Algorithmic Trading Based on the Incidence of Covid-19 in Europe

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Abstract: The study of behavioral finance is showing that profitable investment strategies can be implemented, alternatives to traditional analysis techniques, based on metrics on investors' mood. In this paper, we describe an algorithmic trading system that opens long (short) positions if the cumulative incidence at 7 days is minor (greater) than the cumulative incidence at 14 days, which implies a metric of the fear of COVID-19. The backtests run, using 2020 data, on five of the main European indices (AEX, CAC, DAX, IBEX, and MIB) show that the strategy is profitable, with ROI between 21% and 68% and profit factors ranging from 1.11 to 1.32. This is new evidence that accurate indicators of investors' mood (in this case the expansion of the COVID-19 pandemic) let us develop profitable alternative investment strategies based on behavioral finance.

Keywords: COVID-19, cumulative incidence, algorithmic trading, index futures, behavioral finance.

INTRODUCTION

This paper explores the behavioral finance capacity to anticipate market trends. In this case, we focus on the European stock market and its most representative indexes during the lockdown caused by the Covid-19 epidemic.

Many studies show that the investor's mood is affected by multiple factors, changes over time, and can be conditioned by experience or training (Cohen and Kudryavtsev, 2012). These mood swings provide evidence of anomalies in the behavior of the stock markets (Nofsinguer, 2005). Corredor, Ferrer, and Santamaría (2013) state that investor mood has a significant effect on the performance of stocks.

Some of the factors that cause investor sentiment to change are:

- Wheather (Hirshleifer and Shumway, 2003, Jacobsen and Marquering, 2008) as sunny climates are associated with an optimistic mood and then positive returns.

- Seasonal patterns like vacations generate the effect of "sell in May and go away" or the "Halloween" effect (Bouman and Jacobsen, 2002). This means that the securities market yield should be greater from November to April than from May to October.

- The Moon (Yuan, Zheng, and Zhu, 2006) implies different returns according to the different phases of the moon observing differences from 3% to 5% in yield from one phase to another.

- Sports results: Edmans, García, and Norli (2007) studied the results of football, cricket, rugby, and basketball and others have focused on the NFL(Chang, Chen, Chou and Lin, 2012), football

(Berument, Ceylan and Gozpinar, 2006; Kaplanski and Levy, 2010) and on cricket (Mishra and Smyth, 2010). Gómez-Martínez and Prado-Román (2014) performed a statistical analysis of the following stock markets session return after national team football matches. The results obtained show that after a defeat of the national team, we should expect negative and lower than average prices on the country's stock market, the opposite occurring in the case of a victory.

If these common factors affect the behavior of investors, then we can infer that the fear of the expansion of the Covid-19 pandemic will also affect the evolution of the market.

The declaration of the state of alarm by Covid-19 confined millions of citizens in their homes, exposing them to the consequences on the social, psychological, economic, educational, and, of course, on the communicative plane. Surveys carried out during the most severe confinement phase analyzed how information consumption has been modified during this period and how citizens perceive the media coverage carried out by the media. These studies show that citizens are informed more and more frequently than before the health crisis (Masip, Aran-Ramspott, Ruiz-Caballero, Suau, Almenar, and Puertas-Graell, 2020). Therefore, the COVID-19 outbreak resulted in unprecedented news coverage and an outpouring of opinions in this age of swift propagation of information. Ensuing uncertainty in financial markets leads to heightened volatility in prices. Haroon y Rizvi (2020) finds that overwhelming panic generated by news outlets is associated with increased volatility in the equity markets. Panic-laden news contributed to a greater extent to volatility in the sectors perceived to be most affected by coronavirus outbreaks. Some of the phenomena in effect during the crisis, such as the excessive volatility and the unshaken confidence of financial institutions, are insufficiently explained by the traditional finance paradigm (Bansal, 2020).

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The fear in this exceptional situation changed the way investors face their investment decisions. The Efficient Market Hypothesis (EMH) suggests that prices incorporate all the available information at any point in time, yet as we show a systemic factor, the health risk, was not always rationally incorporated in stock prices. The reason for this inefficiency could be that something is missing from traditional finance models, such as the impact of fear of COVID-19 (Vasileiou, 2020).

Another change observed by the impact of the COVID-19 lockdown in Belgium is that individual investors increased their equity positions, especially investors between 18 and 35 years old (Priem, 2021). On the other hand, in response to the increased volatility and uncertainty in financial markets due to the COVID-19 pandemic in March 2020, Pagano, Sedunov y Velthuis (2021) found that retail investors reduce momentum trading and increase contrarian trading activity during the initial phase of this crisis.

Another change has been observed related to Sustainable and Responsible Investing (SRI). This is a strategy that seeks to combine both financial return and social good. In Spain, several IBEX-35 companies announced donations amid the COVID-19 crisis, which meant an investment flow to these companies. Therefore, in times of upheaval, investors base their strategy on SRI factors, as people's perceptions of corporate social responsibility change, affecting consumption preferences in those companies (Palma-Ruiz, Castillo-Apraiz, and Gómez-Martínez, 2020).

The financial market response to the COVID-19 pandemic provides the first example of a market crash instigated by a health crisis (Smales, 2021). As such, the crisis provides a unique setting in which to examine the market response to changes in investor attention. Google Trends could be used as a proxy for investor attention. Searches for the "coronavirus" keyword increase markedly from late-February and peak in mid-March before declining substantially. These results are broadly consistent with Da, Engelberg, and Gao (2015), indicating that the attention of retail investors negatively influences global stock returns during this crisis period. A rise in the number of internet searches during the COVID-19 crisis induces a faster rate of information flow into financial markets and so is also associated with higher volatility. Rather than searching for information on potential stocks to buy (Barber & Odean, 2008), retail investors are searching for information to resolve uncertainty about household fears (Da et al., 2015) during the COVID-19 crisis.

Therefore, we should conclude that the emergence of the COVID-19 and its consequences have led to fears, worries, and anxiety among individuals worldwide. To measure this fear different "Fear of COVID-19 Scale" has been developed with robust psychometric properties (Ahorsu, Lin, Imani, Saffari, Griffiths, and Pakpour, 2020). Another approach to measure Covid-19 is proposed by Vasileiou (2020) who develops a Coronavirus Fear Index (CFI) based on Google searches and uses Granger causality to provide empirical evidence that the fear drives the S&P500 performance and using a GARCH model he shows that the fear negatively influences the performance of the US stock market. Salisu and Akanni (2020) construct a global fear index (GFI) for

the COVID-19 pandemic to support economic, financial, and policy analyses. This index proposes a common way to measure COVID-19 cases across different countries and is a good predictor of stock returns during the pandemic for different countries.

Gómez-Martínez, Prado-Román and Cachón-Rodríguez (2021) proposed an algorithmic trading system on the future of the Eurostoxx 50 that, instead of following technical indicators, follows the number of cases confirmed by Covid-19 in Europe. The back test of this system carried out throughout the weeks of confinement shows that the system is profitable. Following this approach, the purpose of this study is to identify how the fear of the acceleration of the pandemic has affected financial markets, proposing an alternative metric to Covid-19 fear. The metric we are looking for must be easy to obtain, without delays, allowing us to evaluate sentiment in the most up-to-date and accurate way possible. Likewise, this metric has a clear objective, to be a valid indicator of the evolution of the market and therefore a generator of investment signals. This is the added value that this study aims to provide and the gap to be filled in research related to Covid-19 and its influence in all areas.

HYPOTHESIS, METHODOLOGY, AND DATA

Alternative to the "Fear of COVID-19 Scale" one of the most relevant aspects for pandemic monitoring is the relationship between cumulative incidence (CI) at 14 days and the CI at 7 days (Arganda, 2020)

- If 7-day CI presents figures higher than the 14-day CI, this would represent an acceleration of the pandemic.

- If 7-day CI presents figures lower than the 14-day CI, this would represent a deacceleration of the pandemic.

This is the same concept that uses the Trading Strategies of Moving Averages Crossovers (Fig. **1**). Crossovers are one of the main moving average (MA) strategies. One strategy is to apply two moving averages to a chart: one longer and one shorter (Mitchel, 2021). When the shorter-term MA crosses above the longer-term MA, it's a buy signal, as it indicates that the trend is shifting. This is known as a "golden cross". When the shorter-term MA crosses below the longer-term MA, it's a sell signal, as it indicates that the trend is shifting down. This is known as a "death cross".

Therefore, we could combine both ideas and create a trading strategy in which long positions are held if the epidemic is contained and short positions and if the epidemic spreads. We would change the crossing of the moving averages of the asset price for the crossing of the accumulated incidents.

The hypothesis to test is:

H_0: A trading strategy based on 7 days and 14 days cumulative incidence crossovers is a profitable strategy.

To validate this hypothesis, we developed a swing algorithmic trading system on the main European index futures (Gómez-Martínez, Prado-Román, and Plaza-Casado, 2019). This bot works in the following way:

Fig. (1). Investment Signals based on moving averages crosses.

- Opens a long position when the pandemic is decelerating in Spain (7 days cumulative incidence is minor than 14 days cumulative incidence)

- Opens short position when the pandemic is accelerating in Spain (7 days cumulative incidence is higher than 14 days cumulative incidence)

We will validate H_0 if the main performance stats of the trading systems are profitable:

- Net return: The net return accumulated by the trading strategy throughout the entire backtest must be positive.

- Profit Factor: The ratio between total profits and total losses must be greater than 1.

- Success rate: The percentage of operations carried out that have yielded benefits over the total operations must be greater than 50%.

- Winning sessions ratio: The percentage of sessions with an open position that has closed with benefits over the total number of sessions in the market must be greater than 50%.

Daily confirmed case data have been downloaded from the webpage of the European Centre for Disease Prevention and Control (ECDC):

https://www.ecdc.europa.eu/en/publications-data/download-todays-data-geographic-distribution-covid-19-cases-worldwide

ECDC defines itself as "an EU agency aimed at strengthening Europe's defenses against infectious diseases. The core functions cover a wide spectrum of activities: surveillance, epidemic intelligence, response, scientific advice, microbiology, preparedness, public health training, international relations, health communication, and the scientific journal Eurosurveillance".

The file downloaded starts in December 2019, but we will run the backtest for each country since the first case was recorded. Data are available to 2020, December 14th. It is almost one complete year of pandemic and fears.

RESULTS

The backtests have been run using the Trading Motion SDK tool[1]. On this platform, you can activate different trading systems from various developers on a multitude of financial instruments. The European indexes supported by the platform are:

- AEX: Netherlands

- CAC: France

- DAX: Germany

- IBEX: Spain

- MIB: Italy

According to the investment signals generated by the 7 days and 14 days cumulative incidence crossovers, the backtest of the trading systems has recorded the trading list for AEX index futures shown in Table **1**:

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[1] For more information visit https://www.tradingmotion.com/

Table 1: Trading list AEX Backtest.

Date	Label	Volume	Price	Position	Order P&L	Acum. P&L
02/03/2020	Open short position (02/03/2020 - BAJA)	-1	551,9	-1	-6,00 €	-6,00 €
09/04/2020	Open long position (09/04/2020 - SUBE)	2	505,6	1	9241,58 €	9235,58 €
28/05/2020	Open short position (28/05/2020 - BAJA)	-2	532,15	-1	5291,58 €	14527,16 €
01/06/2020	Open long position (01/06/2020 - SUBE)	2	540,3	1	-1648,42 €	12878,74 €
10/06/2020	Open short position (10/06/2020 - BAJA)	-2	564,1	-1	4741,58 €	17620,32 €
18/06/2020	Open long position (18/06/2020 - SUBE)	2	564,45	1	-88,42 €	17531,90 €
15/07/2020	Open short position (15/07/2020 - BAJA)	-2	577,85	-1	2661,58 €	20193,48 €
21/08/2020	Open long position (21/08/2020 - SUBE)	2	552,9	1	4971,58 €	25165,06 €
01/09/2020	Open short position (01/09/2020 - BAJA)	-2	552,8	-1	-38,42 €	25126,64 €
05/11/2020	Open long position (05/11/2020 - SUBE)	2	570,2	1	-3498,42 €	21628,22 €
07/12/2020	Open short position (07/12/2020 - BAJA)	-2	615,6	-1	9061,58 €	30689,80 €
14/12/2020	Closing backtest position automatically	1	612,5	0	610,79 €	31300,59 €

Fig. (2). Profit and losses chart for AEX backtest.

64% of these trades have been profitable, drawing the profit and losses chart shown in Fig. (**2**).

The trade list recorded for the CAC backtest is shown in Table **2** where 65% of the trades were profitable:

Table 2: Trading list CAC backtest.

Date	Label	Volume	Price	Position	Order P&L	Acum. P&L
28/01/2020	Open short position (28/01/2020 - BAJA)	-1	5887	-1	-5,55 €	-5,55 €
03/02/2020	Open long position (03/02/2020 - SUBE)	2	5815,5	1	703,74 €	698,20 €
10/02/2020	Open short position (10/02/2020 - BAJA)	-2	6009	-1	1923,74 €	2621,94 €
17/02/2020	Open long position (17/02/2020 - SUBE)	2	6081,5	1	-736,58 €	1885,35 €
24/02/2020	Open short position (24/02/2020 - BAJA)	-2	5880,5	-1	-2021,43 €	-136,08 €

25/02/2020	Open long position (25/02/2020 - SUBE)	2	5825,5	1	538,57 €	402,49 €
27/02/2020	Open short position (27/02/2020 - BAJA)	-2	5570	-1	-2566,43 €	-2163,95 €
09/04/2020	Open long position (09/04/2020 - SUBE)	2	4506,5	1	10623,72 €	8459,77 €
11/05/2020	Open short position (11/05/2020 - BAJA)	-2	4560	-1	522,97 €	8982,74 €
15/05/2020	Open long position (15/05/2020 - SUBE)	2	4295	1	2637,97 €	11620,71 €
01/06/2020	Open short position (01/06/2020 - BAJA)	-2	4775	-1	4787,67 €	16408,37 €
05/06/2020	Open long position (05/06/2020 - SUBE)	2	5061,5	1	-2877,33 €	13531,04 €
15/06/2020	Open short position (15/06/2020 - BAJA)	-2	4716,5	-1	-3462,82 €	10068,22 €
18/06/2020	Open long position (18/06/2020 - SUBE)	2	4979	1	-2637,82 €	7430,40 €
24/06/2020	Open short position (24/06/2020 - BAJA)	-2	4961	-1	-191,70 €	7238,70 €
29/06/2020	Open long position (29/06/2020 - SUBE)	2	4859	1	1008,47 €	8247,17 €
03/07/2020	Open short position (03/07/2020 - BAJA)	-2	5035	-1	1749,66 €	9996,83 €
10/07/2020	Open long position (10/07/2020 - SUBE)	2	4879,5	1	1544,44 €	11541,27 €
17/07/2020	Open short position (17/07/2020 - BAJA)	-2	5083,5	-1	2029,83 €	13571,10 €
05/10/2020	Open long position (05/10/2020 - SUBE)	2	4861	1	2217,36 €	15788,46 €
08/10/2020	Open short position (08/10/2020 - BAJA)	-2	4909	-1	472,36 €	16260,81 €
16/11/2020	Open long position (16/11/2020 - SUBE)	2	5435,5	1	-5273,45 €	10987,36 €
10/12/2020	Open short position (10/12/2020 - BAJA)	-2	5554	-1	1176,55 €	12163,91 €
14/12/2020	Closing backtest position automatically	1	5522	0	315,78 €	12479,69 €

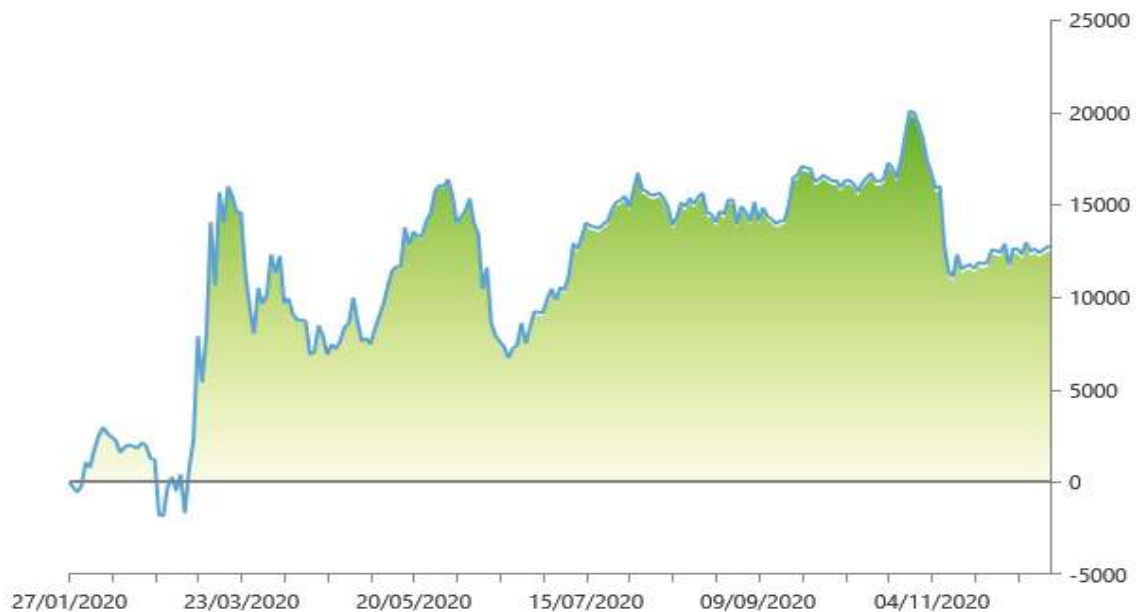The corresponding profit and losses chart are shown in Fig. (**3**):

Fig. (3). Profit and loses chart for CAC backtest.

The management of the pandemic in the first wave in Germany was impeccable, which caused greater stability in the evolution of cases and therefore a lower crossover of inci-dents at 14 days and 7 days, which implies a lower volume of operations, of which 80% were profitable (Table **4**).

Table 3. Trading list DAX Backtest.

Date	Label	Volume	Price	Position	Order P&L	Acum. P&L
26/02/2020	Open short position (26/02/2020 - BAJA)	-1	12695	-1	-2,50 €	-2,50 €
09/04/2020	Open long position (09/04/2020 - SUBE)	2	10478	1	11080,00 €	11077,50 €
19/06/2020	Open short position (19/06/2020 - BAJA)	-2	12340	-1	9304,54 €	20382,04 €
29/06/2020	Open long position (29/06/2020 - SUBE)	2	12033	1	1530,00 €	21912,04 €
17/07/2020	Open short position (17/07/2020 - BAJA)	-2	12899	-1	4325,00 €	26237,04 €
18/11/2020	Open long position (18/11/2020 - SUBE)	2	13089	1	-955,00 €	25282,04 €
14/12/2020	Closing backtest position automatically	-1	13219	0	647,50 €	25929,54 €

The profit and losses chart of this DAX index backtest is shown in Fig. (**4**):

Fig. (4). Profit and loses chart for DAX backtest

On the other hand, the chaotic management of the pandemic in Spain and the errors in the accounting of cases and deaths have caused volatility in the metrics that imply a high volume of trades registered in the IBEX backtest. Although only 41% of the operations have been profitable (Table 4), they have offset the losses of the failed operations as can be seen in the profit and loss graph (Fig. **5**)

Table 4. Trading list IBEX Backtest.

Date	Label	Volume	Price	Position	Order P&L	Acum. P&L
10/02/2020	Open long position (10/02/2020 - SUBE)	1	9785	1	-3,16 €	-3,16 €
17/02/2020	Open short position (17/02/2020 - BAJA)	-2	9975	-1	183,69 €	180,53 €
18/02/2020	Open long position (18/02/2020 - SUBE)	2	9980	1	-11,36 €	169,17 €
26/02/2020	Open short position (26/02/2020 - BAJA)	-2	9205	-1	-781,03 €	-611,85 €
06/04/2020	Open long position (06/04/2020 - SUBE)	2	6800	1	2398,79 €	1786,93 €
12/05/2020	Open short position (12/05/2020 - BAJA)	-2	6665	-1	-141,21 €	1645,72 €
18/05/2020	Open long position (18/05/2020 - SUBE)	2	6545	1	113,79 €	1759,51 €
25/05/2020	Open short position (25/05/2020 - BAJA)	-2	6720	-1	168,75 €	1928,26 €
01/06/2020	Open long position (01/06/2020 - SUBE)	2	7190	1	-476,31 €	1451,95 €

| 15/06/2020	Open short position (15/06/2020 - BAJA)	-2	7085	-1	-111,52 €	1340,43 €
25/06/2020	Open long position (25/06/2020 - SUBE)	2	7120	1	-41,52 €	1298,92 €
29/06/2020	Open short position (29/06/2020 - BAJA)	-2	7125	-1	-1,52 €	1297,40 €
06/07/2020	Open long position (06/07/2020 - SUBE)	2	7525	1	-406,50 €	890,90 €
07/07/2020	Open short position (07/07/2020 - BAJA)	-2	7460	-1	-71,36 €	819,54 €
29/09/2020	Open long position (29/09/2020 - SUBE)	2	6765	1	690,79 €	1510,33 €
13/10/2020	Open short position (13/10/2020 - BAJA)	-2	6940	-1	170,41 €	1680,74 €
10/11/2020	Open long position (10/11/2020 - SUBE)	2	7440	1	-504,33 €	1176,41 €
14/12/2020	Closing backtest position automatically	-1	8125	0	682,89 €	1859,30 €
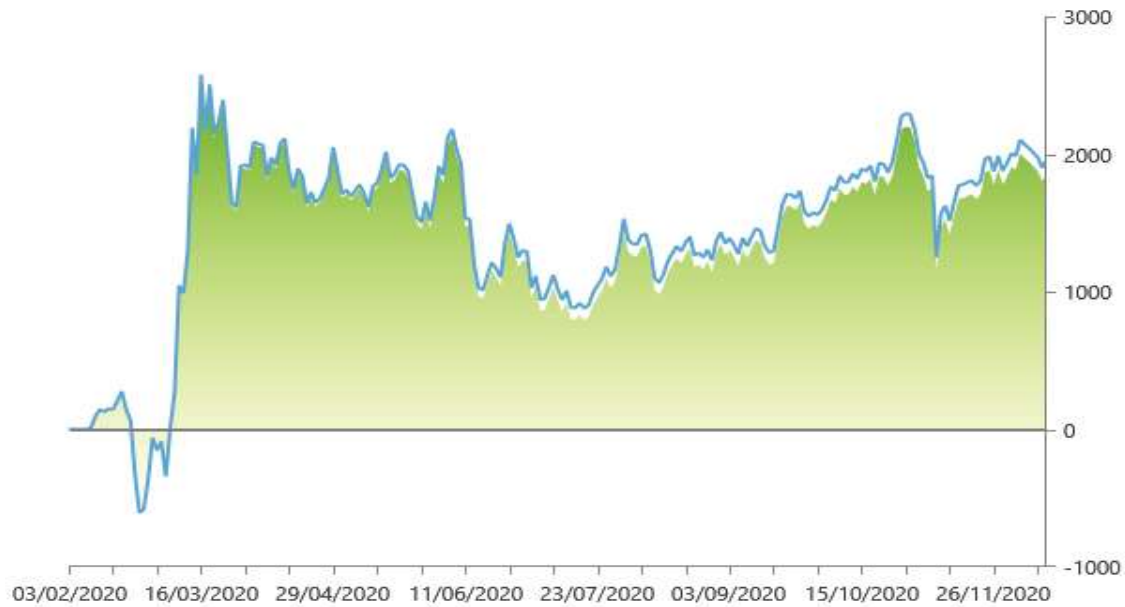
Fig. (5). Profit and losses chart for IBEX backtest.

A similar pattern is observed in Italy, where 33% of profitable operations (Table 5) compensate losses, showing a positive profit and loss chart for the MIB backtest (Fig. **6**).
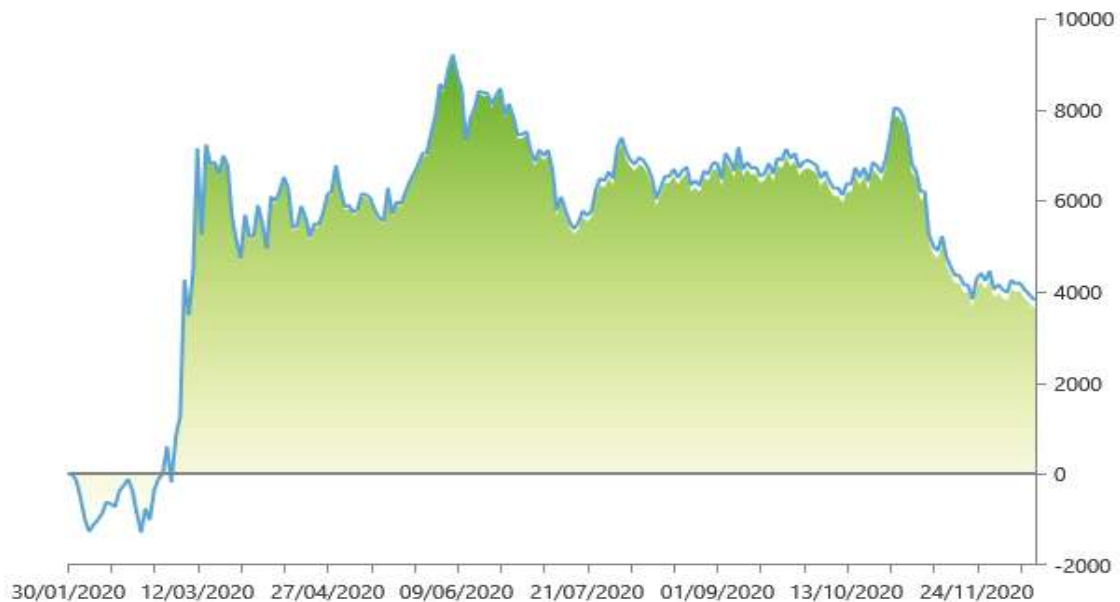

Fig. (6). Profit and losses chart for AEX backtest.

Table 5. Trading list MIB Backtest.

Date	Label	Volume	Price	Position	Order P&L	Acum. P&L
03/02/2020	Open short position (03/02/2020 - BAJA)	-1	23280	-1	-9,63 €	-9,63 €
10/02/2020	Open long position (10/02/2020 - SUBE)	2	24405	1	-1144,26 €	-1153,89 €
24/02/2020	Open short position (24/02/2020 - BAJA)	-2	23765	-1	-659,26 €	-1813,14 €
02/04/2020	Open long position (02/04/2020 - SUBE)	2	16590	1	7155,74 €	5342,60 €
29/06/2020	Open short position (29/06/2020 - BAJA)	-2	19010	-1	2402,75 €	7745,35 €
03/07/2020	Open long position (03/07/2020 - SUBE)	2	19850	1	-857,55 €	6887,81 €
10/07/2020	Open short position (10/07/2020 - BAJA)	-2	19280	-1	-584,40 €	6303,41 €
17/07/2020	Open long position (17/07/2020 - SUBE)	2	20290	1	-1024,58 €	5278,83 €
23/07/2020	Open short position (23/07/2020 - BAJA)	-2	20680	-1	376,16 €	5654,98 €
17/09/2020	Open long position (17/09/2020 - SUBE)	2	19665	1	1002,28 €	6657,26 €
21/09/2020	Open short position (21/09/2020 - BAJA)	-2	19345	-1	-332,72 €	6324,54 €
23/11/2020	Open long position (23/11/2020 - SUBE)	2	21885	1	-2548,30 €	3776,25 €
14/12/2020	Closing backtest position automatically	-1	21765	0	-124,15 €	3652,10 €

Table 6. Backtest Performance Summary.

Performance Summary	AEX	CAC	DAX	IBEX	MIB
Back test description	AEX 60 minute bars [27/02/2020 - 14/12/2020]	CAC 60 minute bars [27/01/2020 - 14/12/2020]	Mini-Dax 60 minute bars [07/02/2020 - 14/12/2020]	Mini-Ibex 60 minute bars [03/02/2020 - 14/12/2020]	Mini FTSE MIB 60 minute bars [30/01/2020 - 14/12/2020]
Net P&L	31.300,59 €	12.479,69 €	25.929,54 €	1.859,30 €	3.652,10 €
Gross P&L	31.500,00 €	12.730,00 €	25.960,00 €	1.960,00 €	3.835,00 €
Profit factor	1,24	1,16	1,32	1,16	1,11
Sharpe ratio	1,31	0,99	1,72	0,99	0,75
Slippage per side	-0,01	-0,04	-0,14	-0,29	-1,06
Annual ROI	46,19 %	35,37 %	67,63 %	30,78 %	20,89 %
Net P&L over Drawdown	1,35	1,27	2,34	1,06	0,67
Mathematical expectation	2625,00	530,42	3708,57	108,89	295,00
Analyzed sessions	205	228	219	223	225
Sessions in market	200	225	206	218	222
Winning sessions	106	113	105	115	106
Winning sessions %	53%	50%	51%	53%	48%
Winning trades	7	15	4	7	4
Losing trades	4	8	1	10	8
Success rate	64%	65%	80%	41%	33%
Winning sessions profit	161.901,11 €	90.778,52 €	105.764,54 €	13.287,70 €	37.306,88 €
Winning sessions average	1.527,37 €	803,35 €	1.007,28 €	115,55 €	351,95 €
Losing sessions	94	112	101	103	116

Losing sessions profit	-130.600,52 €	-78.298,83 €	-79.835,00 €	-11.428,40 €	-33.654,78 €
Losing sessions average	-1.389,37 €	-699,10 €	-790,45 €	-110,96 €	-290,13 €
Worst drawdown	-23.118,42 €	-9.862,97 €	-11.090,00 €	-1.759,60 €	-5.485,50 €
Worst drawdown date	15/04/2020	19/06/2020	15/04/2020	20/07/2020	14/12/2020
Best session	10.650,00 €	5.955,00 €	6.445,00 €	892,00 €	3.005,00 €
Best session date	09/03/2020	12/03/2020	12/03/2020	12/03/2020	09/03/2020
Worst session	-7.110,00 €	-3.415,00 €	-4.455,00 €	-595,00 €	-1.900,00 €
Worst session date	24/03/2020	13/03/2020	24/03/2020	09/11/2020	13/03/2020
30 days volatility	34%	44%	20%	43%	52%
Suggested capital	85.000,00 €	40.000,00 €	45.000,00 €	7.000,00 €	20.000,00 €
Required capital	8.900,00 €	4.300,00 €	5.720,00 €	1.125,00 €	2.400,00 €

We have all the data together from the five backtests performed in Table 6. We observe that all the backtests have been profitable both in Gross P&L and Net P&L (simulating commissions and slippage). All profit factors are above 1 and, except for the MIB, more than 50% of the sessions in which the system operated generated a positive result. Considering the suggested capital calculated by Trading Motion SDK to activate each one of these investment strategies, the annualized ROI ranges from 21% to 68%. Despite the great volatility that the equity markets have had in this period, we observe that the Sharpe ratios of the system are very good, ranging between 0.75 and 1.72.

Therefore, although not all the parameters defined to accept the hypothesis of this study are fulfilled, we can assure that this investment strategy, based on the fear of the expansion of the Covid-19 pandemic, according to the accumulated incidence, is profitable, and a factor to consider for investment managers until herd immunity has been achieved in the countries studied.

CONCLUSIONS

In this study, we have developed a swing algorithmic trading system than run on the futures markets of five of the main European indexes. This algorithmic trading system is based on moving averages crosses, but investment signals are not generated from the cross of the moving averages of the index price, in this case, the signals are identified by the crossing of the moving averages of the accumulated cases at 7 and 14 days. This means that we have an accurate metric on how fast the Covid-19 epidemic spreads or is contained and the fear that this implies. If the cumulated incidence in 7 days is greater (minor) than the cumulated incidence in 14 days, the system opens a short (long) position.

The results obtained in the backtests carried out for the futures of the AEX, CAC, DAX, IBEX, and MIB index show that this strategy is profitable and offers consistently positive results. The main points to highlight form these results are:

- Looking at Gross P&L and Net P&L (simulating commissions and slippage) all the backtests have been profitable.

- Looking at profit factors, all the backtest are above 1.

- Looking at winning sessions rate, all the backtest are abeve 50% but the MIB backtest.

- Looking at the ROI (probably the most important stat) the worst result is a 21% for MIB index, and the best result is a 68% for the DAX.

- Looking at the Sharpe ratio, the figures are ranging between 0.75 and 1.72, despite the great volatility observed.

This study means new evidence of how investors' mood, in this case, the fear of the evolution of the COID-19 pandemic, affects financial markets and can be used to develop alternative and profitable investment strategies.

The practical application of this study is evident, we have a new indicator (in this case an indicator of fear and therefore risk aversion) that can support profitable investment decisions. The limitation is knowing how long this indicator will be valid. As vaccination accelerates and the percentage of the immunized population grows, we can see the light at the end of the tunnel. This will cause the accumulated incidence will be an irrelevant indicator and therefore, the investment strategy described in this study will no longer be valid.

But we have new fears that will always appear, whether for health issues, wars, trade disputes, the arrival of zombies or aliens, or for any other reason that today we are not able to guess. Whatever the new fear the future will bring, knowing how to measure it accurately will provide us a magnificent tool to design new profitable alternative investment strategies such as the one described in this study.

REFERENCES

Arganda, C. (2020, 18/12/2020). Covid-19: La IA a 7 días se acelera en 15 CCAA y hace saltar las alarmas. Diariofarma.Com Retrieved from https://www.diariofarma.com/2020/12/18/covid-19-la-ia-a-7-dias-se-acelera-en-15-ccaa-y-hace-saltar-las-alarmas

Ahorsu, D. K., Lin, C. Y., Imani, V., Saffari, M., Griffiths, M. D., & Pakpour, A. H. (2020). The fear of COVID-19 scale: development and initial validation. International journal of mental health and addiction, 1-9.

Bansal, T. (2020). Behavioral finance and COVID-19: cognitive errors that determine the financial future. Available at SSRN 3595749.

Barber, B. M., & Odean, T. (2008). All that glitters: The effect of attention and news on the buying behavior of individual and institutional investors. The review of financial studies, 21(2), 785-818.

Berument, H., Ceylan, N. B., y Gozpinar, E. (2006). Performance of soccer on the stock market: Evidence from Turkey. The Social Science Journal, 43(4), 695-699.

Bouman, S., y Jacobsen, B. (2002). The Halloween indicator, "sell in may y go away": Another puzzle. The American Economic Review, 92(5), 1618-1635.

Chang, S., Chen, S., Chou, R. K., y Lin, Y. (2012). Local sports sentiment y returns of locally headquartered stocks: A firm-level analysis. Journal of Empirical Finance, 19(3), 309-318.

Cohen, G. y Kudryavtsev, A., (2012). Investor Rationality y Financial Decisions. Journal of Behavioral Finance, 13(1), 11-16.

Corredor, P., Ferrer, E. y Santamaría, R. (2013): El sentimiento del inversor y las rentabilidades de las acciones. El caso español. Spanish Journal of Finance y Accounting, 42 (158), 211-237.

Da, Z., Engelberg, J., & Gao, P. (2015). The sum of all FEARS investor sentiment and asset prices. The Review of Financial Studies, 28(1), 1-32.

Edmans, A., García, D., y Norli, Ø. (2007). Sports sentiment y stock returns. The Journal of Finance, 62(4), 1967-1998.

Gómez-Martínez, R., & Prado-Román, C. (2014). Sentimiento del inversor, selecciones nacionales de fútbol y su influencia sobre sus índices nacionales. Revista Europea de Dirección y Economía de la Empresa, 23(3), 99-114.

Gómez-Martínez, R., Prado-Román, M., & Plaza-Casado, P. (2019). Big data algorithmic trading systems based on investors' mood. Journal of Behavioral Finance, 20(2), 227-238.

Gómez-Martínez, R., Prado-Román, C, & Cachón-Rodríguez, C. (2021). Algorithmic trading based on the fear of COVID-19 in Europe. Business Research.

Haroon, O., & Rizvi, S. A. R. (2020). COVID-19: Media coverage and financial markets behavior—A sectoral inquiry. Journal of Behavioral and Experimental Finance, 27, 100343.

Hirshleifer, D., y Shumway, T. (2003). Good day sunshine: Stock returns y the weather. The Journal of Finance, 58(3), 1009-1032.

Jacobsen, B., y Marquering, W. (2008). Is it the weather? Journal of Banking y Finance, 32(4), 526-540.

Kaplanski, G., y Levy, H. (2010). Exploitable predictable irrationality: The FIFA world cup effect on the U.S. stock market. The Journal of Financial y Quantitative Analysis, 45(2), 535-553.

Masip, P., Aran-Ramspott, S., Ruiz-Caballero, C., Suau, J., Almenar, E., & Puertas-Graell, D. (2020). News consumption and media coverage during the confinement by Covid-19: Information overload, ideological bias and sensationalism. Prof. Inf., 1-12.

Mitchel, C. (2021). How to use a moving average to buy stocks. Retrieved from https://www.investopedia.com/articles/active-trading/052014/how-use-moving-average-buy-stocks.asp

Mishra, V., y Smyth, R. (2010). An examination of the impact of India's performance in one-day cricket internationals on the Indian stock market. Pacific-Basin Finance Journal, 18(3), 319-334.

Nofsinguer, J.R., (2005). Social Mood y Financial Economics. Journal of Behavioral Finance, 6(3), pp. 144-160.

Pagano, M. S., Sedunov, J., & Velthuis, R. (2021). How did retail investors respond to the COVID-19 pandemic? The effect of Robinhood brokerage customers on market quality. Finance Research Letters, 43, 101946.

Palma-Ruiz, J. M., Castillo-Apraiz, J., & Gómez-Martínez, R. (2020). Socially responsible investing as a competitive strategy for trading companies in times of upheaval amid COVID-19: Evidence from Spain. International Journal of Financial Studies, 8(3), 41.

Priem, R. (2021). An exploratory study on the impact of the COVID-19 confinement on the financial behavior of individual investors. Economics, Management, and Financial Markets, 16(3), 9-40.

Salisu, A. A., & Akanni, L. O. (2020). Constructing a global fear index for the COVID-19 pandemic. Emerging Markets Finance and Trade, 56(10), 2310-2331.

Smales, L. A. (2021). Investor attention and global market returns during the COVID-19 crisis. International Review of Financial Analysis, 73, 101616.

Vasileiou, E. (2020). Behavioral finance and market efficiency in the time of the COVID-19 pandemic: does fear drive the market?. International Review of Applied Economics, 1-18.

Yuan, K., Zheng, L., y Zhu, Q. (2006). Are investors moonstruck? lunar phases y stock returns. Journal of Empirical Finance, 13(1), 1-23.