US FEDERAL RESERVE RATE AND SOLAR ACTIVITY (1955-2022): PROOF OF STRONG CORRELATIONS

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Как да се цитира тази статия / How to cite this article:

Belkin, V. (2023). US Federal Reserve Rate and Solar Activity (1955-2022): Proof of Strong Correlations. Economic Thought Journal, 68 (2), 220-229. https://doi.org/10.56497/etj2368204

To link to this article / Връзка към статията:
https://etj.iki.bas.bg/general-economics-and-teaching/2023/06/05/us-federal-reserve-rate-and-solar-activity-1955-2022-proof-of-strong-correlations

Published online / Публикувана онлайн: 06 June 2023

US FEDERAL RESERVE RATE AND SOLAR ACTIVITY (1955-2022): PROOF OF STRONG CORRELATIONS

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Abstract: The report uses a methodological approach founded by Jevons and Chizhevskij. The years of solar cycles have been numbered according to the order established in the astrophysics of the un, then grouped and compared with the arithmetic averages of effective rates for US federal funds. Grouping statistical data by serial numbers of years of solar activity cycles has made it possible to construct a function of effective rates on federal funds (dependent variable) and serial numbers of years of the average solar activity cycle (independent variable) with correlation coefficients on its four segments close to 1 (0.99499269, -0.998464195, 0.986985363, -0.996221106). This function enables predicting the values of the effective interest rate on US federal funds in subsequent years. It follows that in 2023 this rate will increase to 1.996%.

Keywords: effective federal funds rate; solar activity cycles; Wolf numbers; US Federal Reserve rate

JEL codes: G17

DOI: https://doi.org/10.56497/etj2368204

Received 28 March 2023

Revised 27 April 2023

Accepted 17 May 2023

Introduction

A Google search for the title of this article did not yield any results. That is, the object of research has absolute novelty.

The World Bank's 2021 Gross Domestic Product data shows that the US economy continues to be the world's leading economy by a significant margin from China's. At the end of 2021, the US GDP amounted to 22,996,100 million dollars, while China's GDP was 17,734,063 million dollars (World Bank, 2021).

This circumstance explains the fact that the dynamics of the effective interest rate on

federal funds have a significant impact on world exchanges and the exchange rates of other countries, as well as the value of assets around the world.

The website of the Federal Reserve Bank of St. Louis presents statistics on the annual values of the effective interest rate on federal funds for the period 1955-2022 (Federal Reserve Bank of St. Louis, 2023). They are presented in column 4 of Table 1.

Methods

In his article "The Solar-Commercial Cycle", Jevons presented graphs of solar activity cycles (Wolf number cycles) and corn price cycles in Delhi for the period of 1760-1810 (Jevons, 1882).

Chizhevskij in his monograph *Space Pulse of Life*,Chapter 4, "The Sun and Epidemics", built a diagram that depicts the hundred-year average of the cycle of solar activity (the cycle of Wolf numbers) and the average cases of cholera in Russia for the period 1823-1923 (Chizhevskij, 1995).

In another monograph, "The Terrestrial Echo of Solar Storms", he placed graphs of the yield of grain bread in Russia and solar activity (Wolf numbers) together, showing a directly close relationship between them (Chizhevskij, 1976). These graphs cover a long period.

The present article continues the study of solar-terrestrial relationships by comparing the average solar cycle (12 years) and the arithmetic averages of the effective rate for federal funds for the years 1955-2022.

The annual Wolf numbers – the main indicator of solar activity – were taken from a well-known astrophysical site for the production, preservation and dissemination of the international sunspot number (World Data Center, 2023). They are presented in column 2 of Table 1.

Study

The ordinal numbers of the years in column 3 of Table 1 are defined as follows:

1. The first year in the cycle of solar activity is the point from when the Wolf number, which is presented in column 2, begins to grow.
2. Then the years are numbered chronologically, and the last year in the cycle is the year of minimum solar activity.

The Wolf number minima in Table 1 are shown in bold. The 1955 serial number is 1, as 1954 was a year of minimum solar activity.

Table 1. Wolf annual averages, serial numbers of years in solar activity cycles, and effective federal funds rate 1955-2022

Year	Wolf number, 1955-2022	Serial number insolar activity cycle	Effective federal funds rate, %, 1955-2022
1	**2**	**3**	**4**
1955	54.2	1	1.785
1956	200.7	2	2.728333333
1957	269.3	3	3.105
1958	261.7	4	1.5725
1959	225.1	5	3.305
1960	159	6	3.215833333
1961	76.4	7	1.955
1962	53.4	8	2.708333333
1963	39.9	9	3.178333333
1964	**15.0**	**10**	**3.496666667**
1965	22.0	1	4.0725
1966	66.8	2	5.110833333
1967	132.9	3	4.22
1968	150.0	4	5.656666667
1969	149.4	5	8.204166667
1970	148.0	6	7.180833333
1971	94.4	7	4.660833333
1972	97.6	8	4.430833333
1973	54.1	9	8.7275
1974	49.2	10	10.5025
1975	22.5	11	5.824166667
1976	**18.4**	**12**	**5.045**
1977	39.3	1	5.5375
1978	131.0	2	7.930833333
1979	220.1	3	11.19416667
1980	218.9	4	13.35583333
1981	198.9	5	16.37833333
1982	162.4	6	12.25833333
1983	91.0	7	9.086666667
1984	60.5	8	10.225
1985	20.6	9	8.100833333
1986	**14.8**	**10**	**6.805**
1987	33.9	1	6.6575
1988	123.0	2	7.568333333

Year	Wolf number, 1955-2022	Serial number insolar activity cycle	Effective federal funds rate, %, 1955-2022
1	**2**	**3**	**4**
1989	211.1	3	9.216666667
1990	191.8	4	8.099166667
1991	203.3	5	5.6875
1992	133.0	6	3.521666667
1993	76.1	7	3.0225
1994	44.9	8	4.201666667
1995	25.1	9	5.836666667
1996	**11.6**	**10**	**5.298333333**
1997	28.9	1	5.46
1998	88.3	2	5.353333333
1999	136.3	3	4.97
2000	173.9	4	6.235833333
2001	170.4	5	3.8875
2002	163.6	6	1.666666667
2003	99.3	7	1.1275
2004	65.3	8	1.349166667
2005	45.8	9	3.213333333
2006	24.7	10	4.964166667
2007	12.6	11	5.019166667
2008	**4.2**	**12**	**1.9275**
2009	4.8	1	0.16
2010	24.9	2	0.175
2011	80.8	3	0.101666667
2012	84.5	4	0.14
2013	94.0	5	0.1075
2014	113.3	6	0.089166667
2015	69.8	7	0.1325
2016	39.8	8	0.395
2017	21.7	9	1.001666667
2018	7.0	10	1.831666667
2019	**3.6**	**11**	**2.158333333**
2020	8.8	1	0.375833333
2021	29.6	2	0.08
2022	83.1	3	1.683333333

Source: Federal Reserve Bank of St. Louis. Economic data. 2023; World Data Center for the production, preservation and dissemination of the international sunspot number.

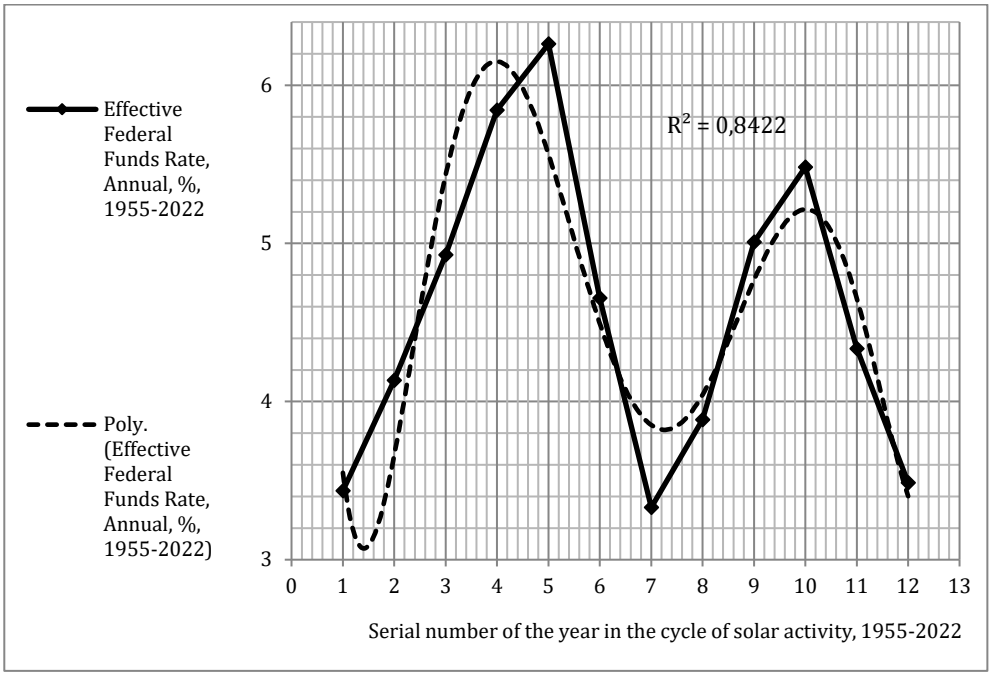
Further, Table 1's statistical data have been grouped according to serial numbers of years in the cycles of solar activity for 1955-2022 (see Table 2). Column 2 shows the number of such years for the period 1955-2022. For example, the number 7 in column 2 to the right of the serial number 1 means that, for the period of 1955-2022, there were seven first years in the cycles of solar activity. The number 2 to the right of the serial number 12 means that there were two twelfth years of solar cycles for the same period that is, these years did not take place in every cycle of solar activity. Column 3 of Table 2 shows the arithmetic average of the federal funds effective rate for each year.

Table 2. Grouping of effective federal funds rates by serial numbers of years in solar activity cycles (1955-2022)

Serial number in solar activity cycle	Number of such years, 1955–2022	Arithmetic averageeffective federal funds rate, %, 1955-2022	Ratio to the previous year's rate
1	**2**	**3**	**4**
1	7	3.43547619	0.985435981
2	7	4.135238095	1.203687019
3	7	4.927261905	1.191530401
4	6	5.843333333	1.185918964
5	6	6.261666667	1.071591557
6	6	4.655416667	0.743478839
7	6	3.330833333	0.715474805
8	6	3.885	1.166374781
9	6	5.009722222	1.28950379
10	**6**	**5.483055556**	**1.09448295**
11	**3**	**4.333888889**	**0.790414915**
12	**2**	**3.48625**	**0.8044161**
Total:	68		

Source: Statistical data in Table 1.

It should be emphasized that Table 2 presents data for all years in the period from 1955 to 2022 without exception. Based on the data from the first and third columns of Table 2, a diagram has been constructed (see Figure 1) which shows the relationship between the effective federal funds rate and the yearly serial numbers in all solar activity cycles for the period 1955-2022, with an approximation coefficient R-squared equal to 0.8422. It should be noted that more years of observation increases the value of this coefficient. This means that the function shown in the graph describes with high accuracy a strong correlation between the effective federal funds rate and the serial numbers of the years in solar cycles, an astrophysical and economic fact that should be recognized by modern traditional economic science.



Source: Data in columns 1 and 3 of Table 2.

Figure 1. The effective federal funds rate as a function of the serial number of the year of the solar activity cycle for the period 1955-2022.

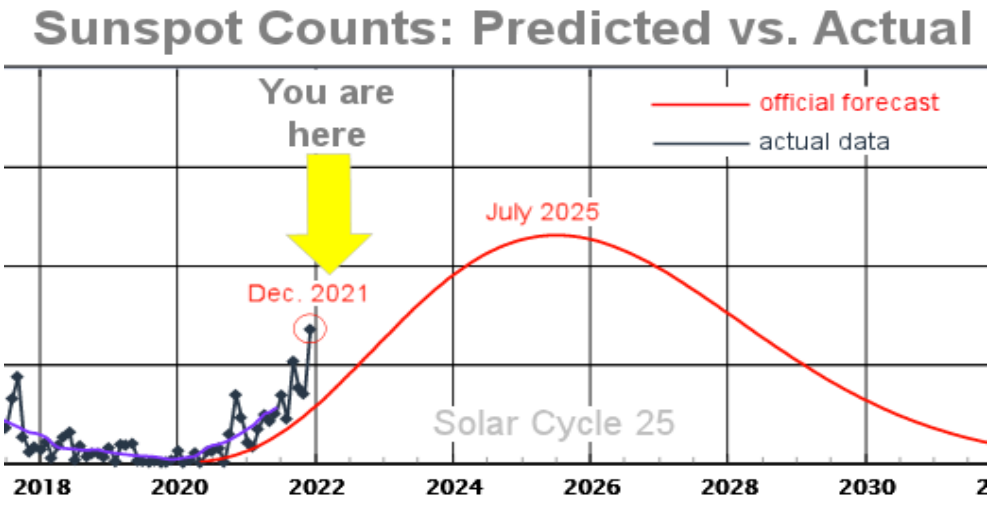
Table 3 presents the values of the correlation coefficients for numbers of years of average solar activity cycle from 1955 to 2022 and the corresponding values for the federal funds rate. They are calculated based on the data in Table 2. Attention should be drawn to the high value of these correlation coefficients.

Table 3. Correlation coefficients between years numbers of average solar cycle and federal funds rate values for the period 1955-2022

Number of years in average solar cycle, 1955–2022	Correlation coefficient with the federal funds rate	Number of years with these numbers for the period 1955–2022
1	**2**	**3**
1–5	0.99499269	33
5–7	-0.998464195	18
7–10	0.986985363	24
10–12	-0.996221106	11

Source: Data in columns 1 and 3 of Table 2.

Consequently, the identified strong ties can be used to predict the values of the effective federal funds rate. One website (spaceweather.com, 2023) has a forecast from which it follows that a further increase in solar activity is expected in 2023, following the minimum in 2019 (see Figure 2). Therefore, 2023 should be the fourth year of growth in solar activity current 25th cycle.

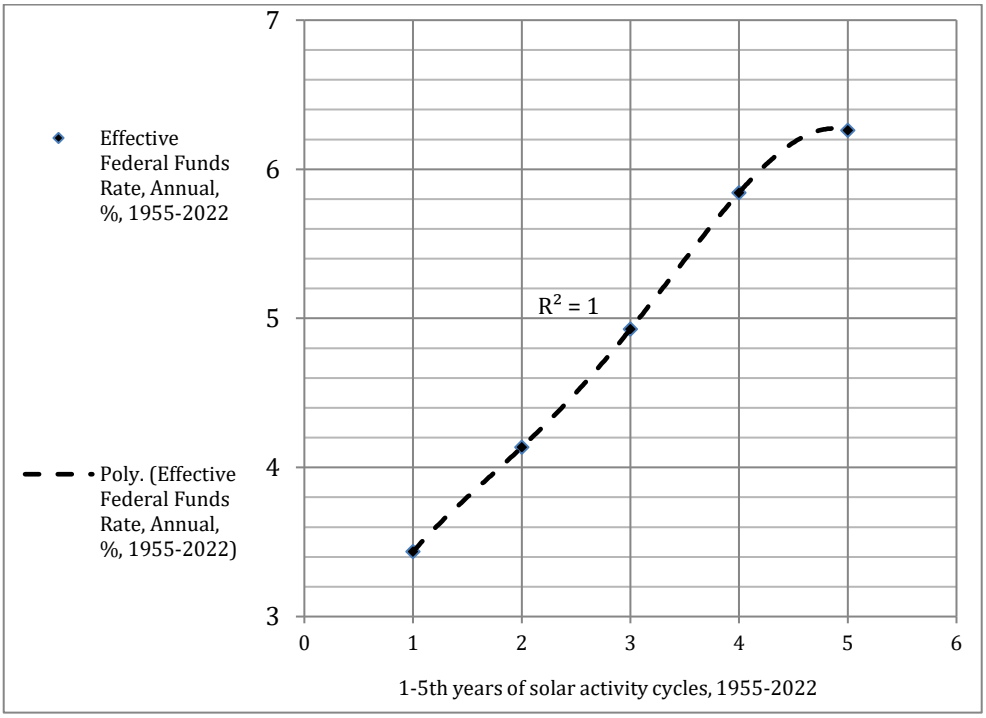


Source: Spaceweather.com.

Figure 2. Forecast of the 25th cycle of solar activity

Therefore, it is permissible to use a segment of the average federal funds rate curve for 15 years of the average solar cycle. The corresponding graph is presented in Figure 3. The extremely high value of the approximation coefficient, equal to 1.0, stands out. Approximation coefficients of 1.0 also occur if similar graphs are plotted for 57, 710 and 1012 years. On the graph in Figure 3, the value of the average rate for the fourth year is 5.843333333; for the third year, it is 4.927261905. The ratio of these values is 1.185918964. Multiplying this ratio by the rate for 2022 (1.6833333333), we get a forecast average value for the 2023 rate of 1.996296923.

- The graph in Figure 1 shows that a sharp rate cut by US Federal Reserve comes one year after a in solar maximum activity, which for the period 1955-2022 falls in the fourth year of the average cycle of solar activity. The next such year should be 2025. Consequently, a sharp US Federal Reserve rate cut in reaction to the economic crisis will occur in 2027.
- These rate cuts occur as belated reactions to economic crises, that is, a significant decline in the US GDP index, which occurs on average the following year after extreme (highs and lows) Wolf numbers.



Source: Data in columns 1 and 3 of Table 2.

Figure 3. Strong relationship between 1-5 ordinal year numbers and average federal funds rates, 1955-2022, 33 years of observations.

I think that the US Federal Reserve is the least focused on solar activity when determining the rate. It rather comes from macroeconomic indicators of the US economy which, as proven in my works, are strongly related to solar activity cycles (Belkin, 2023).

It seems to me that it is necessary to distinguish between the very strong connections between solar and economic activity and the mechanism of these connections. The fact of a convincing link between cycles of solar and economic activity has been proven, among other things, by this article and should be recognized by modern traditional economic science.

It would take a longer discussion to explain the mechanisms of the identified connections. At the same time, it is necessary to use the scientific works of heliobiologists such as Chizhevskij, Gurfinkel, Obridko, Novik, Smirnov and Eliyahu Stoupel, who have proved the negative impact of both maxima and minima of solar activity on the health and mental state of people.

In this paper, I have noted that the minimum average federal funds rate occurs in the

seventh year of an average solar activity cycle (see Figure 1). In the same year there is a maximum number of magnetically disturbed days with the sum of the coefficient's values Kr>25.

It is important to note that the US Federal Reserve's average rate is not a function of the serial number of the average cycle of solar activity, but of solar activity factors (geomagnetic activity, the intensity of galactic cosmic rays, atmospheric pressure, etc.) that influence people's moods (optimistic or pessimistic) and actions throughout the corresponding year.

The practical significance of this study lies its developed methodology for forecasting the effective federal funds rate according to a given year's serial number in the solar activity cycle. It furthermore substantiates the need to include a course on "helioeconomics" in the list of academic or special disciplines taught at universities.

Results

The study has proved a strong correlation between the years order numbers of medium solar cycle and the US Federal Reserve rate. On this basis, a methodology for predicting the Federal Reserve rate has been developed.

Discussion

The main problem with the proposed prediction method is that the actual dynamics of solar activity may differ from predictions. For example, the next year of solar activity maximum may not be 2025, but 2024 or 2023. In this case, the forecast for the next US Federal Reserve rate drop should be adjusted.

Conclusion

The present study proves a strong correlation between solar cycles and US Federal Reserve rates. Prediction error is possible due to the fact that the specific rate value may not coincide with the average value. A further direction of research seems to be determining the relationship between solar activity and other macroeconomic indicators, including in other countries and the world as a whole.

Conflict of interest

The author declares no conflict of interest.

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How to cite this article:

Belkin, V. (2023). US Federal Reserve Rate and Solar Activity (1955-2022): Proof of Strong Correlations. *Economic Thought Journal*, 68 (2), 220-229. https://doi.org/10.56497/etj2368204