The GSR Bands

Raúl Gómez Sánchez

Abstract

This study offers an innovative vision that transcends the concept, uses, and importance traditionally given to opening gaps in terms of market compression, and their use in financial asset investment. By using the concept of Macrostructure of an asset, or decomposition of its price as a formula of equilibrium between the gap and market component, and its comparison with traditional variables such as volume, historical volatility and implied volatility, it is observed how the opening gaps are the supports or resistances of variables such as volume or volatility of an asset. This study demonstrates how the comparison through the technical analysis point of view of a volatility index of an asset, and its opening gaps taking into account the Fibonacci series or prime numbers or GSR Bands, allows to detect quite accurately the total lows of assets such as S&P500, DAX40 or Crude Oil, detecting with an accuracy of 0 or 1 day more than 50% of these total market lows.

Introduction

Opening gaps, understood as the difference in price that occurs between the closing price of a financial asset of any type at t–1 and t, and the opening price at t, are a topic rarely addressed in financial literature. In fact, when searching for academic papers on platforms such as SSRN or Google Scholar, only a handful of studies on this subject can be found. These studies can be categorized into three major areas:

- Those focusing on price behavior before and after the opening gap, with notable contributions from Caporale and Plastun (2017), Plastun et al. (2019), and Plastun et al. (2020).
- Those examining the relationships between gaps and market development (both before and after), highlighting research by Branch and Ma (2012), as well as Cliff, Cooper, and Gulen (2008).
- Those emphasizing the significance of opening gaps and attempting to predict them based on price movements in other markets, with key contributions from De Gooijer, Diks, and Gatarek (2009).

Given the definition of an opening gap and the limited number of authors who have explored this topic, it is essential to consider the factors contributing to its existence. The following causes have been identified by Caporale and Plastun (2017):

- Time differences between the closing and opening periods of the market, particularly before holidays and weekends
- The presence of an after-hours market.
- Unexpected news or corporate announcements, many of which occur at market close (e.g., terrorist attacks, corporate earnings reports, OPEC meetings).
- Significant shifts in the supply and demand of an asset, including changes in volume and liquidity.
- Opening and closing auctions.
- Existing mechanisms to manage extreme volatility, such as Circuit Breakers and Volatility Halts in the U.S. market.

In addition to these factors, Branch and Ma (2012) identified further contributors, the behavior of market makers, pending buy and sell orders, the presence of stocks that are difficult to value and costly to arbitrage.

Furthermore, considering the existence of two major markets the spot market and the derivatives (futures) market which often have nearly identical closing prices but significantly different trading hours, it is reasonable to assume a relationship between these markets. There must be an element that connects them. Consequently, another cause of opening gaps must be considered, the difference in trading hours between spot and futures markets. The evolution of the futures market from the closing of the spot market until its reopening determines the opening gap in the spot market, in addition to the carry of the futures contract, which consists of dividends minus the interest charged for financing the purchase (Cagigas, 2023).

Additionally, following the logic of the existing relationship between spot and futures markets, past market movements are expected to influence the opening gaps of subsequent markets. De Gooijer, Diks, and Gatarek (2009) demonstrated that the evolution of the Asian market affects the direction and magnitude of the gap in the European market, while the European market, in turn, influences the gap in the American market.

By understanding the factors that explain the existence of opening gaps, this study offers a new perspective on them, highlighting their relevance in understanding market behavior and informing trading strategies. Therefore, this study graphically compares the opening gap of an asset with fundamental variables such as market performance, volatility, and the concept of market seasonality.

Macrostructure of an asset

Traditionally, the daily profitability of an asset has been calculated as the difference in closing prices. However, if the total profitability of an asset is decomposed, accumulated, and plotted as the sum of its two basic components, the Gap and the Market, it forms what this study defines as the Macrostructure of an asset. This Macrostructure represents a new approach to visualizing market prices, providing additional information beyond traditional representation methods such as lines, bars, or candlesticks.

Based on the chart presented in the introduction, each component can be formulated in percentage terms as follows:

Gap component: The daily return is produced by the price difference between the market close at t-1 and the opening at t. It can be defined as the return generated after the regular trading hours of the main stock exchanges.

Ln (Open t / Close t-1)

Market component: The daily return generated by the normal course of open market trading occurs from the opening at t to the closing at t.

Ln (Close t / Open t)

Total market component: The return is generated between the closing price at t and the closing price at t-1-

Ln (Close t / Close t-1)

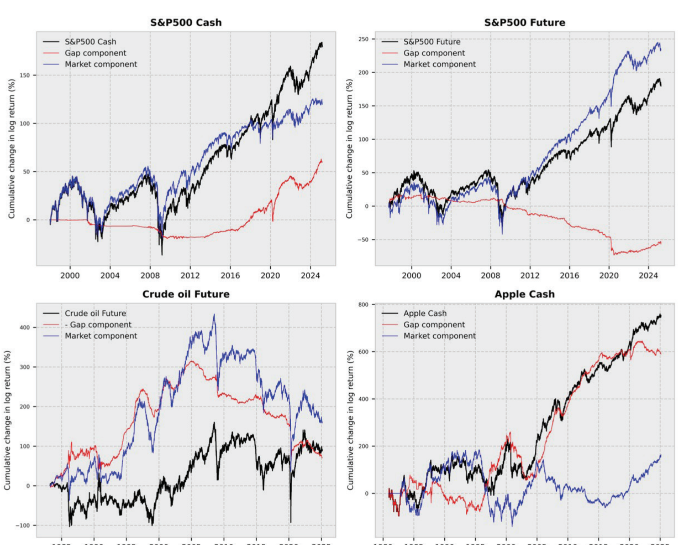
Logically, this division is only meaningful when the sum of the return from the gap component and the return from the market component equals the total return of the asset.

Total, Market = Gap + Market

Ln (Close t / Close t-1) = Ln (Open t / Close t-1) +Ln (Close t / Open t)

As an example, the Macrostructures of four well known assets are presented below: the S&P500 cash and futures, the Crude Oil future, and the Apple stock. It should be noted that each asset, beyond those analyzed in this study, has its own unique Macrostructure, distinct from other assets.

Figure 1: Macrostructure of S&P500 cash and future, Oil crude wti and Apple



In the 5 charts above we observe 3 important things:

First, the existence of an opposite behavior between the gap and market component, as clearly shown in the case of the Apple stock and in the S&P500 future, which fits with the negative correlation results found by B. Branch, A. Ma. (2012). As well as the fact that the gaps of the spot and future are opposite to each other, a fact that happens in many more assets than the S&P500, and which is explained by the stock of 2 markets with different trading hours.

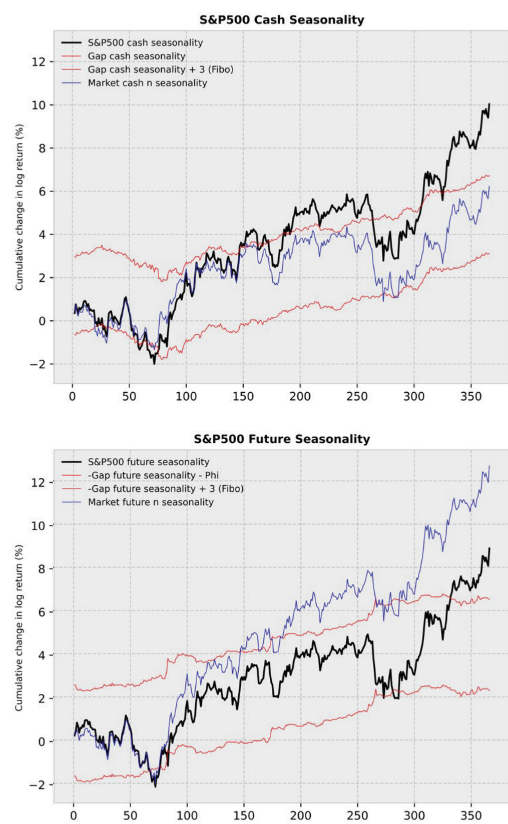
Secondly, the opening gap marks the market lows in assets such as the Crude Oil future, although it should be noted that this also happens in other assets such as the german DAX40.m

And thirdly, although it is not the subject of this study, we emphasize that this Macrostructure could explain why price movements occur after the appearance of the opening gaps, or movements to cover the gaps. Since it is logical to think that if the gap component is bullish in time and the market bearish, the bullish gaps (SELL position) will be covered in a better way than the bearish ones (BUY position), and vice versa.

Opening gaps and seasonality of assets

As we saw in the Macrostructure of the Crude Oil future, the opening gaps show a priori, the ability to detect market lows in a natural way. Knowing this, we wonder if these same gaps also have the ability to detect market lows, through the seasonal behavior of the asset. To answer this question, and having a sample of data since 2000 of the S&P500 spot and futures, we proceed to calculate and plot the seasonality of the gap, market and total market components of these two assets.

Figure 2: S&P500 seasonality since the year 2000



The previous graphs illustrate how, in both the S&P 500 spot and futures markets, the seasonal gap represents the minimum values of this asset over the last 24 years of data. In the case of the futures market, if the Phi number is subtracted from the seasonality of the gap, and if the number 3 is added to the seasonality of the opening gap, the result highlights the maximums of the seasonality of the S&P 500 spot and futures.

Given this intriguing observation, it is relevant to examine how the seasonality of the S&P 500 relates to the seasonal gap components of the VIX, the volatility index of the S&P 500, which measures the expected 30 day implied volatility of this stock index. To address this, a detailed analysis of the seasonality of the VIX spot and futures is conducted, starting from 2009 due to the limited availability of data on this asset. Subsequently, this seasonality is compared to that of the S&P 500 for the same period.

Figure 3: VIX seasonality 2009-2024

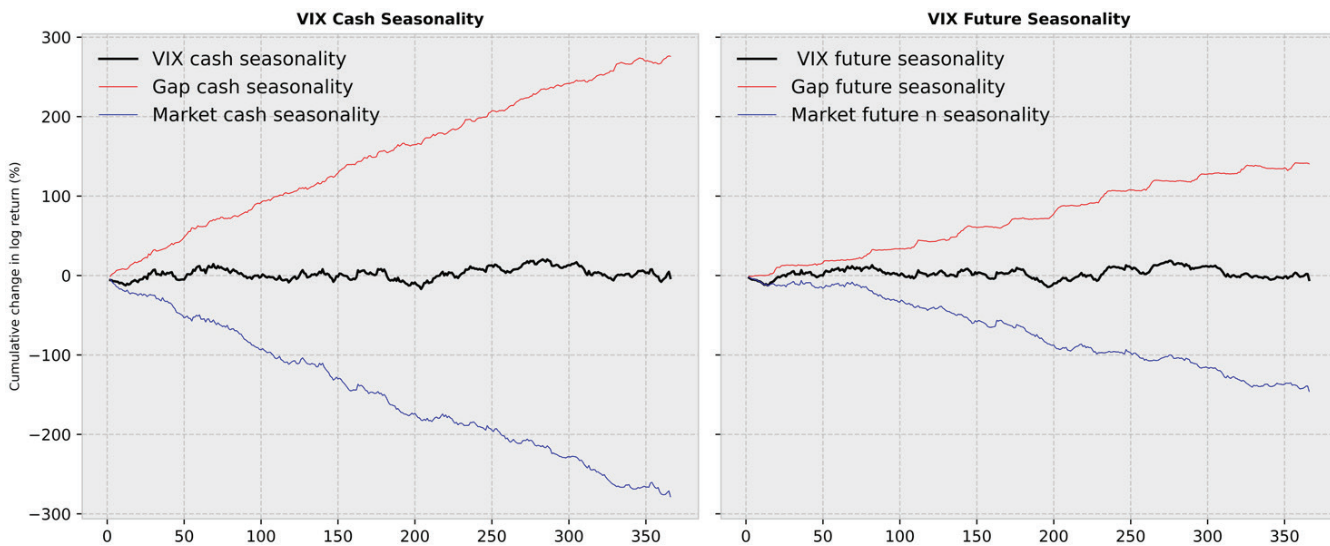


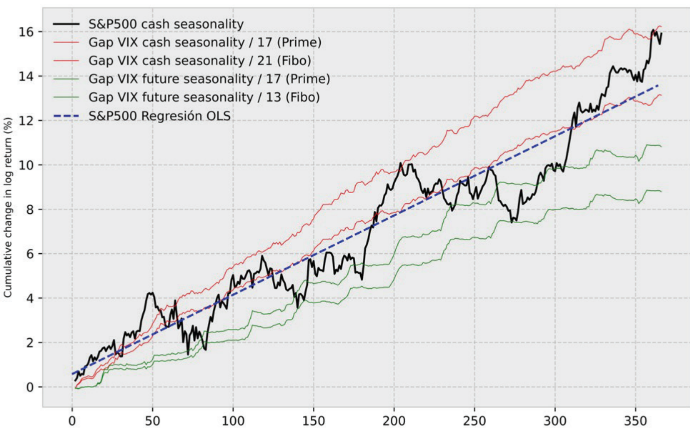
Table 1: Relationship between the slopes of the Gap and Market of the VIX

Degrees of inclinatiom							Phi	
Gap cash	37.16	Relationship	Gap	Market	Gap deviation	Market deviation	Value	Formula
Market cash	-36.34	Cash / Future	1.602	1.592	0.975%	1.65%	1.618	$\varphi_+ = \frac{\sqrt{5}+1}{2}$
Gap future	23.19	Future / Cash	0.624	0.628	-0.965%	-1.62%	0.618	$\varphi_- = \frac{\sqrt{5}-1}{2}$
Market future	-22.83	Sum	2.226	2.220	0.431%	0.72%	2.236	$\varphi_{sum} = \varphi_+ + \varphi_-$

The results indicate that the relationship between the seasonality of the gap and market components of the VIX spot and futures corresponds to the Phi number or a value very close to it. This is a remarkable finding, reinforcing the idea that the minimum of the seasonality of the S&P 500 futures is its seasonalized gap minus the Phi number, while its highs are represented by the gap plus 3. It is worth noting that Phi is the ratio found in the Fibonacci sequence, and 3 is a number belonging to this sequence.

Building on these results and recognizing the significance of the Phi number within them, the analysis now explores how the seasonality of the S&P 500 since 2009 can be further explained, or even better understood, through the gaps of the VIX index in both the spot and futures markets. A graphical representation demonstrates how dividing these values by the Fibonacci sequence and the prime number series allows for the accurate detection of most of the highs and lows in the seasonality of the S&P 500 cash.

Figure 4: VIX gap seasonality and S&P500 future seasonality regression line (2009-2024)



Opening gaps and volume, historical volatility

In addition to the four essential variables that comprise stock market data namely, the opening, high, low, and closing prices two other critical variables must be considered. Volume, which represents the number of contracts traded, serves as an inherent market variable that complements the previously mentioned four. Historical volatility, on the other hand, measures the speed at which prices fluctuate and is typically calculated using the deviations between closing prices or as applied in this study, through the deviations between the differences in maximum and minimum prices.

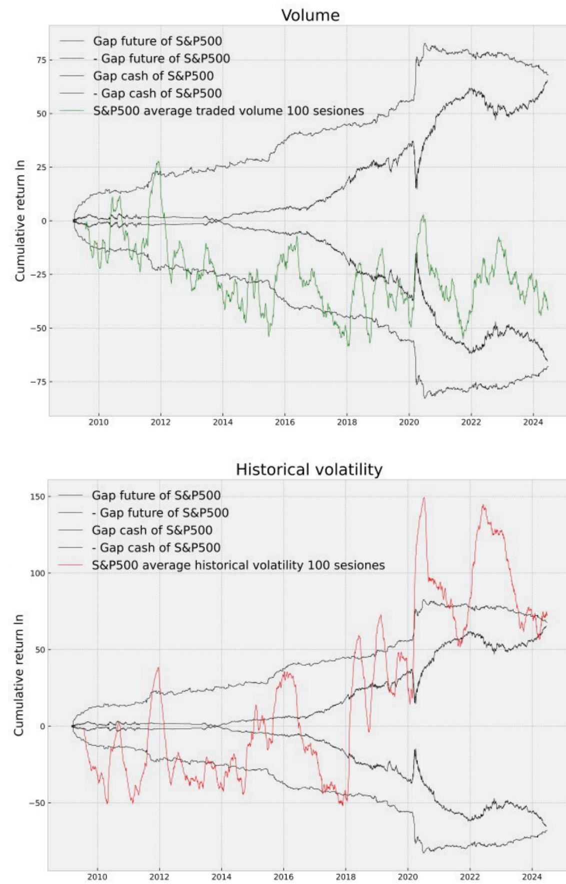
As is widely recognized, the relationship between volatility and volume with the price evolution of an asset can be either inverse or direct. This means that price movements can exhibit sharp increases or declines with rising volume (direct or inverse relationship). Additionally, volatility tends to increase in response to significant price swings. Although volatility and price movements are often inversely correlated given that price declines are usually rapid and steep, whereas price increases tend to be more gradual exceptions to this pattern can occur.

With these considerations in mind, and having previously demonstrated the significance of opening gaps in price behavior and seasonality, this study now examines the relationship between volume, historical volatility, and opening gaps. To explore this relationship, volume and volatility are first calculated using a 100 period moving average of both variables, which is then applied to the following formula:

Ln (Volume or Volatility in t / Volume or Volatility in t-1)

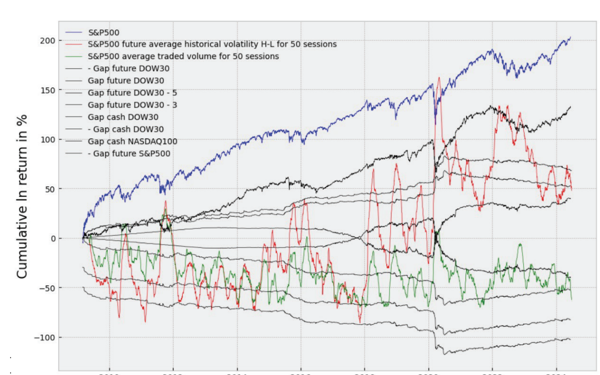
These variables are then accumulated and plotted alongside the positive and negative gaps of the S&P 500 spot and futures.

Figure 5: Relationship of volume and historical volatility to S&P500 gaps



It is curious to observe how volume or volatility do not fluctuate as freely as previously thought, but rather the opening gaps of the index itself, in this case the S&P500, act as a pivot point for these two variables. However, and despite this amazing fact, it can be seen that not all trend changes in volume or volatility are captured by the opening gaps of the S&P500 spot and futures. Bearing in mind that many of the stocks that make up the S&P500 are also included in the other two major American indices, namely the NASDAQ100 and the DOW30, the analysis proceeds by creating the same charts, but this time including the gaps of the three indexes, rather than just those of the S&P500.

Figure 6: GSR Bands: volume and historical volatility of S&P500

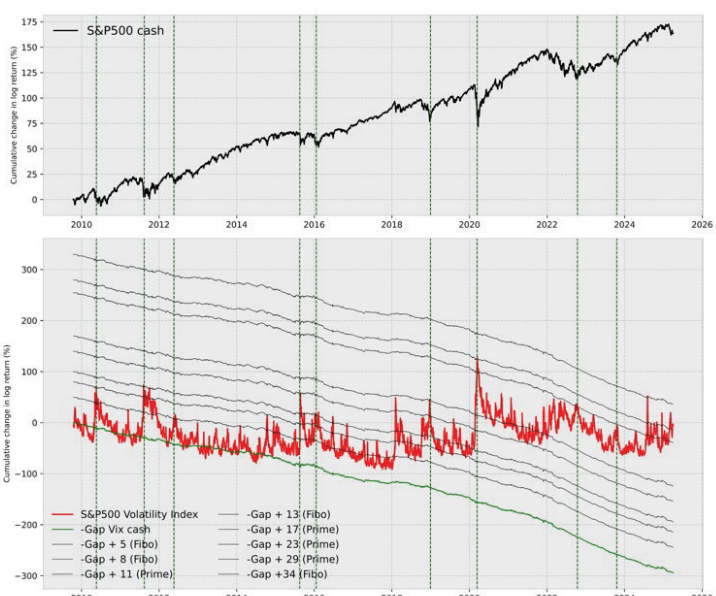


and DOW30, it can be observed how the trading volume of the S&P500 oscillates between the opening gaps of these indexes. However, it is the historical volatility of the S&P500 that presents the best result, with each turn in its movement aligning perfectly with these opening gaps, a phenomenon referred to as the GSR Bands. Taking this into account, the pertinent question arises: what use do the GSR Bands have in trading? Upon closer inspection of the chart above, it can be seen that in most cases, a market low occurs when volatility makes a high and hits an opening gap (red dashed line). Conversely, a market high occurs when volatility makes a low in an opening gap (dashed green line). As previously mentioned, the relationship between the evolution of the S&P price and its historical volatility is, in most cases, inverse.

GSR Bands: opening gaps and implied volatility

Having analyzed the volume and historical volatility of the S&P500, and observed how these two variables fluctuated between the opening gaps of its benchmark and similar indices, the next step is to consider what patterns might exist between the opening gaps of the S&P500 or VIX index and the opening gaps of its benchmark. The analysis now turns to investigating potential patterns between the implied volatility of the S&P500 or VIX index and the opening gaps. The VIX, or "fear index," has the advantage of being a direct daily volatility measure, which can be easily interpreted due to its "spike" shape. This is done without resorting to moving averages, as was the case with historical volatility, which would detect market highs or lows with a certain delay. The next step is to plot the VIX along with its opening gaps, taking into account the Fibonacci series, prime numbers, and the S&P500 index.

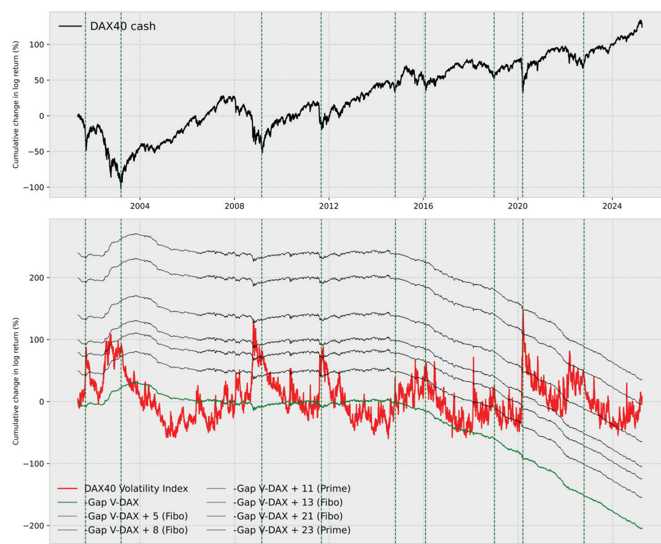
Figure 7: GSR Bands. Implied volatility index of S&P500



It is checked how the implied volatility of the S&P500, measured through the VIX index, fluctuates between the GSR Bands, now calculated as the sum of the VIX gap with the Fibonacci series and the prime number series. Again, many of the market lows reached by the S&P500 are observed when the VIX stops right at one of the gap lines of the GSR Bands.

It is worth noting that this phenomenon is not exclusive to the American index, as the same pattern is seen for any asset with its corresponding implied volatility index, such as the German DAX40 or the WTI crude oil future. Below is a backtest of the GSR model, along with the difference in days between the lows detected by the model and the actual date of the lows produced in the S&P500 from the market low. It is highlighted that the deviation in the number of days is consistently low on both the average and median.

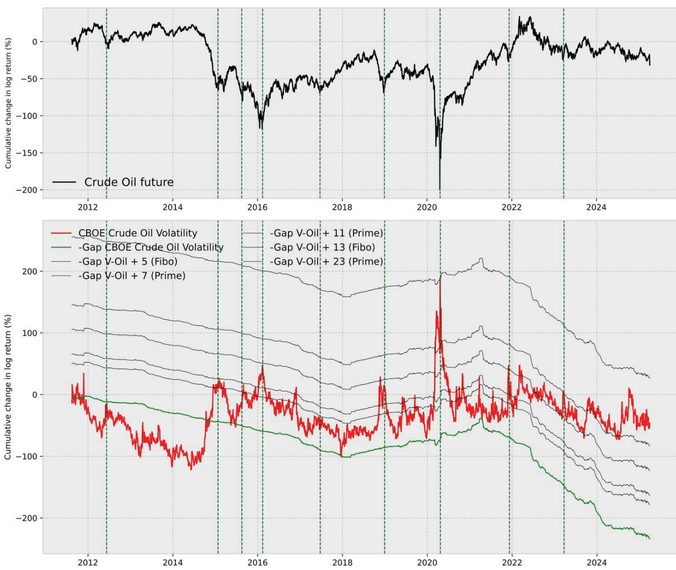
Figure 8: GSR Bands. Implied volatility Index of DAX40



It is highlighted that both for the case of the S&P500 and for the case of DAX40 and the subsequent Crude Oil, the crash of a volatility index with its opening gaps taking into account the Fibonacci series and prime numbers, is not only able to detect the large market lows, or total lows, but it is also able to detect other smaller lows or partial lows. The reason for not marking them with vertical lines on the chart is to facilitate the graphical understanding of the model to the reader, reducing the number of lines on the chart, and to generate a simpler and more interpretable chart.

Next, and to conclude the examples of the application of the GSR Bands, the model is calculated and plotted for the case of Crude Oil futures since 2011.

Figure 9: GSR Bands, implied volatility Index of Oil wti



This section concludes by highlighting the great capacity of GSR Bands to detect market lows, but this model has the disadvantage that a priori, we do not know in which gap band the implied volatility will stop and generate a market low in the analyzed asset. However, the model does provide us with possible price zones where the market will reverse its downward trend to upward, so it is very feasible to carry out a strategy with stop losses close to these price zones, where it is very likely that the price will turn around.

Effectiveness of GSR Bands

The GSR Bands graphs applied on the implied volatility indexes of the S&P500, DAX40 and Crude Oil, show that their large market lows occur graphically when their implied volatility indexes touch or collide with their opening gaps, taking into account the Fibonacci series and prime number series. This article finally asks what is the effectiveness or accuracy of the GSR Bands, that is, what is the deviation between reality and the model.

For this purpose, Table 2 shows the dates and prices of all the total minimums experienced by the S&P500 spot, DAX40 and Crude Oil futures, and the dates and prices at which these were detected by the GSR Bands, showing the deviations that occurred between the real minimums and the minimums detected by the model in this detailed study.

Table 2: Deviation in days and price (%) of GSR Bands with respect to real minimums

Asset	Asset Lows		Shock Implied Volatility - Gap		Deviation	
	Date	Price	Date	Price	Days	Price (%)
DAX40	2001-09-21	3787.23	2001-09-21	3787.23	0	0.00%
	2003-03-12	2202.96	2003-01-27	2643.80	-32	20.01%
	2009-03-06	3666.41	2008-10-16	4622.81	-101	26.09%
	2011-09-22	5164.21	2011-09-12	5072.33	-8	-1.78%
	2014-10-15	8571.95	2014-10-16	8582.90	1	0.13%
	2016-02-11	8752.87	2016-02-11	8752.87	0	0.00%
	2018-12-27	10381.51	2018-12-27	10381.51	0	0.00%
	2020-03-18	8441.71	2020-03-18	8441.71	0	0.00%
	2022-09-29	11975.55	2022-09-29	11975.55	0	0.00%
Crude Oil	2012-06-28	77.69	2012-06-01	83.23	-19	7.13%
	2015-03-17	43.46	2015-02-05	50.48	-28	16.15%
	2015-08-24	38.24	2015-09-01	45.41	6	18.75%
	2016-02-11	26.21	2016-02-11	26.21	0	0.00%
	2017-06-21	42.75	2017-07-11	45.23	14	5.80%
	2018-12-24	42.82	2018-11-23	50.59	-21	18.15%
	2020-04-21	11.57	2020-04-21	11.57	0	0.00%
	2021-12-01	65.37	2021-11-30	65.85	1	0.73%
	2023-03-17	66.93	2023-03-17	66.93	0	0.00%
S&P500	2010-07-02	1022.60	2010-05-20	1071.60	-31	4.79%
	2011-08-08	1119.50	2011-08-08	1119.50	0	0.00%
	2012-06-04	1278.20	2012-06-01	1278.00	-1	-0.02%
	2015-08-25	1867.60	2015-08-24	1893.20	-1	1.37%
	2016-02-11	1829.10	2016-01-20	1859.30	-16	1.65%
	2018-12-24	2351.10	2018-12-24	2351.11	0	0.00%
	2020-03-23	2237.40	2020-03-16	2386.11	-5	6.65%
	2022-10-12	3577.03	2022-09-26	3655.04	-12	2.18%
	2023-10-27	4117.37	2023-10-20	4224.16	-5	2.59%
Average	DAX40 cash				-15.6	4.94%
	Crude Oil future				-5.2	7.41%
	S&P500 cash				-7.9	2.14%
	TOTAL				-9,6	4.83%

Overall, the GSR Bands model detects market lows 9.6 days before they occur, which means detecting the low 4.83% above the actual market low. Although there are differences by assets, since, in the DAX40, these are detected 15.6 days before, and at a price 4.94% above their real minimums, in Crude Oil 5.2 days before at a price 2.24% above the minimum, and in the S&P500 7.9 days before, at a price 2.14% above the total market minimum.

Finally, the great capacity of the GSR Bands to detect market lows is highlighted, since 51.85% of all the lows were detected 0 or 1 day before they occurred, 14.81% between 2 and 10 days before, and only 33.33% were detected more than 10 days before.

GSR-MINI Bands

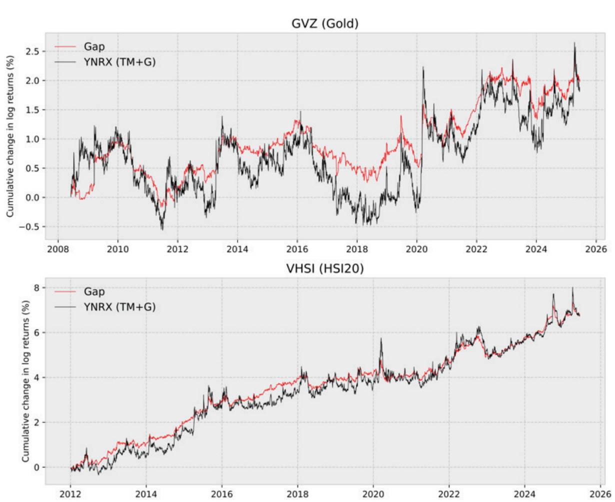
Although surprising in its results, the GSR Bands methodology has the drawback that, a priori, it is impossible to know in which band volatility will be curbed, and therefore where the market low will be. To try to mitigate this drawback, a complementary methodology to GSR Bands is presented below, which aims to reduce the number of bands plotted on an implied volatility index, using a formula based on the inequality of an asset's macrostructure. Below are the formulas for the equilibrium or macrostructure of an asset and market imbalance, the latter referred to as the YNRX model.

Tabla 3: GSR-MINI Band formulas

Description	Formula
Market balance	Total Market = Gap + Market
Market imbalance	YNRX 1 = Gap - Market YNRX 2 = Total Market + Gap YNRX 3 = Total Market + Market

Taking these formulas into account, we now present the graphs of the Gap component and the YNRX (TM+G) model for the cases of the implied volatility indices of Gold (GVZ) and HSI20 (VHSI). In both cases, we can see how the opening gap and its smooth trend serve as a kind of resistance to the YNRX (TM+G) model and its sawtooth trend, which can act as a potential detector of market lows.

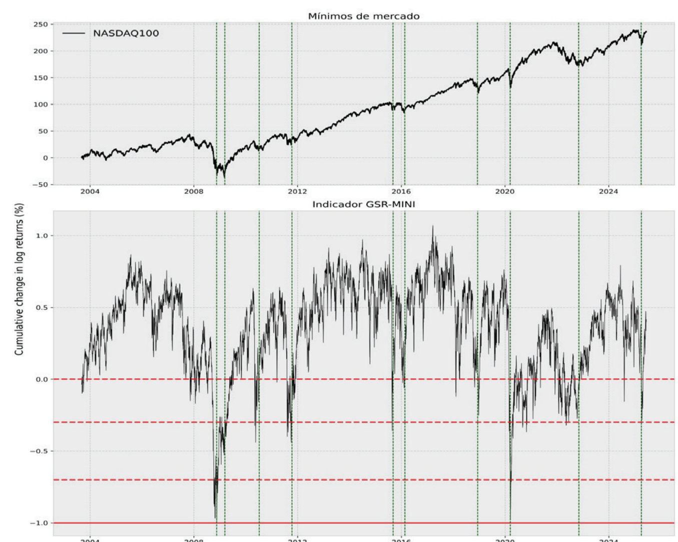
Figure 10: Gap and model YNRX 2 (TM+G) of the GVZ and VHSI



In the previous graphs, we can see how some, but not all, of the sawtooth patterns in the YNRX (TM+G) model bounce off the opening gap in their implied volatility index. Therefore, in order to see if these points correspond to actual market lows, we will now subtract both variables. Logically, if the YNRX variable (total market + gap) is subtracted from the gap variable, the result will be the total market of an implied volatility index with a negative sign. However, what interests us is to see those points where the subtraction takes a value of zero and check whether these correspond to a market low.

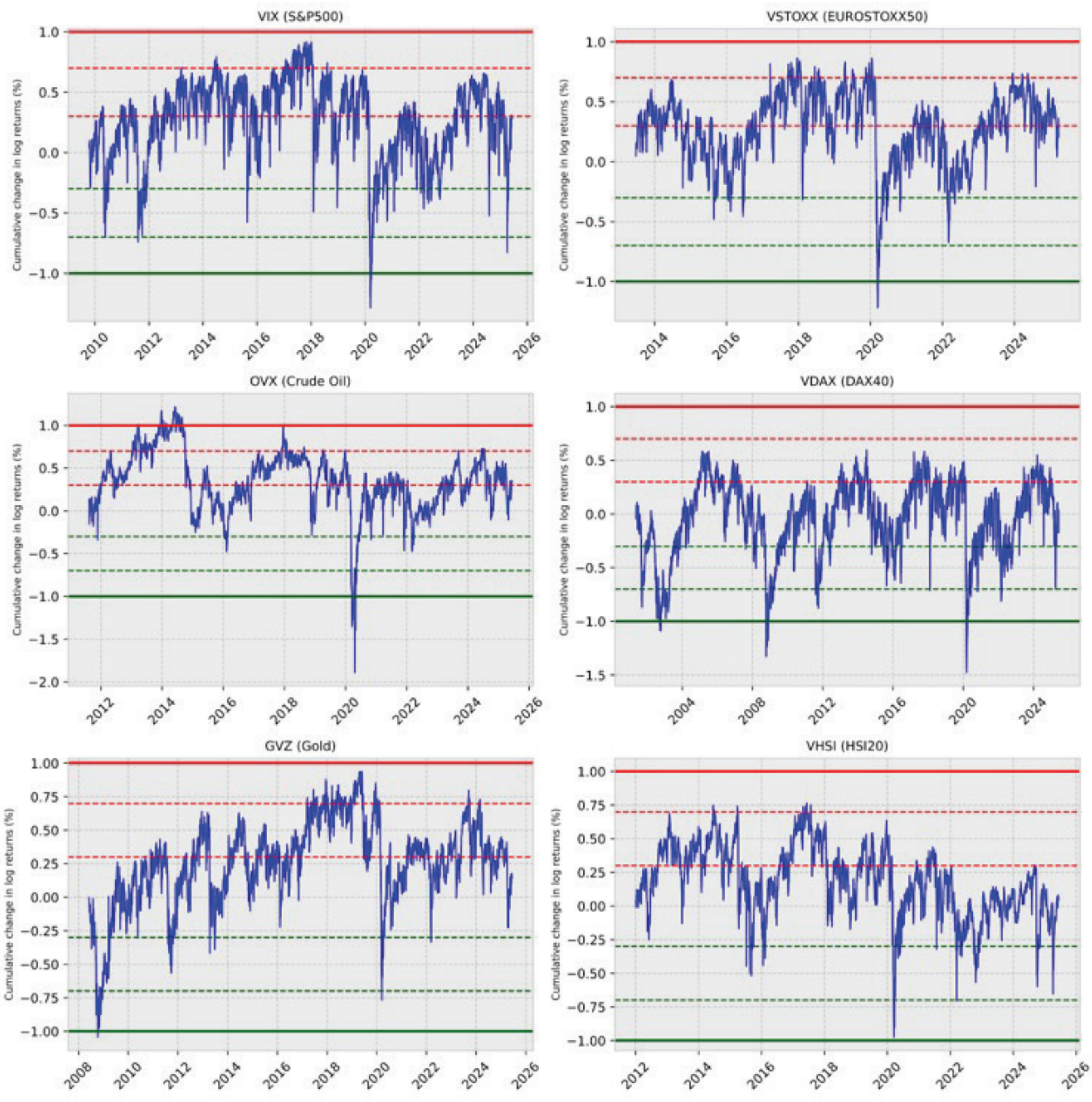
With this objective in mind, we proceed to perform this calculation for the VXN or implied volatility index of the NASDAQ100, and compare it with the NASDAQ100 future itself.

Figure 11: GSR-MINI Bands of the VXN (NASDAQ100)



Once the calculation has been made, it is clear that the GSR-MINI indicator applied to the NASDAQ100 implied volatility index not only reaches its minimum when the indicator value is zero, but market lows also occur when the GSR-MINI indicator reaches levels of -0.3 and -1. Given the curious nature of this fact, it is only necessary to verify that this same pattern occurs in the same way in other assets. To this end, the graphs of six implied volatility indices are presented below, including the VIX (S&P500), VSTOXX (EUROSTOXX50), VDAX NEW (DAX40), OVX (crude oil), GVZ (gold), and VHSI (HSI20).

Figure 12: GSR-MINI Bands for the VIX, VSTOXX, OVX, VDAX NEW, GVZ, and VHSI



After analyzing these six assets, it is confirmed that the values 0, -0.3, -0.7, and -1 act as points of maximum volatility and therefore market lows, highlighting that in the biggest market declines, the GSR-MINI indicator can fall below the value -1.

Conclusions

The graphical interpretation of the market as the sum of the gap and market component, or Macrostructure of an asset, allows for the addition of extra information to any financial analysis, representing a new application of technical analysis.

The seasonal behavior of the S&P500 can be understood through the seasonal behavior of the spot and futures of its implied volatility index or VIX. Since the seasonality of the opening gaps of the VIX spot and futures taking into account the Fibonacci series or prime numbers, they present the lows and highs of the seasonal behavior of the S&P500.

The ratio between the gap and market component of the spot and future VIX is a number very close to Phi. This, along with the use of the Fibonacci series and prime numbers in the rest of the analysis, highlights their influence on the stock market.

Volatility seems to fluctuate within a band formed by the opening gaps of the asset to which it belongs, acting as support or resistance for both volatility and traded volume, and which can mark the highs and lows of the S&P500.

The relationship between implied volatility of an asset and its opening gaps, taking into account the series of Fibonacci numbers and prime numbers or GSR Bands, is an effective methodology to detect total market lows. Representing price zones where the market has many possibilities to change its trend from bearish to bullish, although a priori we do not know in which gap band the price will turn. This methodology allows to create trading strategies, as it allows to detect market lows with an average of 9.6 days before they occur for the S&P500, DAX40 and Crude Oil and being able to detect 51.85% of them with only 0 or 1 days before the actual market lows.

GSR-MINI Bands greatly reduce the drawbacks of GSR Bands, in which there were a large number of bands where implied volatility peaked, and therefore where the market minimum occurred. In this sense, the GSR-MINI indicator limits the number of bands where volatility is most likely to peak to 3 or 4 points, corresponding to the values -0.3, -0.7, and -1.

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