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.

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	

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	Geomagnetic index Ap	Effective Federal Funds Rate, %	
		activity			
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.

The serial	The number of	Arithmetic mean:			Ratio to previous
number of the year in the SA cycles	such years for the period 1955 -2024	Wolf number, 1955 – 2024	Geomagnetic index Ap, 1955-2024	Effective Federal Funds Rate, %, 1955-2024	year's rate
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				

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

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

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Conflicts of Interest

The author has no conflicts of interest to declare.

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