A seasonal behavioral stock buying pattern in the United States stock exchange.

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Humans, like all life, are sensitive to their environment. Human and animal individuals can be triggered into impulsive and even violent activities from spikes in serum serotonin. Serum histamine level is directly proportional to environmental allergen levels producing dreaded seasonal allergic symptoms. But serum serotonin level, or the control of the level, is inversely proportional to serum histamine levels. Examples are presented where analysis over time of stock buying, as measured in the daily closing level of the United States stock exchange, shows a seasonal "J" shaped pattern that correlates with serotonin falls and spikes (histamine spikes and crashes) induced by the rise and fall of environmental allergens. A logical predictive strategy is thus presented where, excluding very large shocks like wars, market players could "buy low" an exchange-traded fund (ETF) i.e., indexed "stock," every fall season (between August 25 to October 5) and then subsequently "sell high" (between October 17 and November 10) as increased serotonin in the aggregate population leads to the increase in impulsive and speculative (over-confident) stock buying before "normalizing" around late November.

"We are all animals, my lady. Most are too afraid to see it!"
-- Darkness -- Legend

"In all the known history of Mankind, advances have been made primarily in physical technology; in the capacity of handling the inanimate world about Man. Control of self and society has been left to chance or to the vague gropings of intuitive ethical systems based on inspiration and emotion… Psychohistory was the quintessence of sociology; it was the science of human behavior reduced to mathematical equations. The individual human being is unpredictable, but the reactions of human mobs, Seldon found, could be treated statistically."
-- Isaac Asimov -- Second Foundation

"We human beings are part of nature and therefore we are more likely to find out about our 'inner' nature, to understand ourselves, by looking outside ourselves, at our role and place as animals. In John Gray's words, 'A zoo is a better window from which to look out of the human world than a monastery.' This is not paradoxical, and without some such realignment of approach, the modern incoherence will continue."
-- Peter Watson -- Ideas a history of thought and invention, from fire to Freud

"Wouldn't economics make a lot more sense if it were based on how people actually behave, instead of how they should behave?"
-- Dan Ariely -- Predictably Irrational: The Hidden Forces That Shape Our Decisions

"Pages and pages of data... efficiency functioning on multiple levels and in multiple dimensions... there it was all the time, staring you in the face. Buried within the message itself."
-- S.R. Hadden -- Contact

***Serotonin**: …serotonergic neurons play an important part in a variety of psychiatric conditions from anxiety disorders to schizophrenia as well as behavioral impulse-related disorders (violence, substance abuse, obsessive control, gambling, etc.…)*

Humans, like all life forms, are sensitive to their environment. So much so, in fact, that mentally ill or mentally unstable individuals can be triggered into impulsive and violent activities from spikes in serum serotonin (Cetin et. al., 2017) including spikes after seasonal drops in pollen (**Fig. 1**). But serotonin spikes also affect "normal" humans as well. Further note that serum histamine levels are directly proportional to

environmental allergen levels producing the obvious, and dreaded, seasonal allergic reaction symptoms. But serum serotonin level, or the control of the level in the brain, is inversely proportional to serum histamine levels (Hough, 1999, and Munari et. al., 2015, and Ryo et. al., 2006). Also note that male humans have 52% more serotonin than females (Nishizawa et. al., 1997).

Analysis over time of stock market stock buying, as measured in the daily closing level of the United States stock exchange (also the S&P 500 and Dow Jones Industrial Average indexes), shows a seasonal "J" shaped pattern that correlates with serotonin falls and spikes (histamine spikes and crashes) induced by the rise and fall of environmental allergens.

A logical predictive strategy is thus presented where, excluding very large shocks like wars or a Presidential election scandal before November voting, or in our specific analysis presented here, the removal of the 2008 financial crisis and the 2020 global pandemic impact from covid-19, market players could "buy low" an exchange-traded fund (ETF) i.e., indexed "stock," every fall season (between an approximate date range of August 25 to September 5) and then subsequently "sell high" (between an approximate date range of October 17 and November 10) as increased serotonin in the aggregate population leads to the increase in impulsive and speculative (over-confident) stock buying before "normalizing" back to the normal regression curve around the middle to end of November each year (**Fig. 2-3**).

A scientific motto, often demonstrated to be true, is that "biology drives psychology." The advent of near real-time tracking of allergen levels in given cities or zip codes has led to a possible predictive model from the known human serum biochemistry of histamine and serotonin interactions versus observed year-over-year acts of violence (mass shootings) from mentally unstable individuals or even stock market overly optimistic buying akin to impulsive gambling. "Normal" individuals can be observed and analyzed tracking simple impulsive behaviors from similar, albeit manageable, increases in blood serum serotonin levels leading to excess confidence and risk taking from the biochemistry of the associated crash in airborne allergens of pollen that thus lowers serum histamine levels.

Examples of the phenomena can be seen in both fall and spring allergy seasons but the fall season with ragweed weed pollen is very consistent with the dates of start, peak, and end each year occurring within a specific range while the spring season involves various trees that pollenate and the start, peak, and end can vary by a month or two depending on the length of a year's winter (bomb cyclones etc.…). The fall "J" shaped event is also more obvious and significant in size, compared to spring example events (**Fig. 4**). The observation that the fall pollen start date and stop dates "moves" down the latitudes (while spring moves up latitudes) still only leads to a date range that is at most two to three weeks in length and this can be seen in examples. Fall and spring of 2020 and 2021 are shown (**Fig. 5**) with the original graph followed by the diagramed graph for comparison. The same is done using the years 2004 and 2005 (**Fig. 6**) and fall of 2021 (**Fig. 7**) to show fall season buy and sell ranges and the "J" shaped drop with subsequent larger increase. Note it is interesting to observe that the market almost never fully drops below the higher level reached at the top of the "J." Part of this is growth in human population, investors, and transactions but this could also help explain the aggregate growth in the stock market period (S&P 500 year over year 9% growth rate); perhaps human bias is too optimistic.

The histamine dropping, and thus serotonin spiking, and even post-histamine (post-pollen) serotonin rebound or two to three week "serotonin hump" (**Fig. 8**) has its own impact including possible increases in cardiac arrests (**Fig. 9**) and consumer spending. Impulsivity from this higher-than-normal serotonin includes spending, not just on stocks, but also spending "in general" a la gifts - like those for the annual Christmas holiday in the United States. Thus, those infamous Black Friday (major shopping event after the annual last Thursday in November Thanksgiving holiday) 5 am store front mobs of shoppers suddenly make a lot more sense. Shoppers imbued with high serotonin (driving aggression and anger) and with their unbeknownst impulsive drive to want and to buy act accordingly regardless of context of free will. In reflection what a convenient if not perfect time of year for a gift-buying holiday season to maximize consumer spending and economic output.

Also, if our assumed correlation with pollen/histamine/serotonin/stock buying is accurate, then note how exogenous factors like climate change (increases number of pollination weeks before frost), increased use of antidepressant (selective serotonin uptake inhibitor SSRI) medications, and even gym related exercise, stimulants, and steroids could all, in theory, have an effect on a population of investors or stock traders that, in the end, are still making a decision or bet with serotonin influencing their judgment, to one degree or another, whether any individual actor understands or admits this. Note too that this investment strategy must involve an indexed stock as any individual stock is too correlated with events specific to a given

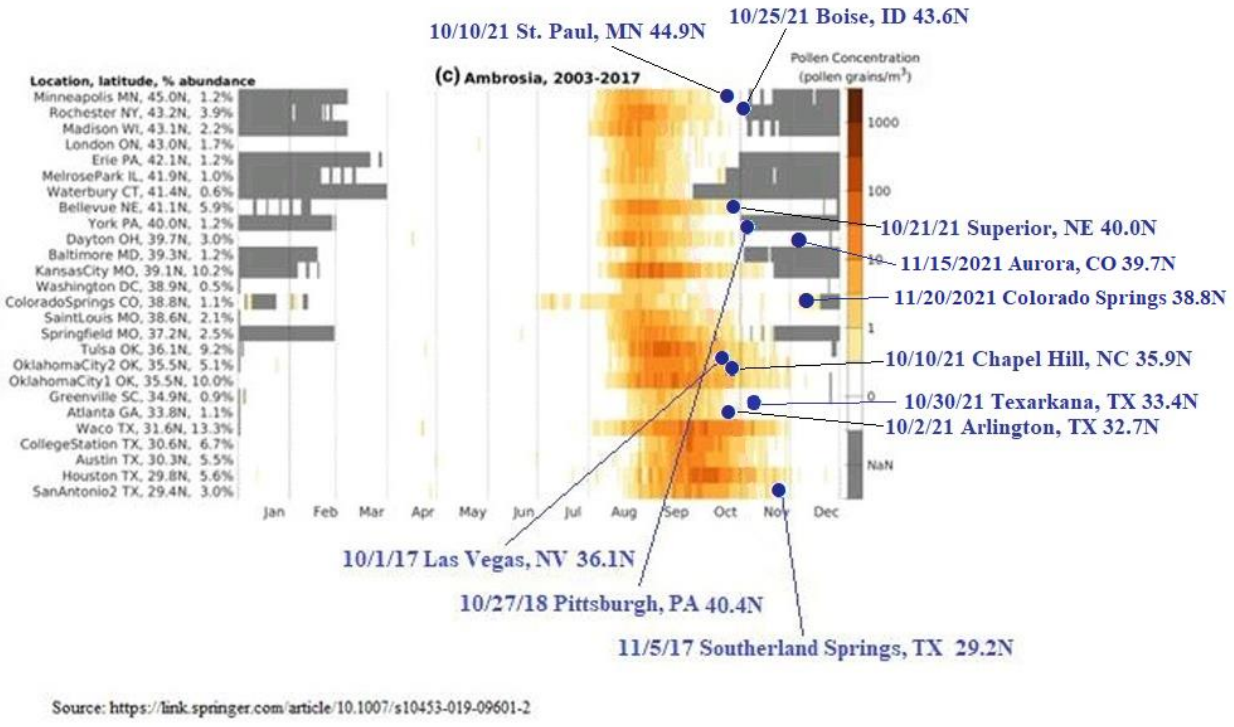
company or industry versus the aggregate effect noticed at scale with the entire market (population) and with indexed stocks.

The goal of this essay is only to propose this possible correlation and to promote additional considerations for behavioral economics if not environmental, sociological, bio-chemical, psychological economics or finance research. The data exists so that experienced analysts can do full regression and statistical analysis to carefully exclude minor shocks and to compare every annual season, as far back as the data allows, to confirm or refute the given hypothesis with formal analysis. Thus, the limitations of this proposal are known and understood in depth.

An example analysis is done using closing daily stock market data from 1915 to 2019. Years 2008 and 2020 are removed as outliers – they lead to excessively low closing values as exogenous events. As a model to proxy the hypothesis, the BUY LOW day is chosen to be the last day of August for each year and then SELL HIGH day is chosen to be the last day of October for each year. The difference between the last market day in October price minus the last day in August price, per the hypothesis, should be a positive value with statistical significance with, at the very least, a weak direct relationship. Removing 2008 and 2020 shocks, which is the observed result from a basic linear regression analysis using Microtrends.net data (**Fig. 10-15**).

Figures

Fig. 1. United States mass shootings by date versus city, latitude, and fall pollen range (orange).



Source: https://link.springer.com/article/10.1007/s10453-019-09601-2

Fig 2. BUY/SELL strategy timeline dates vs fall seasonal allergen/histamine/serotonin levels.

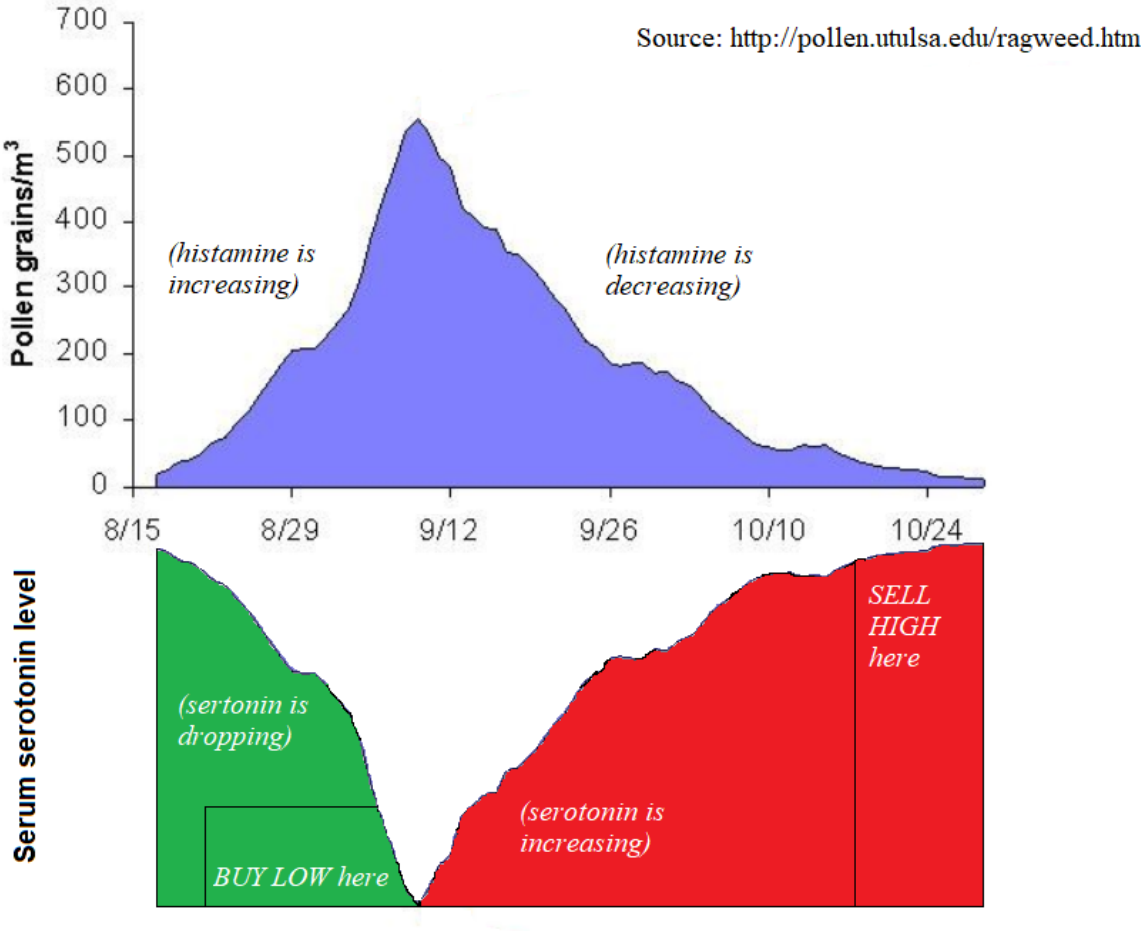


Fig. 3. Example indexed fund Spyder ETF on Robinhood app.

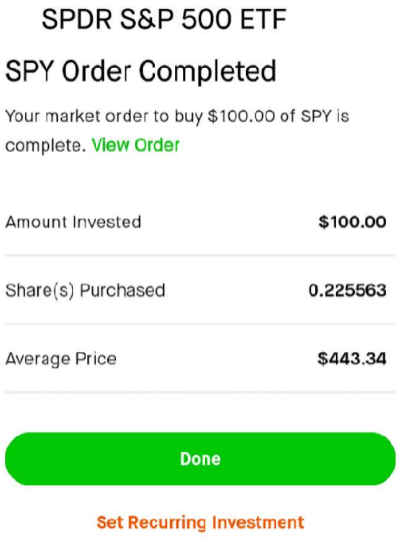


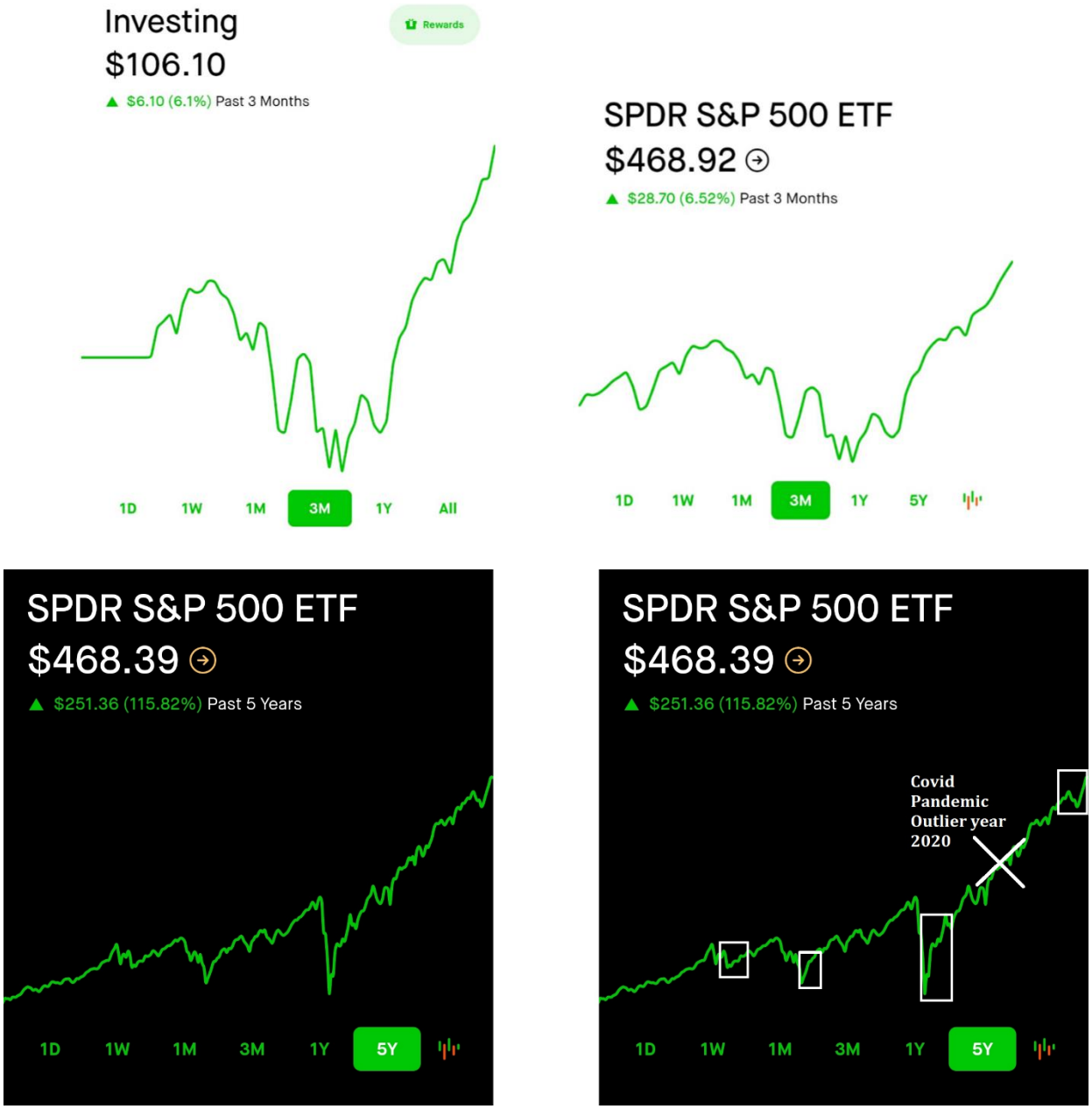
Fig 4. Example Robinhood SPDR S&P 500 ETF indexed fund in 2021 showing "J" shaped movement.

8/20/2021 $100.00 purchased to monitor.

9/16/2021 $100.87 baseline

10/4/2021 $96.69 (low buy)

11/5/2021 $106.10 (high sell) 32 days later (25 trading days) = **9.7%** growth rate.

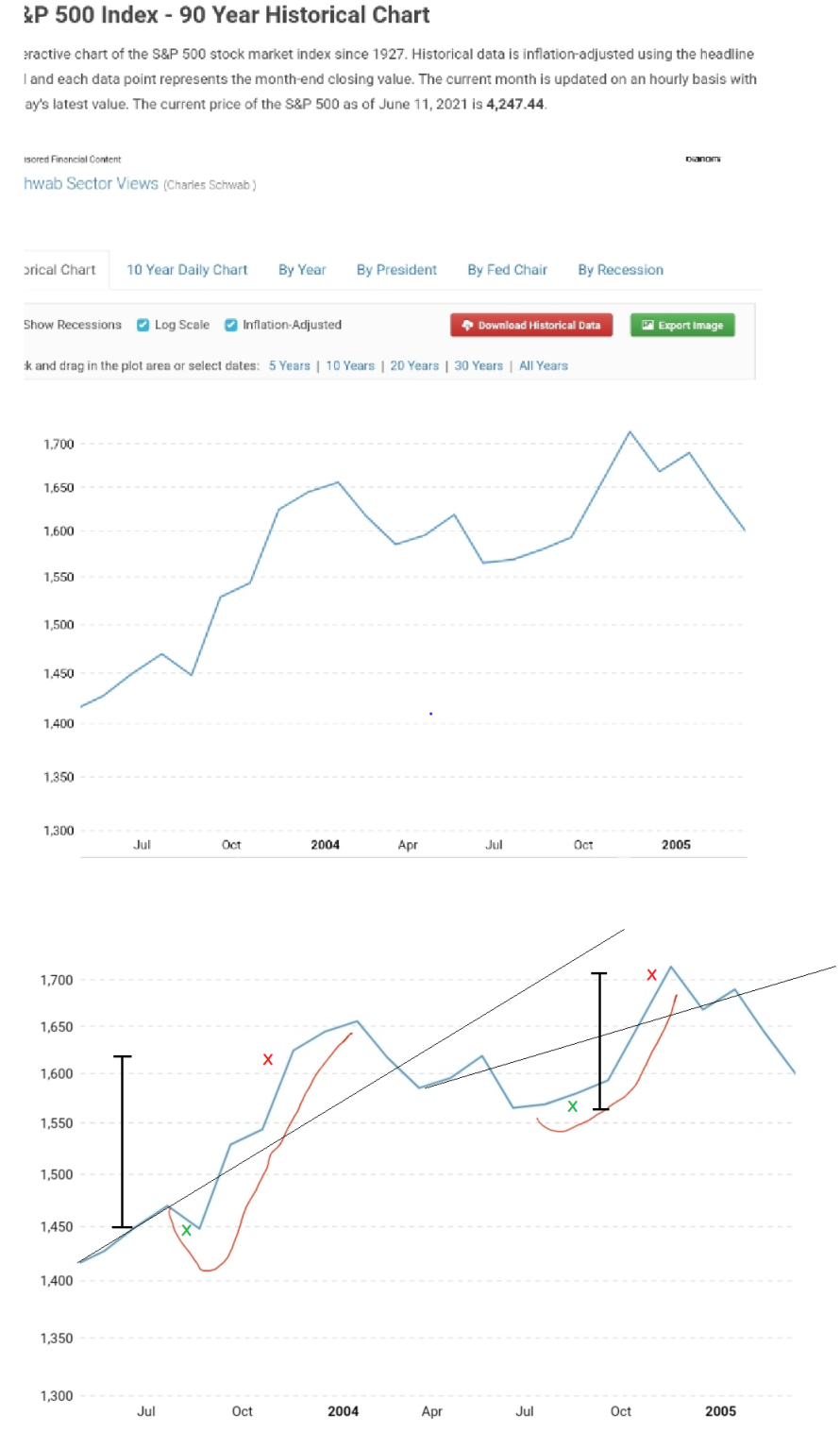


Source: Robinhood android smartphone app display of SYDR SAP 500 ETF fund retrieved 11/5/2021.

Fig 5. Original and overlay of Fall 2020 to Spring 2021 of Dow Jones (DJIA) index vs pollen/serotonin.

Source: https://www.macrotrends.net/1358/dow-jones-industrial-average-last-10-years

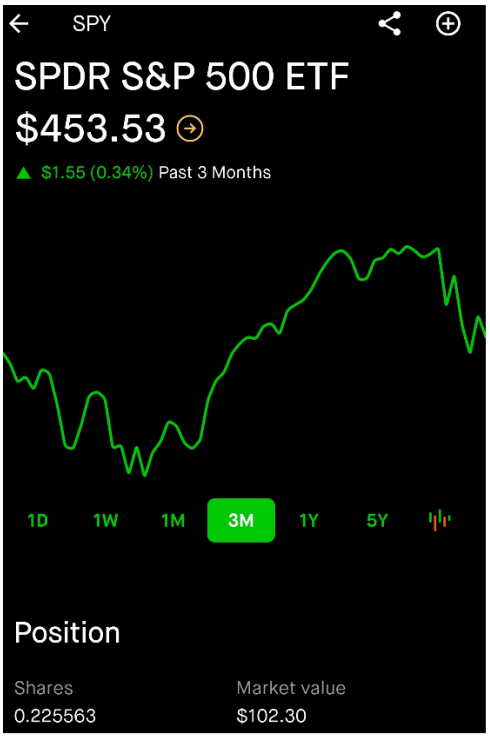
Fig 6. Original and overlay of fall 2004 and 2005 S&P 500 vs serotonin vs BUY/SELL date ranges.



Source: https://www.macrotrends.net/2324/sp-500-historical-chart-data

Fig 7. Robinhood SPDR indexed ETF in fall 2021 showing "J-shaped" annual pattern.

Fig 8. 3-month (3M) prior window from 12/2/2021 of SPDR ETF Robinhood app. Original and overlay of annual drop, spike, and 2-3 week serotonin hump of (violence, impulsivity, and spending in blue).



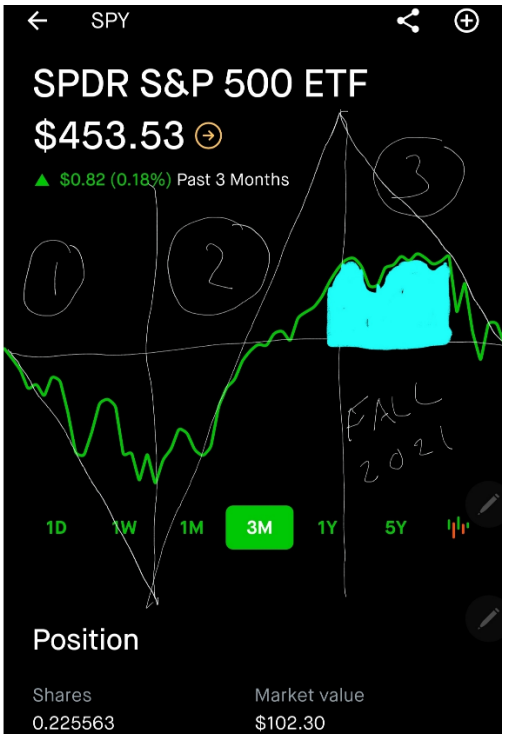
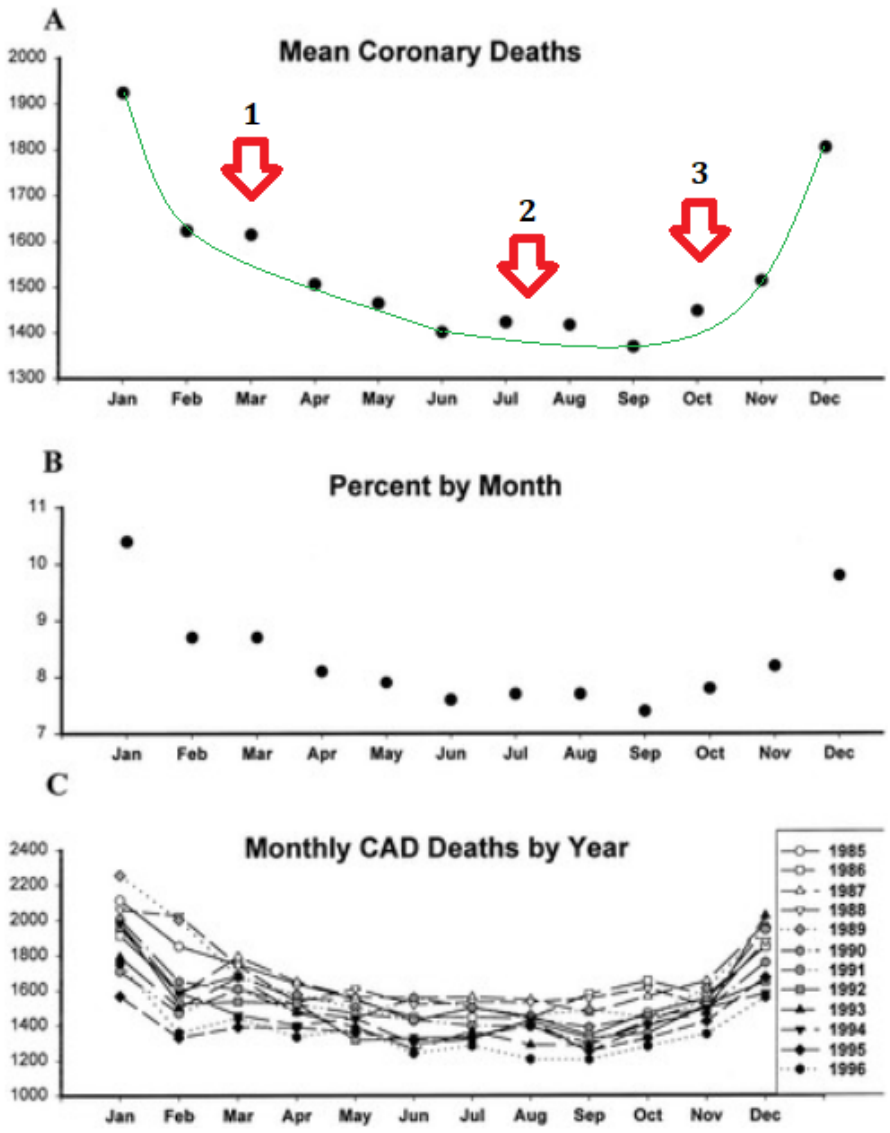
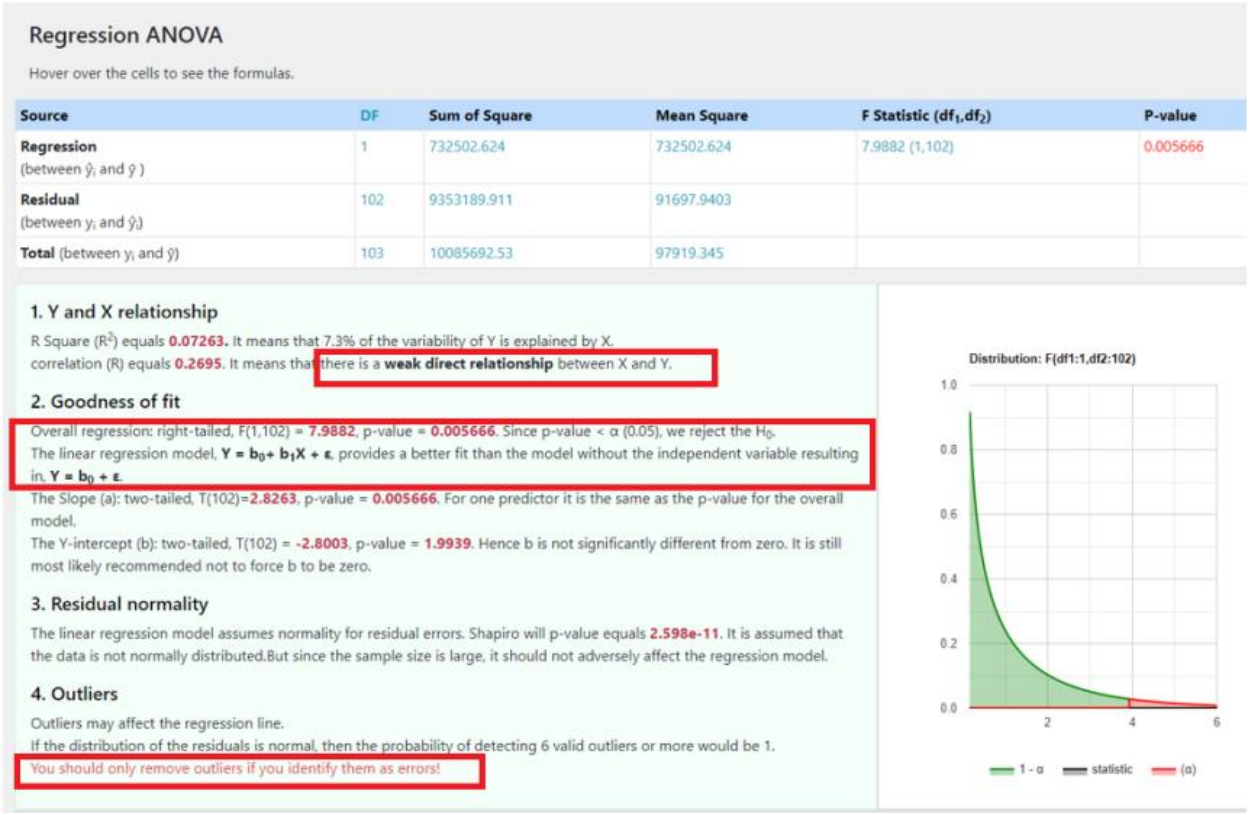


Fig. 9. Example of US cardiac arrests by months vs "serotonin spikes" after tri-annual pollen events (spring tree (juniper), summer grass, fall weed (ragweed).



Source: https://www.ahajournals.org/doi/full/10.1161/01.CIR.100.15.1630

Fig. 10: Final regression using all years from 2015 to 2019 removing the years 2008 (global financial crisis exogenous hit) and 2020 (covid19 global pandemic) as both are considered large overwhelming outliers. Doing so then leads to a p-value that rejects null hypothesis.



Regression ANOVA

Hover over the cells to see the formulas.

Source	DF	Sum of Square	Mean Square	F Statistic (df_1,df_2)	P-value
Regression (between $\hat{y}_i$ and $\bar{y}$)	1	732502.624	732502.624	7.9882 (1,102)	0.005666
Residual (between y_i and $\hat{y}_i$)	102	9353189.911	91697.9403		
Total (between y_i and $\bar{y}$)	103	10085692.53	97919.345		

1. Y and X relationship

R Square (R^2) equals **0.07263.** It means that 7.3% of the variability of Y is explained by X.
correlation (R) equals **0.2695**. It means that there is a **weak direct relationship** between X and Y.

2. Goodness of fit

Overall regression: right-tailed, F(1,102) = **7.9882**, p-value = **0.005666**. Since p-value < α (0.05), we reject the H_0.
The linear regression model, $\mathbf{Y = b_0 + b_1X + \varepsilon}$, provides a better fit than the model without the independent variable resulting in, $\mathbf{Y = b_0 + \varepsilon}$.
The Slope (a): two-tailed, T(102)=**2.8263**, p-value = **0.005666**. For one predictor it is the same as the p-value for the overall model.
The Y-intercept (b): two-tailed, T(102) = **-2.8003**, p-value = **1.9939**. Hence b is not significantly different from zero. It is still most likely recommended not to force b to be zero.

3. Residual normality

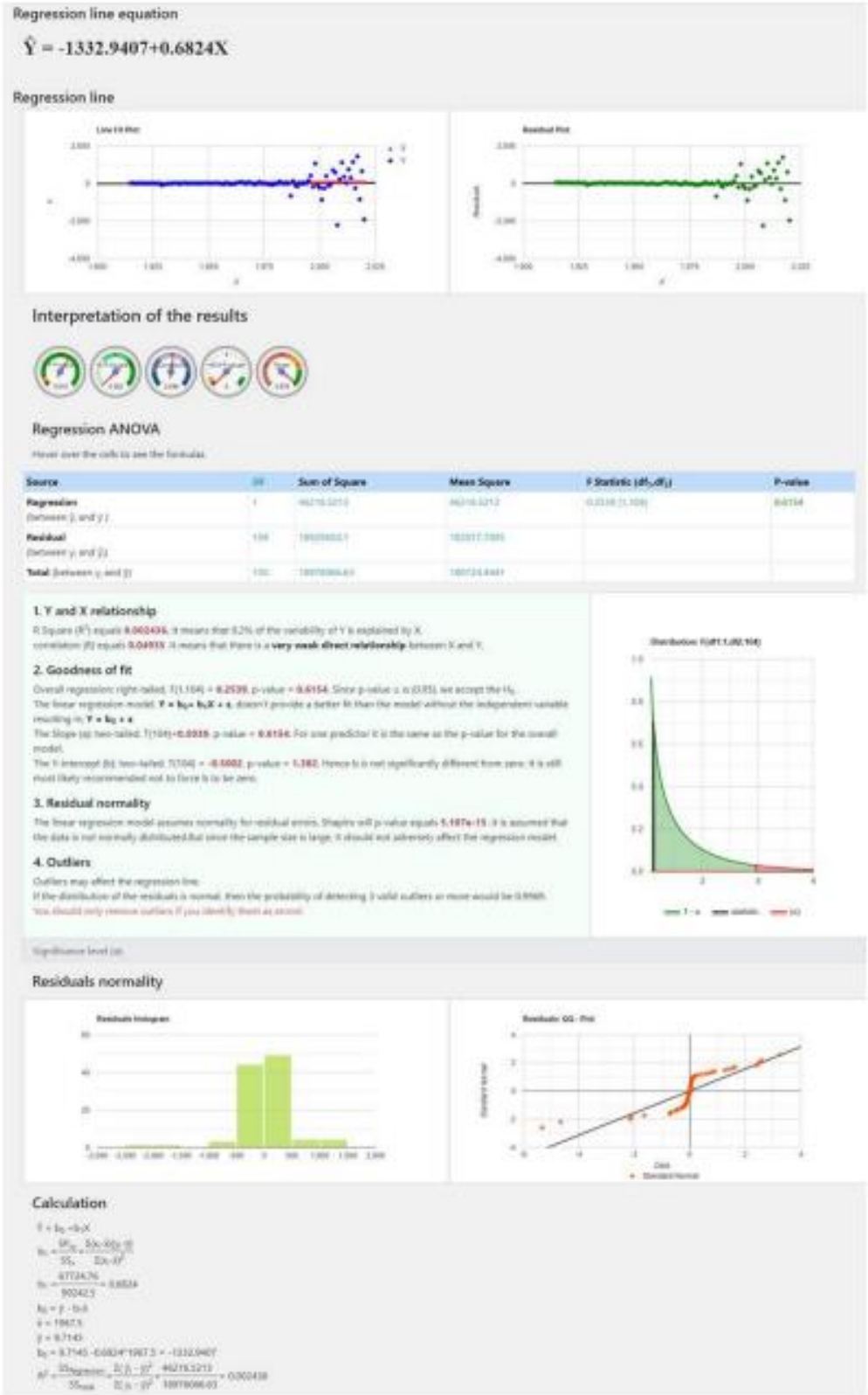
The linear regression model assumes normality for residual errors. Shapiro will p-value equals **2.598e-11**. It is assumed that the data is not normally distributed.But since the sample size is large, it should not adversely affect the regression model.

4. Outliers

Outliers may affect the regression line.
If the distribution of the residuals is normal, then the probability of detecting 6 valid outliers or more would be 1.
You should only remove outliers if you identify them as errors!

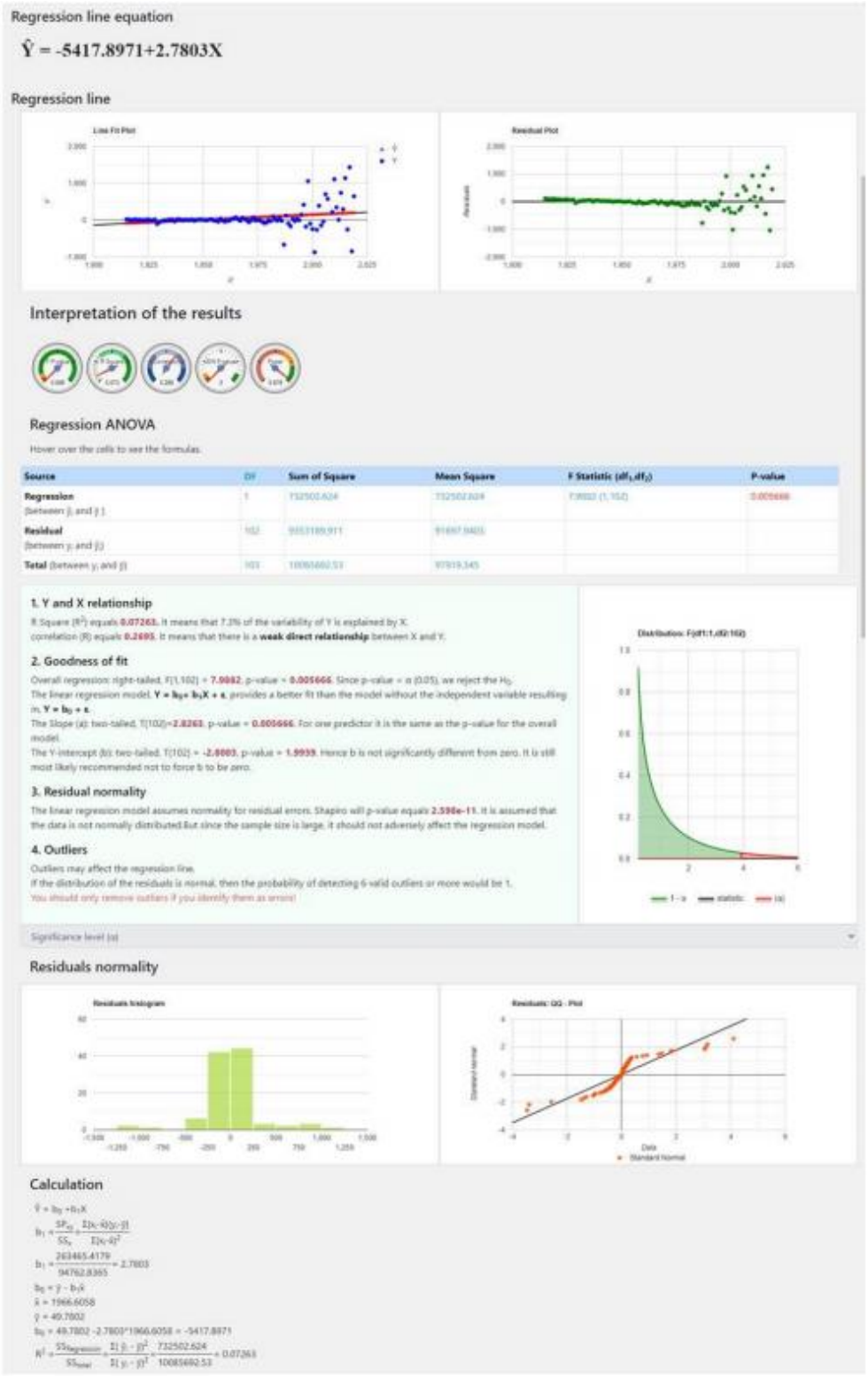
Source: https://www.statskingdom.com/linear-regression-calculator.html

Fig. 11: **Data using all years including 2008 and 2020 (1915 to 2020) (below).**



Source: https://www.statskingdom.com/linear-regression-calculator.html

Fig. 12: **All years (1915-2019) removing 2008 and 2020 outlier exogenous shocks (below): Now we can reject the H0 null hypothesis.**



Source: https://www.statskingdom.com/linear-regression-calculator.html

Fig. 13: **Regression Test.**

Linear Regression Calculator

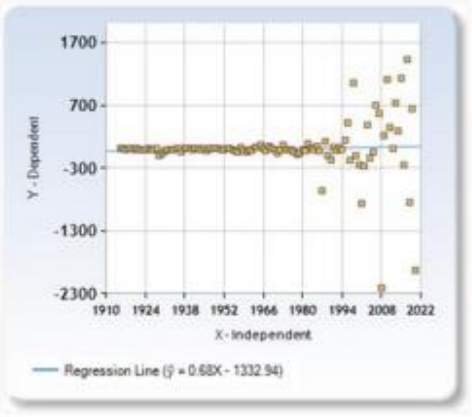
For your data, the regression equation for *Y* is:

$$\hat{y} = 0.68242X - 1332.94074$$

As you can see the output from this calculator is fairly verbose. Mostly it should be self-explanatory, but you should note that any apparent discrepancies in calculations are because rounding is used for the purposes of display, but not for the calculations themselves.

If you wish to perform a further calculation, it is necessary to hit the reset button at the bottom of the page.

X Values	*Y* Values
1915	14.14
1916	12.36
1917	-8.9
1918	3.05
1919	14.17
1920	-1.08
1921	6.1
1922	-4.67
1923	-4.93
1924	-0.08
1925	14.47
1926	-11.75
1927	-8.06
1928	11.75
1929	-106.82
1930	-57.07
1931	-33.98
1932	-11.26
1933	-14.25
1934	0.5



Estimate

Calculation Summary

Sum of X = 208555
Sum of Y = 1029.74
Mean X = 1967.5
Mean Y = 9.7145
Sum of squares (SS_X) = 99242.5
Sum of products (SP) = 67724.76

Regression Equation = $\hat{y} = bX + a$

$b = SP/SS_X$ = 67724.76/99242.5 = 0.68242

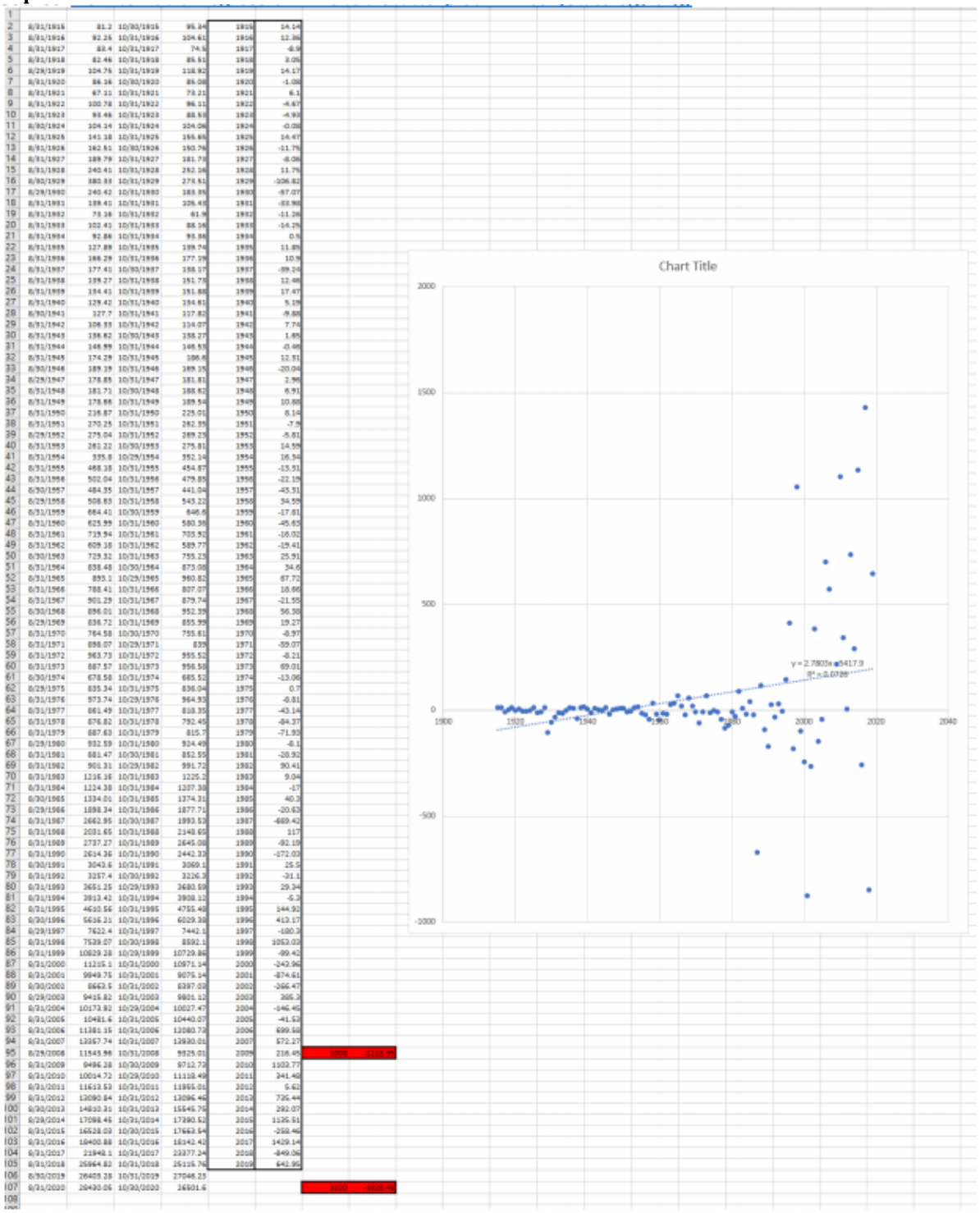
$a = M_Y - bM_X$ = 9.71 - (0.68*1967.5) = -1332.94074

$\hat{y}$ = 0.68242X - 1332.94074

$X - M_X$	$Y - M_Y$	$(X - M_X)^2$	$(X - M_X)(Y - M_Y)$
-52.5	4.4255	2756.25	-232.3373
-51.5	2.6455	2652.25	-136.2418
-50.5	-18.6145	2550.25	940.0337
-49.5	-6.6645	2450.25	329.8942
-48.5	4.4555	2352.25	-216.0904
-47.5	-10.7945	2256.25	512.7401
-46.5	-3.6145	2162.25	168.0756
-45.5	-14.3845	2070.25	654.496
-44.5	-14.6445	1980.25	651.6815
-43.5	-9.7945	1892.25	426.062
-42.5	4.7555	1806.25	-202.1075
-41.5	-21.4645	1722.25	890.7779
-40.5	-17.7745	1640.25	719.8684
-39.5	2.0355	1560.25	-80.4011
-38.5	-116.5345	1482.25	4486.5793
-37.5	-66.7845	1406.25	2504.4198
-36.5	-43.6945	1332.25	1594.8503
-35.5	-20.9745	1260.25	744.5958
-34.5	-23.9645	1190.25	826.7762
-33.5	-9.2145	1122.25	308.6867
-32.5	2.1355	1056.25	-69.4028

Source: https://www.socscistatistics.com/tests/regression/default.aspx

Fig. 14: Excel results using same data where original data has 2008 and 2020 removed. Last day market day of August is used as BUY LOW indexed price and the last market day of October is used as the SELL HIGH index price. The October price minus the August price (indexed closing level) is the gain. This gain is analyzed year over year where the weak direct positive relationship is seen as expected.



Source: How to Add a Regression Line to a Scatterplot in Excel (statology.org)

Fig. 15: **Original Data Set.**

8/29/1958	508.63	10/31/1958	543.22	1958	34.59
8/31/1959	664.41	10/30/1959	646.6	1959	-17.81
8/31/1960	625.99	10/31/1960	580.36	1960	-45.63
8/31/1961	719.94	10/31/1961	703.92	1961	-16.02
8/31/1962	609.18	10/31/1962	589.77	1962	-19.41
8/30/1963	729.32	10/31/1963	755.23	1963	25.91
8/31/1964	838.48	10/30/1964	873.08	1964	34.6
8/31/1965	893.1	10/29/1965	960.82	1965	67.72
8/31/1966	788.41	10/31/1966	807.07	1966	18.66
8/31/1967	901.29	10/31/1967	879.74	1967	-21.55
8/30/1968	896.01	10/31/1968	952.39	1968	56.38
8/29/1969	836.72	10/31/1969	855.99	1969	19.27
8/31/1970	764.58	10/30/1970	755.61	1970	-8.97
8/31/1971	898.07	10/29/1971	839	1971	-59.07
8/31/1972	963.73	10/31/1972	955.52	1972	-8.21
8/31/1973	887.57	10/31/1973	956.58	1973	69.01
8/30/1974	678.58	10/31/1974	665.52	1974	-13.06
8/29/1975	835.34	10/31/1975	836.04	1975	0.7
8/31/1976	973.74	10/29/1976	964.93	1976	-8.81
8/31/1977	861.49	10/31/1977	818.35	1977	-43.14
8/31/1978	876.82	10/31/1978	792.45	1978	-84.37
8/31/1979	887.63	10/31/1979	815.7	1979	-71.93
8/29/1980	932.59	10/31/1980	924.49	1980	-8.1
8/31/1981	881.47	10/30/1981	852.55	1981	-28.92
8/31/1982	901.31	10/29/1982	991.72	1982	90.41
8/31/1983	1216.16	10/31/1983	1225.2	1983	9.04
8/31/1984	1224.38	10/31/1984	1207.38	1984	-17
8/30/1985	1334.01	10/31/1985	1374.31	1985	40.3
8/29/1986	1898.34	10/31/1986	1877.71	1986	-20.63
8/31/1987	2662.95	10/30/1987	1993.53	1987	-669.42
8/31/1988	2031.65	10/31/1988	2148.65	1988	117
8/31/1989	2737.27	10/31/1989	2645.08	1989	-92.19
8/31/1990	2614.36	10/31/1990	2442.33	1990	-172.03
8/30/1991	3043.6	10/31/1991	3069.1	1991	25.5
8/31/1992	3257.4	10/30/1992	3226.3	1992	-31.1
8/31/1993	3651.25	10/29/1993	3680.59	1993	29.34
8/31/1994	3913.42	10/31/1994	3908.12	1994	-5.3
8/31/1995	4610.56	10/31/1995	4755.48	1995	144.92
8/30/1996	5616.21	10/31/1996	6029.38	1996	413.17
8/29/1997	7622.4	10/31/1997	7442.1	1997	-180.3
8/31/1998	7539.07	10/30/1998	8592.1	1998	1053.03
8/31/1999	10829.28	10/29/1999	10729.86	1999	-99.42
8/31/2000	11215.1	10/31/2000	10971.14	2000	-243.96
8/31/2001	9949.75	10/31/2001	9075.14	2001	-874.61
8/30/2002	8663.5	10/31/2002	8397.03	2002	-266.47
8/29/2003	9415.82	10/31/2003	9801.12	2003	385.3
8/31/2004	10173.92	10/29/2004	10027.47	2004	-146.45
8/31/2005	10481.6	10/31/2005	10440.07	2005	-41.53
8/31/2006	11381.15	10/31/2006	12080.73	2006	699.58
8/31/2007	13357.74	10/31/2007	13930.01	2007	572.27
8/29/2008	11543.96	10/31/2008	9325.01	**2008**	**-2218.95**
8/31/2009	9496.28	10/30/2009	9712.73	2009	216.45
8/31/2010	10014.72	10/29/2010	11118.49	2010	1103.77
8/31/2011	11613.53	10/31/2011	11955.01	2011	341.48
8/31/2012	13090.84	10/31/2012	13096.46	2012	5.62
8/30/2013	14810.31	10/31/2013	15545.75	2013	735.44
8/29/2014	17098.45	10/31/2014	17390.52	2014	292.07

8/31/1915	81.2	10/30/1915	95.34	1915	14.14
8/31/1916	92.25	10/31/1916	104.61	1916	12.36
8/31/1917	83.4	10/31/1917	74.5	1917	-8.9
8/31/1918	82.46	10/31/1918	85.51	1918	3.05
8/29/1919	104.75	10/31/1919	118.92	1919	14.17
8/31/1920	86.16	10/30/1920	85.08	1920	-1.08
8/31/1921	67.11	10/31/1921	73.21	1921	6.1
8/31/1922	100.78	10/31/1922	96.11	1922	-4.67
8/31/1923	93.46	10/31/1923	88.53	1923	-4.93
8/30/1924	104.14	10/31/1924	104.06	1924	-0.08
8/31/1925	141.18	10/31/1925	155.65	1925	14.47
8/31/1926	162.51	10/30/1926	150.76	1926	-11.75
8/31/1927	189.79	10/31/1927	181.73	1927	-8.06
8/31/1928	240.41	10/31/1928	252.16	1928	11.75
8/30/1929	380.33	10/31/1929	273.51	1929	-106.82
8/29/1930	240.42	10/31/1930	183.35	1930	-57.07
8/31/1931	139.41	10/31/1931	105.43	1931	-33.98
8/31/1932	73.16	10/31/1932	61.9	1932	-11.26
8/31/1933	102.41	10/31/1933	88.16	1933	-14.25
8/31/1934	92.86	10/31/1934	93.36	1934	0.5
8/31/1935	127.89	10/31/1935	139.74	1935	11.85
8/31/1936	166.29	10/31/1936	177.19	1936	10.9
8/31/1937	177.41	10/30/1937	138.17	1937	-39.24
8/31/1938	139.27	10/31/1938	151.73	1938	12.46
8/31/1939	134.41	10/31/1939	151.88	1939	17.47
8/31/1940	129.42	10/31/1940	134.61	1940	5.19
8/30/1941	127.7	10/31/1941	117.82	1941	-9.88
8/31/1942	106.33	10/31/1942	114.07	1942	7.74
8/31/1943	136.62	10/30/1943	138.27	1943	1.65
8/31/1944	146.99	10/31/1944	146.53	1944	-0.46
8/31/1945	174.29	10/31/1945	186.6	1945	12.31
8/30/1946	189.19	10/31/1946	169.15	1946	-20.04
8/29/1947	178.85	10/31/1947	181.81	1947	2.96
8/31/1948	181.71	10/30/1948	188.62	1948	6.91
8/31/1949	178.66	10/31/1949	189.54	1949	10.88
8/31/1950	216.87	10/31/1950	225.01	1950	8.14
8/31/1951	270.25	10/31/1951	262.35	1951	-7.9
8/29/1952	275.04	10/31/1952	269.23	1952	-5.81
8/31/1953	261.22	10/30/1953	275.81	1953	14.59
8/31/1954	335.8	10/29/1954	352.14	1954	16.34
8/31/1955	468.18	10/31/1955	454.87	1955	-13.31
8/31/1956	502.04	10/31/1956	479.85	1956	-22.19
8/30/1957	484.35	10/31/1957	441.04	1957	-43.31

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