WAVES OF THE CHANGE AND CHANGE OF THE WAVES
(Analysis of the Shortening of the Kondratiev Waves by Moving Sub-Periods)

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1. Introduction to the problem

Kondratiev waves of economic conjuncture are of special interest for sociology. The reason is the fact that they are not purely economic phenomena but also related to a number of other aspects of social development – technical and technological progress, politics, culture, peace and war, etc. Above all, they describe processes related not only with economic development of particular country but also with the whole world economic development. One of the most important problems of Kondratiev waves is the problem about their **period**. Could we claim that Kondratiev waves of economic conjuncture are **shortened** nowadays? Because it is obvious that the third and the fourth cycle are undoubtedly shorter than the first and the second ones[1]. This is probably due to the fact that history accelerates its rhythm and social time "compresses"[2].

An interesting and original conception about the shortening of the Kondratiev waves is suggested by Professor Vladimir Pantin[3]. He distinguishes two types of waves. The first one he describes as "waves on the border between the centuries". Such waves are the first one, described by Kondratiev himself, which continued from the end of XVIII to the middle of the XIX century, the third – from the end of XIX to the middle of the XX century, and the current fifth wave which started at the end of XX century. Professor Pantin denotes the second type as "waves from the middle of the century". Such waves are the second one – from the middle to the end of XIX century, and the fourth – from the middle to the end of XX century (Pantin 1996: 57).

For the **first type** of waves **its increasing part** is connected with radical industrial and technological revolution (**technological upheaval**). After that – for **the decreasing part of**

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[1] The first and the second waves are with period 50-60 years while the third and the second waves are with period 40-45 years.
[2] Using the acceleration of the speed of the history Braudel explains the shortening of the secular trend (Braudel 2005: 69).
[3] Vladimir Pantin is a professor of the Moscow State University of International Relations (MGIMO), chief researcher of the Institute of World Economy and International Relations, Russian Academy of Sciences.

the wave – the economic growth is unstable, followed by "**great depression**" and "**great disturbances**" of the world's economy and politics (Pantin 1996: 57).

For the **second type** of waves **the increasing part of the wave** is connected with geo-political and geo-economical revolution (**revolution of the international market**). As a result conditions – new of a principle – are created for distribution of the new technologies and new branches of manufacture, which have already been established in the previous Kondratiev wave. When this new manner of manufacture is spread from the centre of the international trading to the semi-periphery and periphery, and its potential is exhausted, only then **the decreasing part of the wave** begins. It is characterized with **structural crisis** – a crisis of existing specialized and technological structure as well as a crisis of the related social structures and institutions.

The structural crisis of the economy and society creates preconditions and leads to **new industrial and technological revolution** – **a new spiral** of technological, economical and political development of the international market starts (Pantin 1996: 58).

Thus, according to Pantin, one cycle of the international market's evolution includes two Kondratiev waves. He adduces a number of arguments. He also refers to the research of a number of authors, such as: Piatier, Glazov, Freeman, Maevski, Kulpin and especially Braudel, who indirectly supports his thesis (Pantin 1996: 58-61). Increasing and decreasing waves which twice succeed each other form **four-phase cycle of the international market's evolution**. Although it is possible to look over the cycle with whatever phase, Pantin suggests the phase of "**structural crisis**" to be considered as a beginning. He points out that during this phase the preconditions for the growth of the following new manner of manufacture are created (Pantin 1996: 58). By using **qualitative methods,** he suggests the following chronology of the international market's evolution (Table 1).

Table 1

Dating of the evolution of the international market

Cycle	Phase of the whole cycle of the evolution of the international market since XVIII century	Dating	Duration
1	1. Structural crisis	1753 – 1789	Approx. 36 years
	2. Technological upheaval	1789 – 1813	Approx. 24 years
	3. Great disturbances	1813 – 1849	Approx. 36 years
	4. Revolution of the international market	1849 – 1873	Approx. 24 years
2	1. Structural crisis	1873 – 1897	Approx. 24 years
	2. Technological upheaval	1897 – 1921	Approx. 24 years
	3. Great disturbances	1921 – 1945	Approx. 24 years
	4. Revolution of the international market	1945 – 1969	Approx. 24 years
3	1. Structural crisis	1969 – 1981	Approx. 12 years
	2. Technological upheaval	1981 – 2005	Approx. 24 years
	3. Great disturbances	2005 – 2017	Approx. 12 years
	4. Revolution of the international market	2017 – 2041	Approx. 24 years

It is here that we reach Pantin's thesis about **shortening of the Kondratiev waves**. According to him, the decreasing part of the fourth Kondratiev wave (structural crisis of the international market's third cycle) continued from 1969 to 1981, i.e. it covers only 12 years. This thesis stands on the contrary to the widely spread opinion, including the thesis of Nikolov, who thinks that the decreasing part of the fourth wave continued from 1966 to 1985 (Nikolov 1985: 43). Pantin's expectations are that the decreasing part of the next Kondratiev wave (the great disturbances of the third cycle of the international market whose start he dates in 2005) will also continue 12 years.

To sum up, the considerably shorter period of the decreasing parts of the waves in the end of XX century is the reason for the shortening of the Kondratiev waves. We have to notice that Pantin's substantial analysis, supporting his thesis as well as his criticism of the concept (he calls it "dogma") for the same periods of the former Kondratiev waves, are quite convincing. However, the most important point is that his forecasts (for example, forthcoming world economic crisis and widely large wars) have been realized with terrible power[4].

It is here to point out that the idea about the **quantitative method's** search for proving the Kondratiev waves' shortening belongs to Pantin himself. Since he was aware of our research into Kondratiev waves, he asked us whether it was possible, except the qualitative methods which he uses, to find out also **quantitative methods** for analysis of this problem –

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[4] In his next book Pantin himself mentioned this fact (Pantin, Lapkin 2006: 309-313).

the shortening of the Kondratiev waves. The following method which uses **moving sub-periods** is the result of our efforts to answer this question.

2. Method

Throughout our research of cyclic recurrence, we have been using own modification of Bayesian spectrum analysis which is described in details in Naidenov, Haralampiev (2007: 127-132). One of the special aspects of this modification is that the trend and the cycles are described by functions of the same type – the so-called harmonic functions. This fact poses the following question: when we receive harmonic function with particular period how to reveal whether it describes a trend or a cycle. As a criterion reliable enough for distinguishing between the trend and the cycles, we have accepted that there have to be at least one whole cycle and the half of the other in the time series of raw data. As long as the period of harmonic function is under two thirds of length of raw data's time series, we accept that this function describes cycle. Thus, if we need to reveal Kondratiev waves, whose period is 45-60 years, then the time series with raw data have to be at least one and half time longer, i.e. not less than 90 years.

If, however, the time series with raw data is longer than 90 years, we could adapt and use one statistical technique known as moving averages. In our situation this technique can be described in the following way:

- We take the first 90 terms of the time series and apply Bayesian spectrum analysis. All harmonic functions with a period less than 60 years describe real cycles;

- We exclude the first term of the initial time series and include the 91st. In this way we deal again with time series of 90 terms. The Bayesian spectrum analysis is once again applied;

- We exclude the second terms of the initial time series and include the 92nd. And so on until we finish the whole initial time series.

This algorithm gives us an opportunity to examine cyclic recurrences for time sub-periods which slowly move forward in time. It helps us to reveal whether the periods of the waves are shortened or not.

3. Data

Until now we have used only data for Bulgaria and Russia in our research. There are nine indicators out of the ten, previously analyzed by us, which allow us to use moving sub-periods because the time series are long enough (longer than 90 years). These are:

A) For Bulgaria:

- coal extraction per capita: there are data for the period 1896-1997, i.e. 102 years;

- index of the wage of ordinary worker: there are data for the period 1896-1991, i.e. 96 years;

- price index of the foodstuffs and non-foodstuffs: there are data for the period 1899-2009, i.e. 111 years.

B) For Russia:

- coal extraction: there are data for the period 1860-1990, i.e. 131 years;

- output of pig-iron and steel: there are data for the period 1892-1990, i.e. 99 years;

- gross domestic product, industrial production and national wealth: there are data for the period 1900-2000, i.e. 101 years.

The data for Bulgaria are taken from the statistical yearbooks of the Kingdom of Bulgaria and the People Republic of Bulgaria. The data for the natural indicators in Russia are taken from statistical yearbooks of USSR (Народное хозяйство СССР) and also from the first statistical yearbook of Russian Empire – Ежегодникъ Россіи 1904 (Годъ первый), СПб., 1905. The data concern the whole territory of the Russian Empire and the later USSR which covered the same territory. The data for the value indicators are taken from the book of Simchera "Development of Russian Economic for 100 Years – Historical Series" (Simchera 2006: 322-324, 134-136, 49-51).

4. Results

The results from applying the method are shown in the form of tables and graphs in Appendix 1. In the tables are presented the periods of all revealed cycles. In the graphs are represented only Kondratiev and Menshikov waves. Moreover, in the column "Kondratiev waves" we include also waves with periods between 40 and 45 years which we call "non-classical". In the same manner in the column "Menshikov waves" we include also waves with periods between 25 and 30 years which we call also "non-classical".

5. Analysis of the results

5.1. Analysis of the results for Bulgaria

A) **Kondratiev waves appear incidentally** in the time series of the coal extraction per capita only when we analyze four sub-periods (Table 1 and Figure 1 in Appendix 1). However, in two of the sub-periods appear classical waves whereas in the other two sub-periods – non-classical waves. These poor results do not allow us to make definite conclusions about the shortening of the Kondratiev waves concerning this indicator.

B) Upon analyzing the index of the wage of ordinary worker, appear both classical and non-classical Kondratiev waves (Table 2 and Figure 2 in Appendix 1). **The classical waves have period which is stable over time**, even it slowly increases when we include the last year of the initial time series. The non-classical waves have periods which both increase and decrease over time. For this indicator we also could not claim that Kondratiev waves shorten, however have to take into consideration that this is the shortest time series for Bulgaria.

C) The price index of the foodstuffs and non-foodstuffs is the largest time series for Bulgaria (Table 3 and Figure 3 in Appendix 1). Besides, it extends most forward over time – till 2009. This fact allows us to make some interesting conclusions – first of all, **when we include 1991 all kinds of waves disappear**, not only Kondratiev waves but also all others. **Only when we include 2001, then Kondratiev waves appear again** and when we include 2002, then other waves appear. This fact confirms empirically our previous observation that the transition in Bulgaria could be divided into two sub-periods – before 2001 and after 2001 which are substantially different (Naidenov 2010). Also it confirms the methodological note that, if we want to "catch" Kondratiev waves, the covered period directly after considerable qualitative change has to be larger than few years. Secondly, **Kondratiev waves after including 2001 are 10 years longer than the Kondratiev's waves before including 1991**. Third, and most important, **Kondratiev waves shorten their periods over time**.

5.2. Analysis of the results for Russia

A) The coal extraction is the largest time series for Russia (Table 4 and Figure 4 in Appendix 1). Besides, it extends most backward over time – till 1860. This fact allows us to make some conclusions. First of all, **before including of 1957 the classical Kondratiev waves increase their periods**. Second, **when we include years between 1958 and 1967 the periods of Kondratiev waves are stable over time**. Third, **after we include 1968 the classical Kondratiev waves start to shorten**. Fourth, it is obvious that except the line of

classical Kondratiev waves, there is another line of **shortened waves with periods between 37 and 34 years**. The problem is how to **identify** them. On the one hand, we could consider them as Menshikov waves. However, on the other hand we could consider them as **non-classical Kondratiev waves**. Thus, if the Pantin's hypothesis for shortening of Kondratiev waves is true (and our research for Russia confirms this), then the period of these waves completely correspond to the 36 years duration of the fourth cycle of the world conjuncture defined by him.

B) The situation in the output of pig-iron (Table 5 and Figure 5 in Appendix 1) and steel (Table 6 and Figure 6 in Appendix 1) is quite similar and, in broad outlines, it repeats the conclusion done for coal extraction – **the common tendency is the classical Kondratiev waves to transform into non-classical and they themselves to transform into Menshikov waves (or into non-classical Kondratiev waves if we accept the other identification)**. The new point is that **at the end of the period appear classical Kondratiev waves**. We can make a suggestion that the matter is similar to the dynamics of the price index of the foodstuffs and non-foodstuffs in Bulgaria. Namely, after the break there appear Kondratiev waves 10 years longer than before the break. Of course differences also exist. First of all, there is no break in Russia. Second, the longer Kondratiev waves appear in Russia when we include 1989, rather earlier than in Bulgaria where the longer Kondratiev waves appear only when we include 2001. Unfortunately, the lack of data for Russia does not allow us to suggest how these waves will develop forward – whether they are only incidental phenomenon or they will start to shorten like the Kondratiev waves of the price index of the foodstuffs and non-foodstuffs in Bulgaria. However, this phenomenon – together with classical Kondratiev waves to exist also non-classical – seems to be normal.

C) Similar situation appears also when we analyze the value indicators. For gross domestic product (Table 7 and Figure 7 in Appendix 1) and industrial production (Table 8 and Figure 8 in Appendix 1) **the common tendency is the classical Kondratiev waves to transform into non-classical and they themselves to transform into Menshikov waves**.

D) **The periods of the Kondratiev waves of the national wealth** (Table 9 and Figure 9 in Appendix 1) **shorten by altering from classical to non-classical waves but they remain only in the bounds of the Kondratiev waves and never transform into Menshikov waves**.

6. Conclusions

To sum up, the results for Bulgaria are contradictory – **only for one of out of the three indicators we have found that Kondratiev waves undoubtedly shorten their period**.

In the same time the results for Russia speak for themselves – **for all analyzed indicators Kondratiev waves shorten by consecutive transformations over time from classical Kondratiev waves to non-classical ones and then to Menshikov waves. The Menshikov waves (in upper part of time period) as a period as well as time of manifestation correspond to the time and the period of the fourth cycle of the world conjuncture according to Pantin's conception**.

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Table 1

Periods of the waves in the coal extraction per capita (Bulgaria)

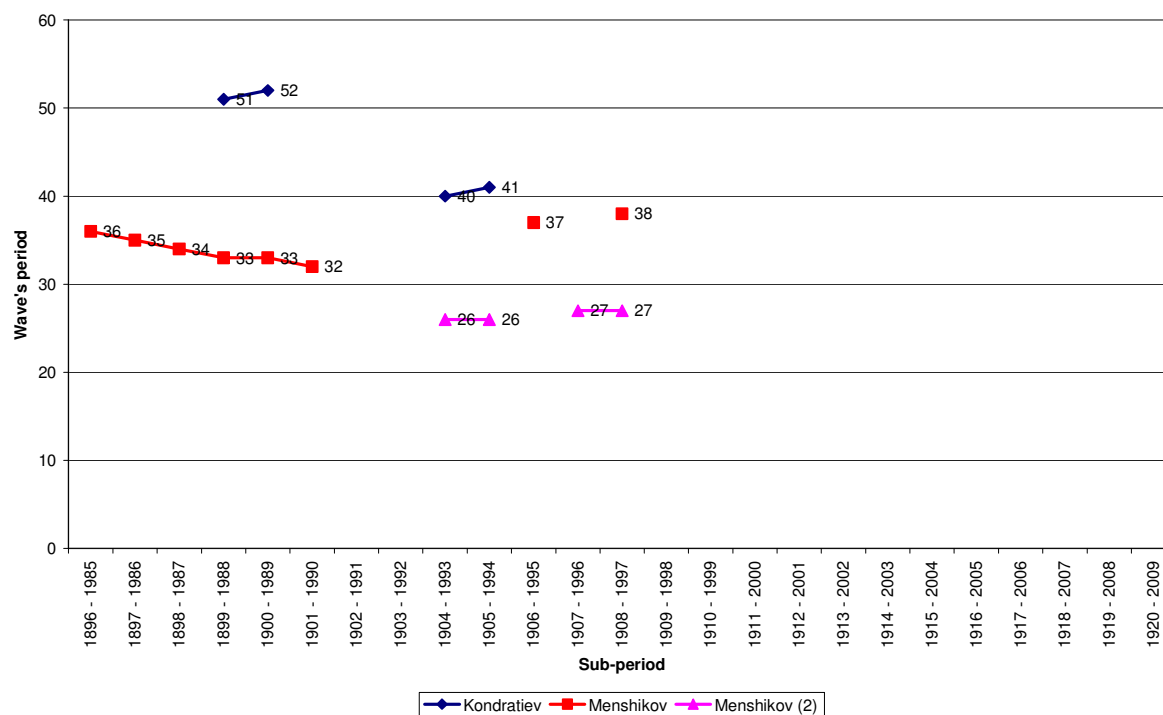| Sub-period	Waves					
	Kondratiev (45-60)	Menshikov (30-40)	Kuznets (15-25)	Intermediate (12-14)	Juglar (7-11)	Kitchin (3-5)
1896 – 1985		36	17;20;25			
1897 – 1986		35	17;20;25			
1898 – 1987		34	20;25			
1899 – 1988	51	33	24			
1900 – 1989	52	33	19;24			
1901 – 1990		32	15;18			
1902 – 1991			18;22			
1903 – 1992			18;22			
1904 – 1993	40	26	17			
1905 – 1994	41	26	17;20			
1906 – 1995		37	17;20			
1907 – 1996		27	17;20			
1908 – 1997		27;38	16;20	14		

Figure 1. Kondratiev and Menshikov waves in the coal extraction per capita (Bulgaria)

Table 2

Periods of the waves in the index of the wage of ordinary worker (Bulgaria)

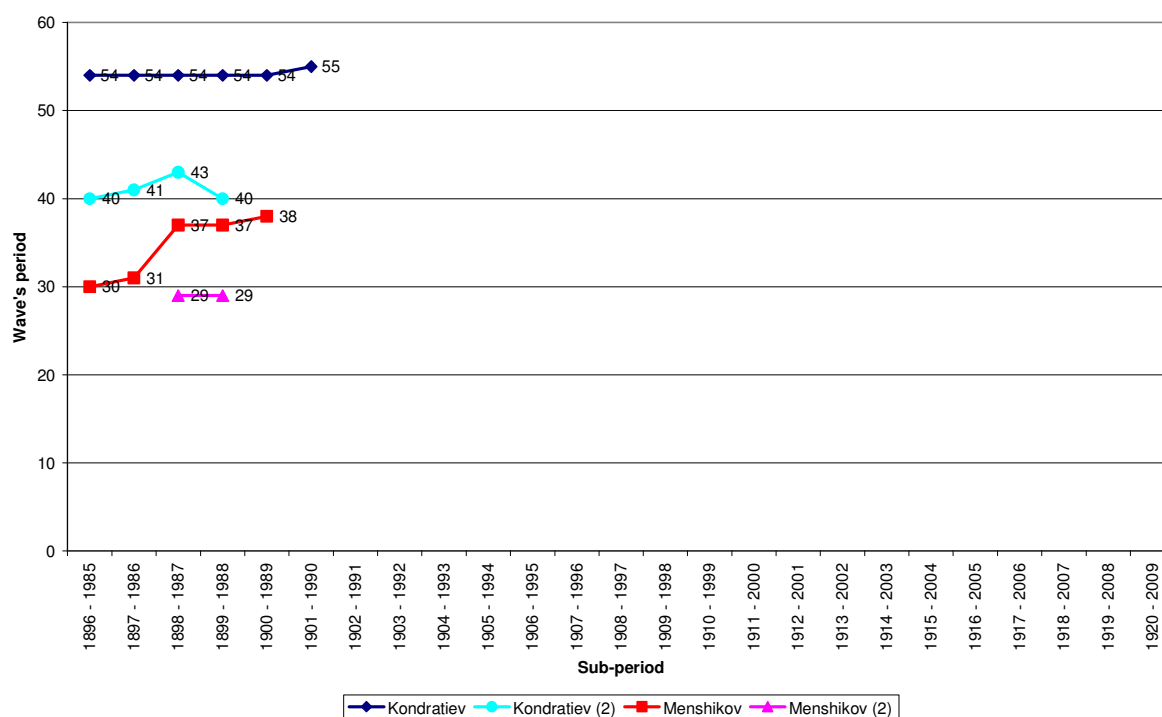| Sub-periods	Waves					
	Kondratiev (45-60)	Menshikov (30-40)	Kuznets (15-25)	Intermediate (12-14)	Juglar (7-11)	Kitchin (3-5)
1896 – 1985	40;54	30	16	12	11	
1897 – 1986	41;54	31	17			
1898 – 1987	43;54	29;37				
1899 – 1988	40;54	29;37	22			
1900 – 1989	54	38	19			
1901 – 1990	55					
1902 – 1991						

Figure 2. Kondratiev and Menshikov waves in the index of the wage of ordinary worker (Bulgaria)

Table 3

Periods of the waves in the price index of the foodstuffs and non-foodstuffs (Bulgaria)

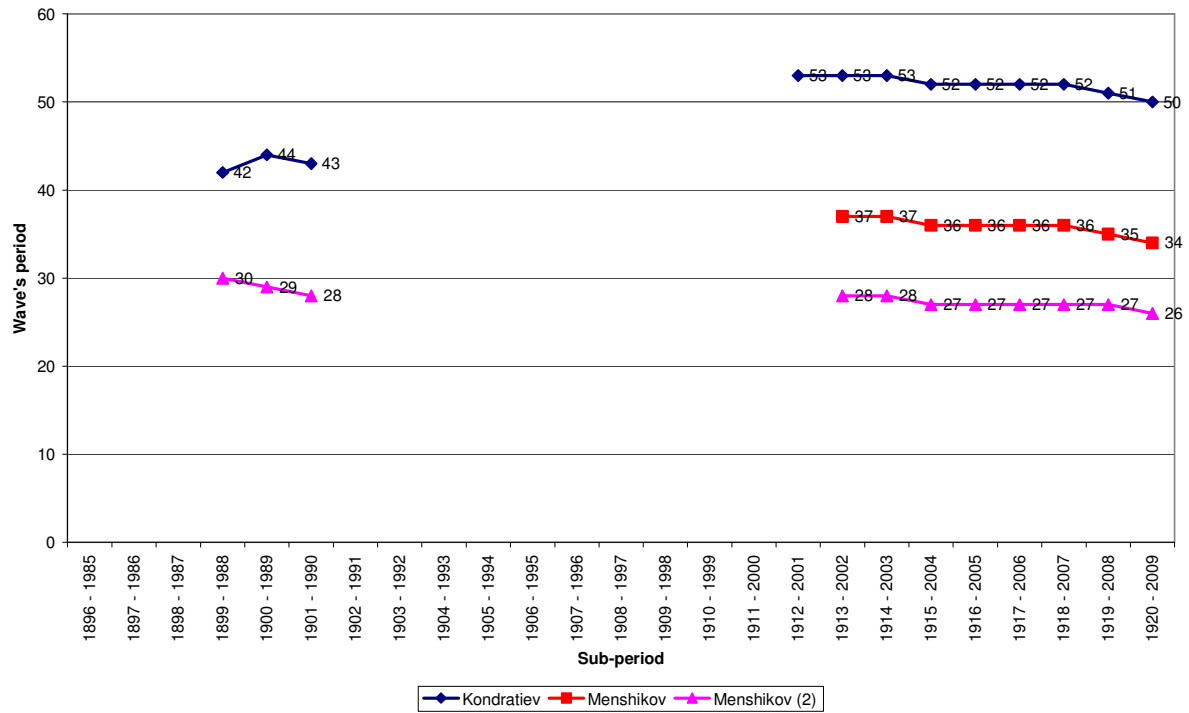| Sub-period	Waves					
	Kondratiev (45-60)	Menshikov (30-40)	Kuznets (15-25)	Intermediate (12-14)	Juglar (7-11)	Kitchin (3-5)
1899 – 1988	42	30	17;20	13		
1900 – 1989	44	29	18;22	14		
1901 – 1990	43	28	15;17;21;25	13	10	
1902 – 1991						
1903 – 1992						
1904 – 1993						
1905 – 1994						
1906 – 1995						
1907 – 1996						
1908 – 1997						
1909 – 1998						
1910 – 1999						
1911 – 2000						
1912 – 2001	53					
1913 – 2002	53	28;37				
1914 – 2003	53	28;37	16			
1915 – 2004	52	27;36	22			
1916 – 2005	52	27;36	22			
1917 – 2006	52	27;36				
1918 – 2007	52	27;36				
1919 – 2008	51	27;35				
1920 – 2009	50	26;34				

Figure 3. Kondratiev and Menshikov waves in the price index of the foodstuffs and non-foodstuffs (Bulgaria)

Table 4

Periods of the waves in the coal extraction (Russia)

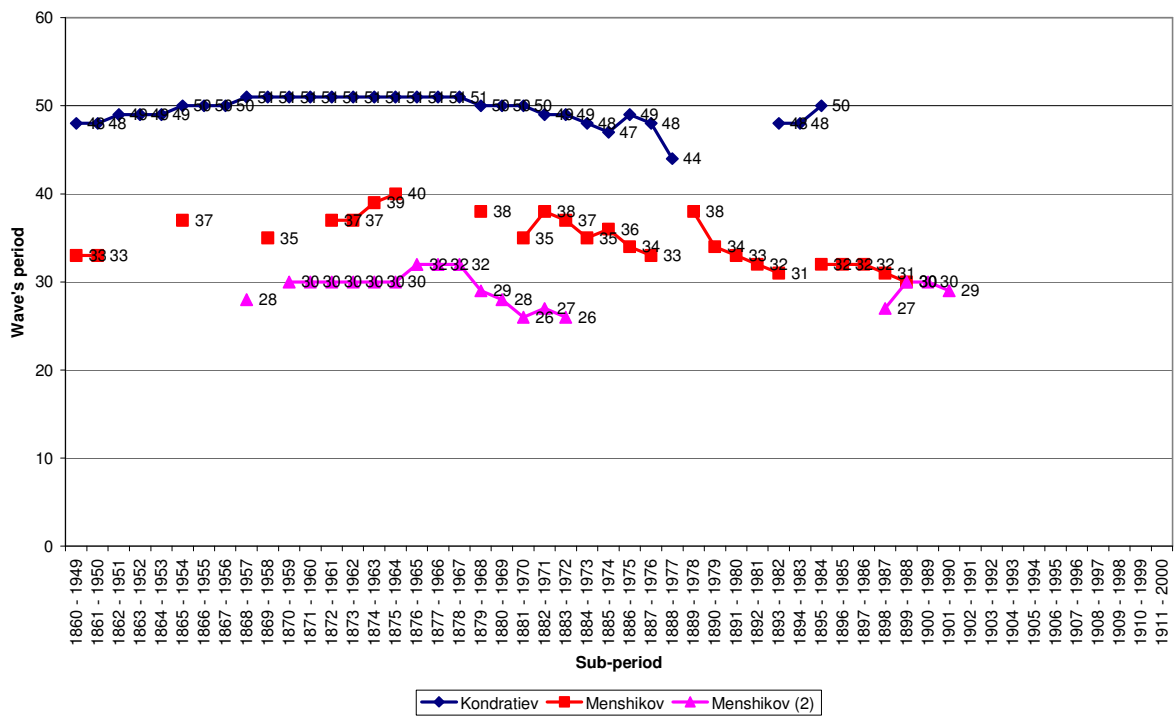| Sub-period	waves					
	Kondratiev (45-60)	Menshikov (30-40)	Kuznets (15-25)	Intermediate (12-14)	Juglar (7-11)	Kitchin (3-5)
1860 – 1949	48	33	17		11	
1861 – 1950	48	33	17;20	13	11	
1862 – 1951	49		15;18	13	9;10	
1863 – 1952	49		15;18;21;24	12;13		
1864 – 1953	49					
1865 – 1954	50	37	19	12		
1866 – 1955	50		16;19;23	13;14		
1867 – 1956	50		16;23			
1868 – 1957	51	28	19			
1869 – 1958	51	35	15;17;20;22;23		10;11	
1870 – 1959	51	30	20;24			
1871 – 1960	51	30	20;24			
1872 – 1961	51	30;37	17;20;24	12	11	
1873 – 1962	51	30;37	20;24	12	11	
1874 – 1963	51	30;39	20;24			
1875 – 1964	51	30;40	20;24			
1876 – 1965	51	32	20;25			
1877 – 1966	51	32	20;25		8	
1878 – 1967	51	32	20;25	13	8;9;10;11	
1879 – 1968	50	29;38	15;23	13	8;9;10;11	
1880 – 1969	50	28	15;17;22		8;9;10;11	
1881 – 1970	50	26;35	16;21	14	8;10;11	
1882 – 1971	49	27;38	17;21		8;10;11	
1883 – 1972	49	26;37	17;20		11	
1884 – 1973	48	35	16;19;25	12	8	
1885 – 1974	47	36	16;19;25	12	8	
1886 – 1975	49	34	16;19;25		8;9	
1887 – 1976	48	33	17;19;24	14	7;8	
1888 – 1977	44		19;24	14	7;9	
1889 – 1978		38	15;18;24		8;9	
1890 – 1979		34	15;18;24		8	
1891 – 1980		33	15;17;24			
1892 – 1981		32	17;24			
1893 – 1982	48	31;34	16;19;21;25	12	7;8;9;10	6
1894 – 1983	48		16	12	7;8	
1895 – 1984	50	32	17;20			
1896 – 1985		32	17;20;25	14	7;8;9;10	
1897 – 1986		32	16;20;25		7;8;9;10	
1898 – 1987		27;31	16;20	13	7;8;9;10	
1899 – 1988		30	16;20	13	8;9;10	6
1900 – 1989		30	16;20		8;10	
1901 – 1990		29	20			

Figure 4. Kondratiev and Menshikov waves in the coal extraction (Russia)

Table 5

Periods of the waves in the pig-iron output (Russia)

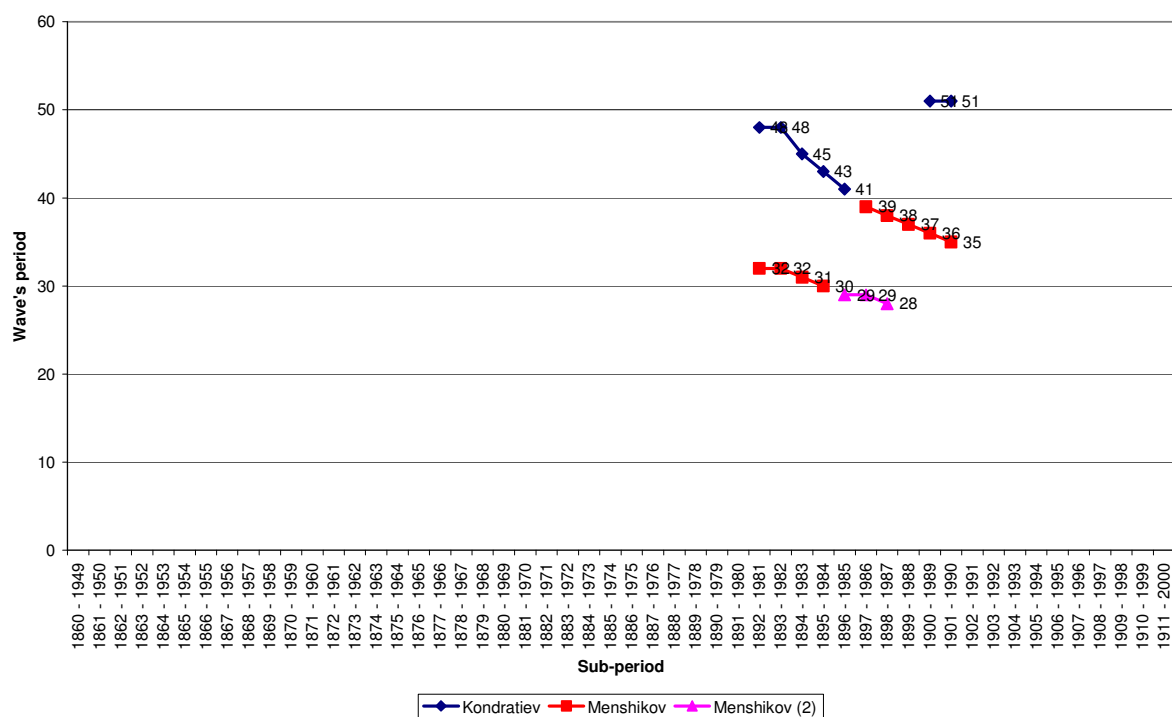| Sub-period	Waves					
	Kondratiev (45-60)	Menshikov (30-40)	Kuznets (15-25)	Intermediate (12-14)	Juglar (7-11)	Kitchin (3-5)
1892 – 1981	48	26;32	16;20	12;13	7	
1893 – 1982	48	26;32	16;20	12;13	7	
1894 – 1983	45	31	16;20	12;13	7	
1895 – 1984	43	30	16;20	12;13	7	
1896 – 1985	41	29	17;21	12;13	7	
1897 – 1986		29;39	15;17;20;24	12;13		
1898 – 1987		28;38	15;17;20	13		
1899 – 1988		37	20	13		
1900 – 1989	51	36	20	12;14		
1901 – 1990	51	35	20	12;14		

Figure 5. Kondratiev and Menshikov waves in the pig-iron output (Russia)

Table 6

Periods of the waves in the steel output (Russia)

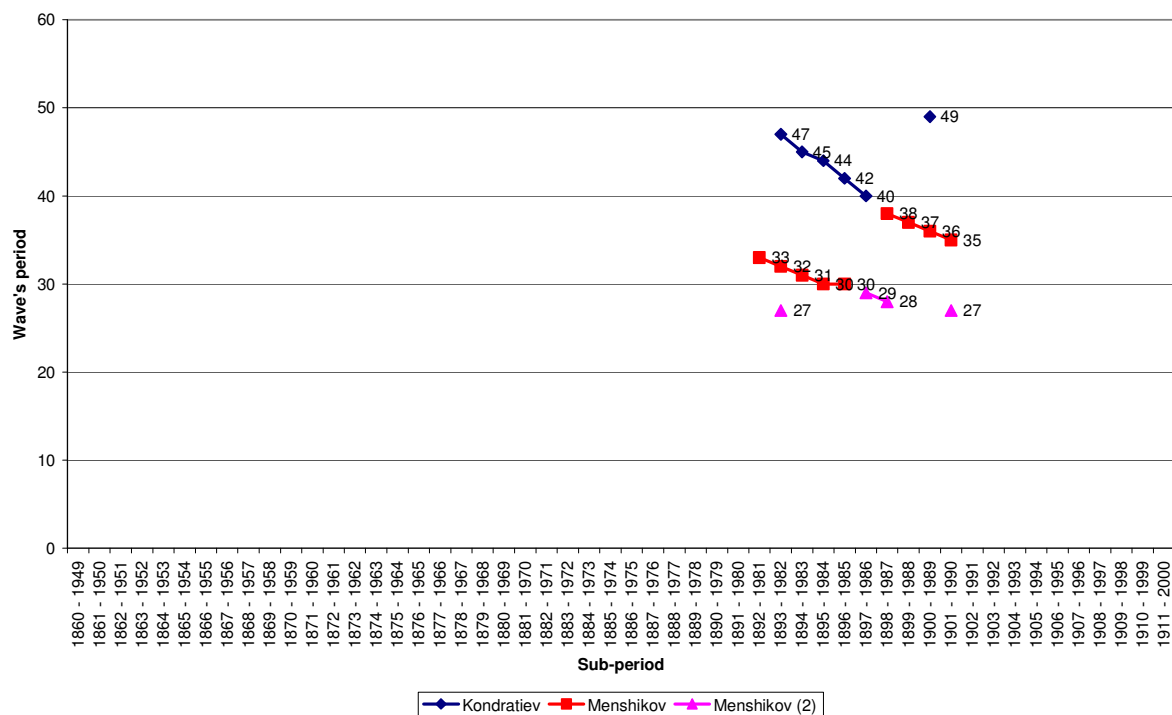| Sub-period	Waves					
	Kondratiev (45-60)	Menshikov (30-40)	Kuznets (15-25)	Intermediate (12-14)	Juglar (7-11)	Kitchin (3-5)
1892 – 1981	48	33	17;21	12		
1893 – 1982	47	27;32	17;20	12;14		
1894 – 1983	45	31	15;20	12		
1895 – 1984	44	30	15;20	12		
1896 – 1985	42	30	18;20	12;14		
1897 – 1986	40	29	17;20	12;14		
1898 – 1987		28;38	17;20	12;14		
1899 – 1988		37	17;20	12;13		
1900 – 1989	49	36	20			
1901 – 1990		27;35	15;20			

Figure 6. Kondratiev and Menshikov waves in the steel output (Russia)

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Table 7

Periods of the waves in the gross domestic product (Russia)

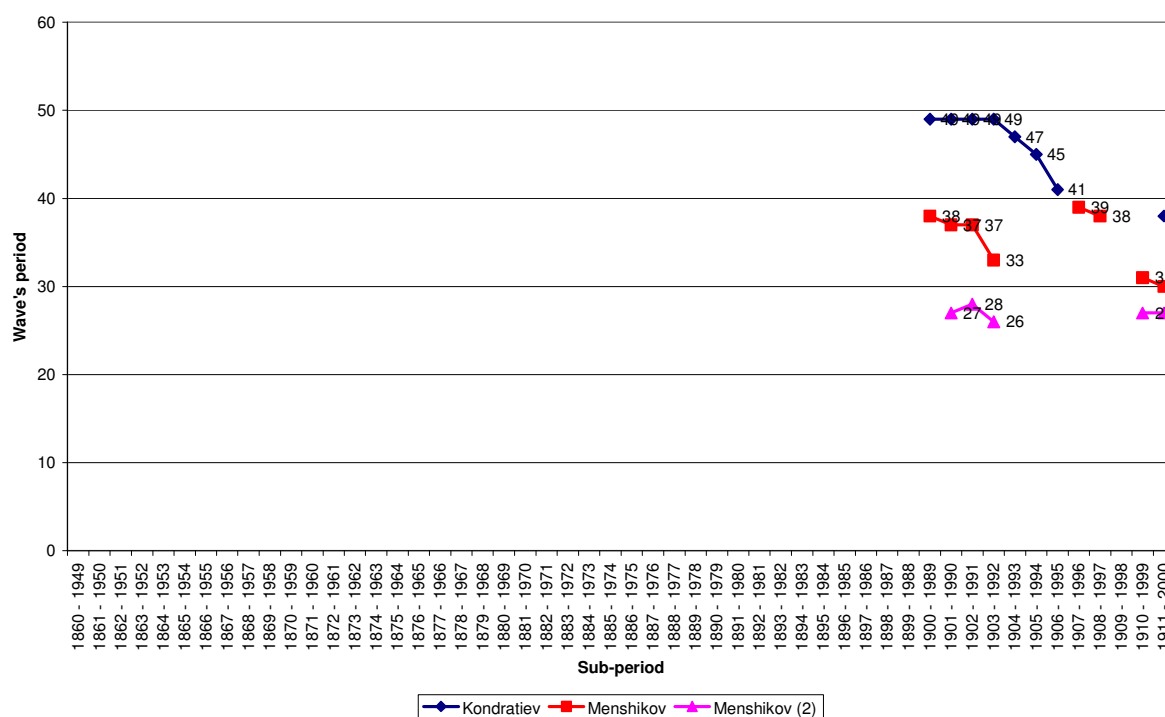| Sub-period	Waves					
	Kondratiev (45-60)	Menshikov (30-40)	Kuznets (15-25)	Intermediate (12-14)	Juglar (7-11)	Kitchin (3-5)
1900 – 1989	49	38				
1901 – 1990	49	27;37				
1902 – 1991	49	28;37				
1903 – 1992	49	26;33				
1904 – 1993	47					
1905 – 1994	45					
1906 – 1995	41					
1907 – 1996		39				
1908 – 1997		38	16;18	12;14	10;11	
1909 – 1998			16;18;22	12;14	10;11	
1910 – 1999		27;31	16;18;22	12	9;10;11	
1911 – 2000		27;30;38	15;18;22	13	9;10;11	

Figure 7. Kondratiev and Menshikov waves in the gross domestic product (Russia)

Table 8

Periods of the waves in the industrial production (Russia)

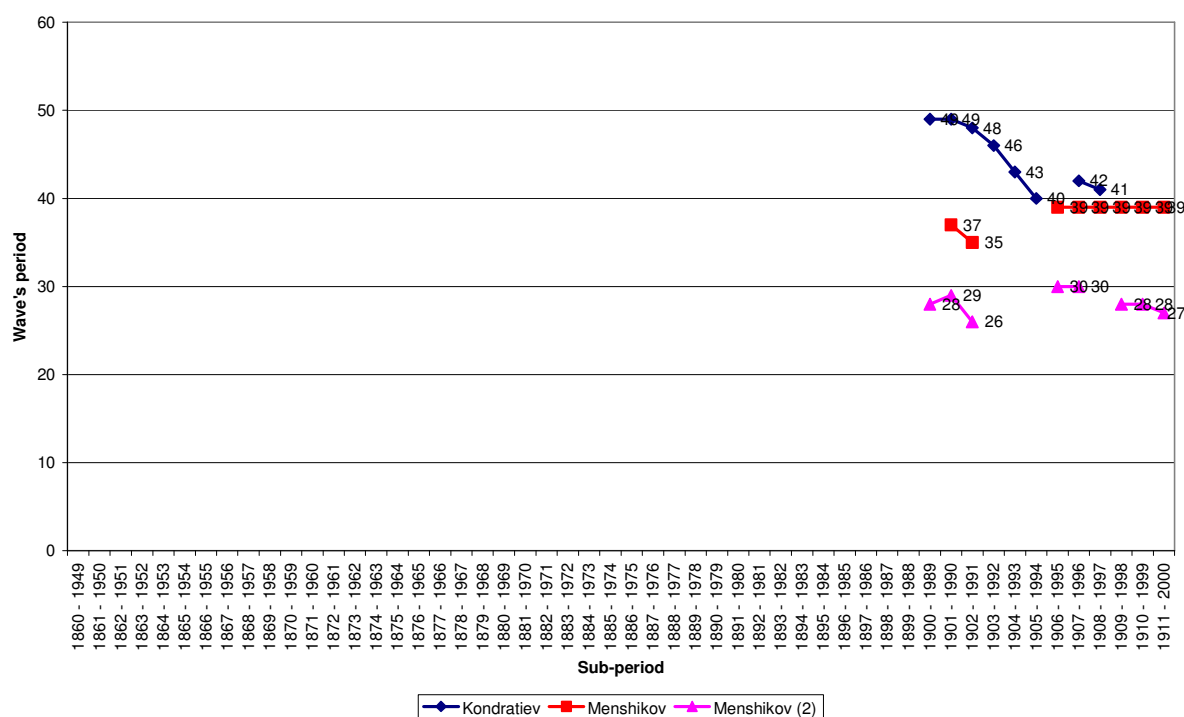| Sub-period	Waves					
	Kondratiev (45-60)	Menshikov (30-40)	Kuznets (15-25)	Intermediate (12-14)	Juglar (7-11)	Kitchin (3-5)
1900 – 1989	49	28	23			
1901 – 1990	49	29;37	19;23			
1902 – 1991	48	26;35				
1903 – 1992	46					
1904 – 1993	43					
1905 – 1994	40					
1906 – 1995		30;39	16;19;20;24	12;14	9;10;11	
1907 – 1996	42	30;39	16;19;23;25	12;14	9;10;11	
1908 – 1997	41	39	16;19;23;25	14	10;11	
1909 – 1998		28;39	16;19;23	12;14	9;10;11	
1910 – 1999		27;28;39	16;19;23	12;14	9;10;11	
1911 – 2000		27;39	15;18	13	9;10;11	

Figure 8. Kondratiev and Menshikov waves in the industrial production (Russia)

Table 9

Periods of the waves in the national wealth (Russia)

| Sub-period	Waves					
	Kondratiev (45-60)	Menshikov (30-40)	Kuznets (15-25)	Intermediate (12-14)	Juglar (7-11)	Kitchin (3-5)
1900 – 1989	46;50	28;35	23	14		
1901 – 1990	50	28;35	16;23	13;14		
1902 – 1991	50	28;35	16;19;23	13;14		
1903 – 1992	45;50	28;31;35	16;19;23	14		
1904 – 1993	50	27;35	15;18;22			
1905 – 1994	49	34	17;21			
1906 – 1995	49	30;32	16;19;25	12;14	9;11	
1907 – 1996	48	30	24			
1908 – 1997	47	29;31	16;23;25	12	11	
1909 – 1998	45	28;32	16;19;22;23	12	11	
1910 – 1999	43	28;33	19;22;23	12;14	11	
1911 – 2000	41	28	15;22	12;13	9;10	
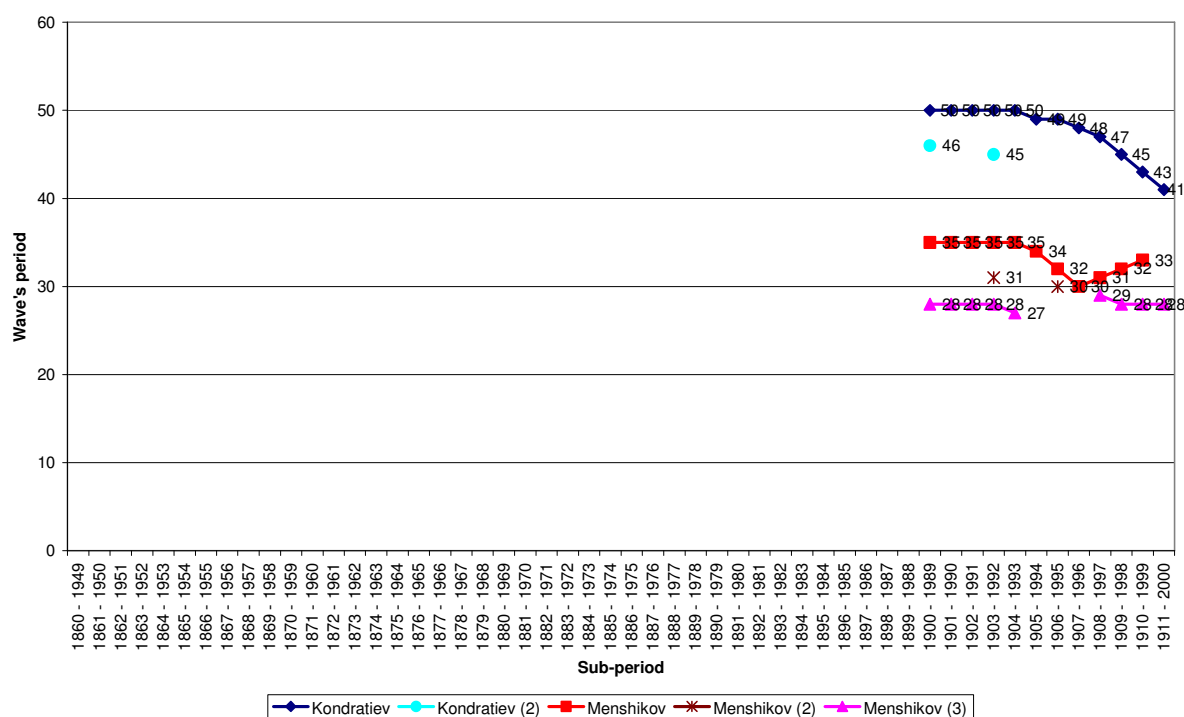
Figure 9. Kondratiev and Menshikov waves in the national wealth (Russia)