with the world tendencies.

The results in Table 2 show that the increasing branch of Kondratev cycle II has not started in harmony with world tendencies, in 1945. The delay in the case of the steel, brown coal and lignite and hard coal production are 6–6 and 8 years respectively, while for agricultural products the lag is even longer, 8–11 years, except for sugar-beet, where it is only 2 years.

Table 2

Summary of empirical results for Hungary

Observed time series, Hungary. Production of	Observation period		Cycle I					Cycle II				
	period	duration (year)	Rising branch (year)		Declining branch (year)		Duration of cycle (year)	Rising branch (year)		Declining branch (year)		Duration of cycle (year)
			period	duration	period	duration		period	duration	period	duration	
Steel	1920–2000	81			1932–1951	20		1951–1983	33	1983-		
Brown coal and lignite	1920–1999	80			1920–1951	32		1951–1967	17	1967–		
Hard coal	1920–1999	80			1920–1953	34		1953–1973	21	1973–		
Natural gas	1945–1999	55						1967–1986	20	1986–		
Wheat	1920–1999	80	1920–1940	21	1940–1966	27	48	1966–1990	25	1990–		
Maize	1920–1999	80			1920–1955	36		1955–1983	29	1983–		
Sugar-beet	1920–1999	80			1931–1947	17		1947–1968	22	1968–		
Potatoes	1920–1999	80	1920–1945	26	1945–1954	10	36	1954–1963	10	1963–		
Pigs	1920–1999	80			1920–1953	34		1953–1988	36	1988–		

The declining branch of Cycle II also appears with delay except for hard coal production, which turned in declining branch in 1973 and the brown coal and lignite production where the cycle turned earlier.

These delays, besides the mentioned economic factors, are closely related to political ones. The impact of the most important political events to the long term economic movements is clear. In the second half of the last century the Hungarian economy was an appendage of the Soviet economy and policy, the political events and changes in the Soviet Union and in Hungary modified and shifted the long term cycles analyzed before. Among these the changing political and economic periods conducted by Stalin, Hrushtsev, Breshniev an Gorbatshov, and the most important events of the Hungarian political – economic life (the crisis of the 1950-s, the revolution in 1956, the consolidation and the experimental reforms of the Kádár era, the new economic crisis of the late 1980-s and the transition) are to be mentioned.

It is obvious that the impacts are mutual: some political changes are forced by long-term economic movements, manifested just in the investigated long term cycles. This happens, even if sometimes the influence or even the existence of these cycles are denied. Political events are often connected to persons, political leaders but the driving force can always be sought in the economy and in the long-term cycles.

CONCLUSION

This study tries to prove the fact, that the Kondratev cycles are not characterised by the national features. Kondratev cycles are global; they are the cycles of the entire world economy, even if significant time-shifts of the cycles of different economics can be observed.

Economic development is realized through introduction of new innovations that means introduction of new products and production-organization methods, opening new markets and exploiting new raw materials, therefore we studied at first the role of basic innovations. We have investigated the relationship between innovations and long-term cycles. We have found that in the declining branch of Kondratev cycles with duration of 50-60 years, have arisen those epoch-making inventions in the past 200 years which then turned to the declining branch of cycle making the prosperity possible. It is a general experience that before or at the beginning of increasing branch of long-term cycles substantial changes take place in the economy; arising and introduction of inventions, changes in production relation, broadening of connections in world economy, changes of money circulation, increasing of gold production, etc.

There is no simple match between long waves and innovation cycles. Long waves are also caused by fluctuations in infrastructural investment. Two kinds of infrastructural investments can be distinguished: one which serves more directly the growth of leading sectors, and another which provides transportation and communication infrastructure for the economy as a whole. When innovations enter their growing phase, demand for both categories of infrastructural investment will increase, output in the first responding rather more quickly than output in the second. Long wave prosperity will therefore be characterized by a rapid growth in leading sectors as well as a rapid growth of infrastructural investments. In the absence of any aggressive innovation-promotion government strategy

the day also will come when excess capacity will be eliminated, and even in the lack of new growing industries, the existing infrastructure will need to be renewed.

At last we have shown some empirical results of long waves for industrial series and plant cultivation. The results of empirical investigations proved the existence and the global feature of long-term cycles.

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