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FEDERAL FUND RATE AND GEOMAGNETIC INDEX Ap CYCLES (1955–2024)

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Abstract: The paper uses a methodological approach based on W. S. Jevons and A. L. Chizhevsky. The years of solar cycles were numbered according to the order established in solar astrophysics, grouped and compared with the arithmetic mean values of the effective US federal funds rates and the geomagnetic index Ap. The Fed rate is minimal either in the year of the geomagnetic index Ap extremum (this is the first year of the solar cycle) or in the year following it (these are the seventh and twelfth years of the solar cycle) as a reaction to the Ap index extremum. The forecast value of the effective federal funds rate for 2025 is 3.92%, and for 2026 it is 2.81%.

Keywords: Fed rate; solar activity cycles; Wolf numbers; geomagnetic index Ap; economic cycles

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Introduction

A Google search yields only my previously published preprint “Geomagnetic Ar index (1954–2022) and federal funds rates (1955–2023): evidence for strong relationships”. As follows from the title of the preprint, the relationship between the geomagnetic index Ap and the Fed rates was examined with a time lag of 1 year. In the present study, there is no time lag and evidence of a closer relationship between the geomagnetic index Ap and the Fed rates was obtained by dividing the average solar cycle into 4 segments. Thus, the subject of the research has absolute scientific novelty.

Methods

In his article “Solar-Commercial Cycles” W. S. Jevons placed graphs of solar activity cycles (Wolf number cycles) and corn price cycles in Delhi over the period 1760–1810 one after the other (Jevons, 1882), that is, he *compared* solar and economic activity.

A. L. Chizhevsky in his monograph “The Cosmic Pulse of Life: Earth in the Embrace of the Sun” in Chapter 4 “The Sun and Epidemics” in Fig. 33 constructed a diagram that shows *the average solar activity cycle* over a hundred years (the Wolf number cycle) and the average cases of cholera in Russia for the period 1823-1923 by year of the solar cycle (Chizhevskij, 1976).

In the article by Walsh Bryan "Economic Cycles and Changes in the Earth's Geomagnetic Field" (Walsh Bryan, 1993) a review of works and a list of references including 20 sources are given. During the review of works the author copies diagrams from these sources showing strong connections of changes in the *geomagnetic index Ap* and such indicators as the US industrial production index (for 100 years), the US gross national product, the consumer price index, the price of gold, the Dow Jones index, the rate of government securities. However, in this work the author did not construct an average cycle of solar activity and the studied indicators, which is done in the present work.

In this study, one diagram *compares* the numbers of years of the *mean* solar cycle and the arithmetic mean values of the Fed rates, as well as the values of the *geomagnetic index Ap* and Fed rates for the years of the mean solar cycle for 1955-2024.

Study

The annual mean Wolf numbers, the main indicator of solar activity (SA), were taken from the well-known astrophysical website for the definition, conservation and distribution of the international sunspot number (SILSO, 2025). They are presented in column 2 of Table 1.

The ordinal numbers of years in column 3 of Table 1 are defined as follows. The first year in the SA cycle is considered to be the first year of its growth, i.e. the growth of the Wolf number, which is presented in column 2. Then the years are numbered in order, and the last year in the cycle is considered to be the year of the minimum of SA. The years of the minimum of the Wolf number in Table 1 are highlighted in blue. The years of the maximum are highlighted in red.

The annual monthly average values of the geomagnetic index Ap for the period 1955–2024 were taken from the website of the Helmholtz Centre Potsdam (Helmholtz Centre Potsdam, 2025). They are presented in column 4 of Table 1.

The Federal Reserve Bank of St. Louis website provides statistics on annual Fed rate values for the period 1955-2024 (Federal Reserve Bank of St. Louis, 2025). They are presented in column 5 of Table 1.

Table 1. Average annual Wolf numbers, ordinal numbers of years in solar activity cycles, geomagnetic index Ap, and effective federal funds rates, 1955–2024

The years	*Wolf numbers*	*The serial number of the year in the cycle of solar activity*	*Geomagnetic index Ap*	*Effective Federal Funds Rate, %*
1	2	3	4	5
1955	54.2	1	11.3	1.785
1956	200.7	2	18.1	2.728333333
1957	**269.3**	**3**	**20.2**	**3.105**
1958	261.7	4	19.3	1.5725
1959	225.1	5	21.3	3.305
1960	159	6	23.7	3.215833333
1961	76.4	7	14.4	1.955
1962	53.4	8	12.3	2.708333333
1963	39.9	9	12.6	3.178333333
1964	**15**	**10**	**9.9**	**3.496666667**
1965	22	1	7.8	4.0725
1966	66.8	2	10.3	5.110833333
1967	132.9	3	12	4.22
1968	**150**	**4**	**13.5**	**5.656666667**
1969	149.4	5	11.4	8.204166667
1970	148	6	11.9	7.180833333
1971	94.4	7	11.3	4.660833333
1972	97.6	8	12.6	4.430833333
1973	54.1	9	17.1	8.7275
1974	49.2	10	19.6	10.5025
1975	22.5	11	13.9	5.824166667
1976	**18.4**	**12**	**12.9**	**5.045**
1977	39.3	1	11.9	5.5375
1978	131	2	16.9	7.930833333
1979	**220.1**	**3**	**14.5**	**11.19416667**
1980	218.9	4	11.1	13.35583333
1981	198.9	5	16.3	16.37833333
1982	162.4	6	22.5	12.25833333
1983	91	7	18.6	9.086666667
1984	60.5	8	18.8	10.225
1985	20.6	9	13.7	8.100833333
1986	**14.8**	**10**	**12.6**	**6.805**
1987	33.9	1	10.9	6.6575
1988	123	2	12.7	7.568333333
1989	**211.1**	**3**	**19.4**	**9.216666667**
1990	191.8	4	16.3	8.099166667
1991	203.3	5	23.4	5.6875
1992	133	6	16.6	3.521666667
1993	76.1	7	15	3.0225

The years	*Wolf numbers*	*The serial number of the year in the cycle of solar activity*	*Geomagnetic index Ap*	*Effective Federal Funds Rate, %*
1994	44.9	8	18.2	4.201666667
1995	25.1	9	12.7	5.836666667
1996	**11.6**	**10**	**9.3**	**5.298333333**
1997	28.9	1	8.4	5.46
1998	88.3	2	12	5.353333333
1999	136.3	3	12.5	4.97
2000	**173.9**	**4**	**15**	**6.235833333**
2001	170.4	5	12.9	3.8875
2002	163.6	6	13.1	1.666666667
2003	99.3	7	21.7	1.1275
2004	65.3	8	13.4	1.349166667
2005	45.8	9	13.5	3.213333333
2006	24.7	10	8.4	4.964166667
2007	12.6	11	7.5	5.019166667
2008	**4.2**	**12**	**6.9**	**1.9275**
2009	4.8	1	3.9	0.16
2010	24.9	2	6	0.175
2011	80.8	3	7.5	0.101666667
2012	84.5	4	9.1	0.14
2013	94	5	7.6	0.1075
2014	**113.3**	**6**	**7.7**	**0.089166667**
2015	69.8	7	12.2	0.1325
2016	39.8	8	10.5	0.395
2017	21.7	9	10.3	1.001666667
2018	7	10	6.9	1.831666667
2019	**3.6**	**11**	**6.1**	**2.158333333**
2020	8.8	1	5.3	0.375833333
2021	29.6	2	7.2	0.08
2022	83, 2	3	10.1	1.68
2023	125, 5	4	10.9	5.02
2024	**154.6**	**5**	**11.7**	**5.14**
2025		6		
2026		7		

Source: 1. DC-SILSO, Royal Observatory of Belgium, Brussels; 2. Helmholtz Centre Potsdam – https://kp.gfz-potsdam.de/kpdata?startdate=1932-01-01&enddate=2023-12-11&format=avgap#kpdatadownload-143; https://kp.gfz-potsdam.de/en/data; 3. Federal Reserve Bank of St. Louis. Economic data. Effective Federal Funds Rate – https://fred.stlouisfed.org/series/FEDFUNDS

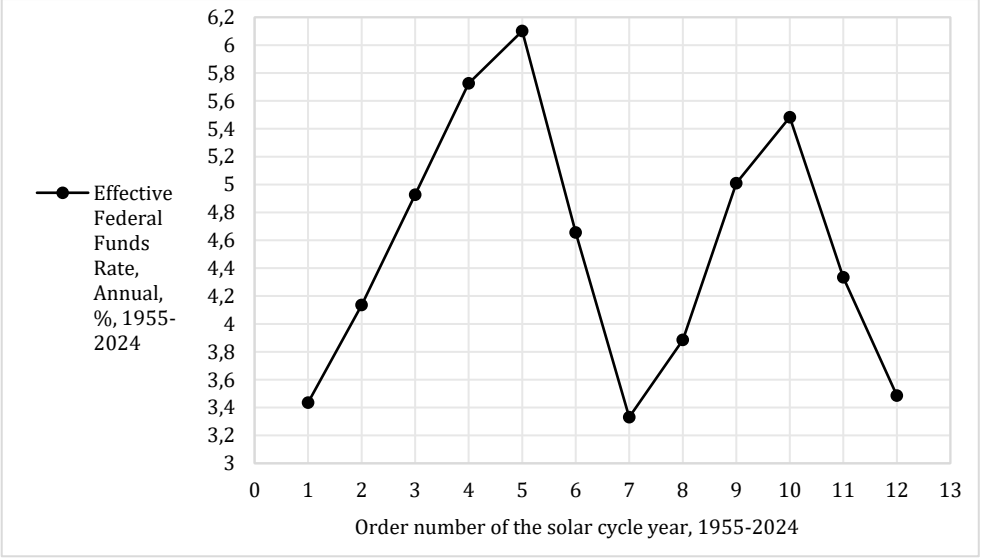
The statistical data in Table 1 were then grouped by the ordinal numbers of years in the SA cycles. Column 2 of Table 2 shows the number of such years for the period 1955–2024.

Table 2. Grouping of data from Table 1 by ordinal numbers of years in solar activity cycles

The serial number of the year in the SA cycles	The number of such years for the period 1955 -2024	Arithmetic mean:			Ratio to previous year's rate
		Wolf number, 1955 – 2024	Geomagnetic index Ap, 1955-2024	Effective Federal Funds Rate, %, 1955-2024	
1	2	3	4	5	6
1	7	27.414285	8.5	3.43547619	0.985435981
2	7	94.9	11.8857142	4.135238095	1.203687019
3	7	161.95714	13.7428571	4.927261905	1.191415246
4	**7**	**172.32857**	**13.6**	**5.725714286**	**1.16216020**
5	7	170.81428	14.9428571	6.101428571	1.065618762
6	6	146.55	15.9166666	4.655416667	0.763004371
7	6	84.5	15.5333333	3.330833333	0.715474805
8	6	60.25	14.3	3.885	1.166374781
9	6	34.533333	13.3166666	5.009722222	1.28950379
10	**6**	**20.383333**	**11.1166666**	**5.483055556**	**1.09448295**
11	**3**	**12.9**	**9.16666666**	**4.333888889**	**0.79041491**
12	**2**	**11.3**	**9.9**	**3.48625**	**0.8044161**
Total:	70				

Source: Statistical data in Table 1.

Based on columns 1 and 5 of Table 2, the following diagram (see Figure 1) is constructed, which shows very strong correlations between the ordinal numbers of solar cycles and average Fed rates.



Source: Data in lines 1-12 and columns 1 and 5 of Table 2.

Figure 1. Solar cycle year ordinal numbers and average effective federal funds rates (1955–2024)

The ordinal number of the year 2025 in the current 25th SA cycle is 6. The ratio of the average Fed rates of the 6th year to those of the 5th year is 0.763004371 (see Table 2). Therefore, the forecast Fed rate for 2025 is 0.763004371 * 5.14 = 3.92184246 (%). We determine the forecast Fed rate for 2026 in a similar way. Namely, it is equal to 3.921842465 * 0.715474805 = 2.805979474 (%). This calculation is made based on the very strong connection between the ordinal numbers of years of the SA cycles and the aver+++age Fed rates.

It should be noted that Fed rates are a function not just of the number itself, but of numerous solar activity factors (geomagnetic disturbances and others) that were in effect during the year with that particular number.

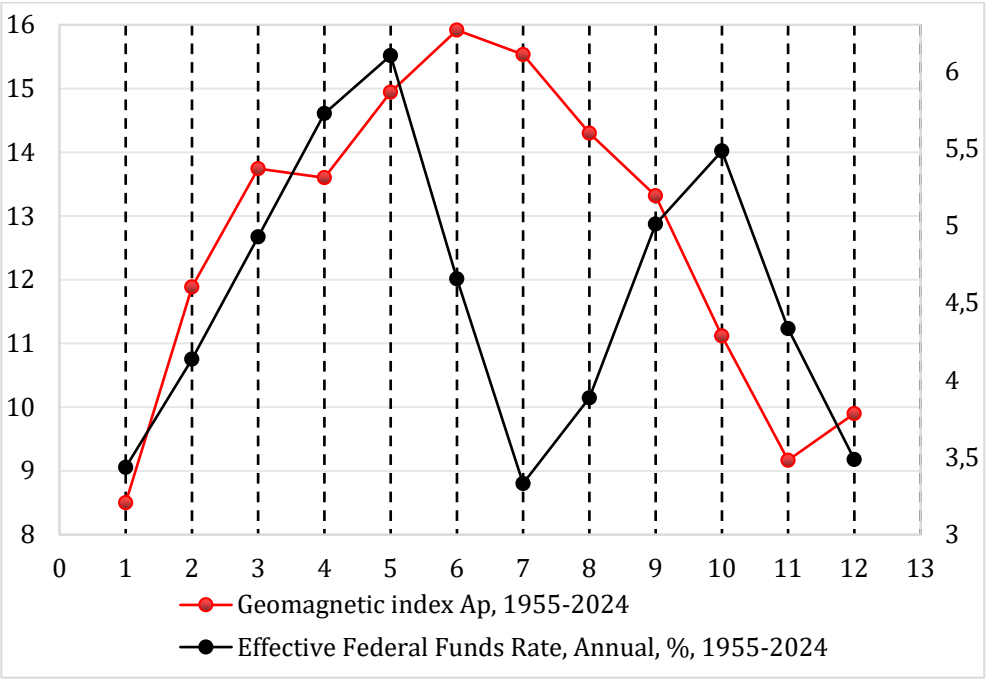
Based on columns 1, 4 and 5 of Table 2, the following diagram (see Fig. 2) is constructed, which shows that the Fed rate is minimal either in the year of the extreme of the geomagnetic index Ap (this is the first year of the average solar cycle) or in the year following it (this is the seventh and twelfth years of the average solar cycle) as a reaction to it.

"After a long search, when we had gone through, it seems, all conceivable possibilities," says Doctor of Medical Sciences Mikhail Blank in his interview with Rossiyskaya Gazeta, "we came to an unexpected discovery: hemodepression (deterioration of blood composition – V. B.) increases in *extreme geomagnetic conditions – during magnetic storms and magnetic calm*. But average values of the magnetic field do not affect blood composition" (Valentinov, 2004). The text in bold in the quotes above is mine.

Doctor of Medical Sciences Yu. I. Gurfinkel, during experiments, established a significant decrease in the speed of capillary blood flow at extreme values of the geomagnetic index Ap (Gurfinkel, 2012, p. 38).

A significant decrease in the speed of capillary blood flow and hemodepression, that is, a deterioration in the composition of the blood during periods of magnetic extremes (maximums and minimums of the geomagnetic activity index Ap) lead, as it seems, to an increase in pessimistic sentiments in all markets and, accordingly, an increase in the propensity to save, a deterioration in the dynamics of macroeconomic indicators, which prompts the Fed to lower the rate.

Possible causal relationships between worsening blood conditions during periods of geomagnetic extremes and increased market pessimism or worsening macroeconomic indicators could be explored in future studies.



Source: 1. DC-SILSO, Royal Observatory of Belgium, Brussels; 2. Helmholtz Centre Potsdam – https://kp.gfz-potsdam.de/kpdata?startdate=1932-01-01&enddate=2023-12-11&format=avgap#kpdatadownload-143; https://kp.gfz-potsdam.de/en/data; 3. Federal Reserve Bank of St. Louis. Economic data. Effective Federal Funds Rate – https://fred.stlouisfed.org/series/FEDFUNDS

Figure 2. Fed rate and geomagnetic index Ap by years of solar cycles (1955–2024)

Results

The work shows the relationship between the geomagnetic index Ap and the Fed rates, and also puts forward a hypothesis about the relationship between the extremes of the geomagnetic index Ap, hemodepression, and a decrease in the velocity of capillary blood flow, on the one hand, and an increase in pessimism and a deterioration in the dynamics of macroeconomic indicators, on the other hand.

Discussion

It seems appropriate to conduct econometric studies with the aim of quantitatively measuring the strength of the relationship between the geomagnetic index Ap and the Fed rates, as well as studies of the relationship between extremes of the geomagnetic index Ap and the growth of pessimism, uncertainty, fear, panic, etc.

Conclusion

Traditional theories of economic cycles explain cycles of some indicators by cycles of other indicators, the nature of which (duration and amplitude of cycles) are unknown. The main result of this work is the proof of a strong connection between economic cycles and solar activity cycles and, first of all, the cycles of the geomagnetic index Ap.

Gratitude

I express my deep gratitude to the famous economist John Komlos for his appreciation of the scientific result presented in Figure 2 of this paper and moral support.

Conflicts of Interest

The author has no conflicts of interest to declare.

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