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Herding Behaviour in the Portuguese Stock Market:

Impact of COVID-19.

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Abstract

The present study aimed at identifying the presence of herding in the Portuguese stock market in the years 2020 and 2021, corresponding to the COVID-19 pandemic, and to compare these two years to the control year 2019. This aim was chosen since the pandemic was a source of stress for the economic and the financial worlds. Data from the PSI20 index were used, and the analysis by the Christie & Huang method (1995) failed to show the presence of herding. The use of the Chang *et al.* method (2000), also evaluating aggregate market activity, allowed the finding of herding in the pandemic period, but only at a 10% significance level.

We found insufficient evidence to definitively establish the presence of herding during the COVID-19 pandemic in the Portuguese stock market (in 2020 and 2021), although we cannot exclude that it may have existed at a relatively limited degree. Overall, national and international institutions may have been sufficiently strong to deal, to an important degree, with the strain placed on the Portuguese stock market.

Keywords: Behavioural Finance; Stock Market; Portugal; PSI20; Herding Behaviour, Equity Return Dispersion.

Resumo

O presente estudo teve como objetivo identificar a presença de *herding* na bolsa portuguesa nos anos de 2020 e 2021, correspondentes à pandemia de COVID-19, e comparar estes dois anos com o ano de controlo de 2019. Este objetivo foi escolhido uma vez que a pandemia foi uma fonte de *stress* para os mundos económico e financeiro. Foram utilizados os dados do índice PSI20. A análise pelo método de Christie & Huang (1995) não demonstrou a presença de *herding*. O uso do método de Chang et al. (2000), avaliando, de igual forma, a atividade agregada do mercado, permitiu a constatação de *herding* no período de pandemia, mas apenas ao nível de significância de 10%.

Não encontramos evidência suficiente para estabelecer definitivamente a presença de *herding* durante a pandemia de COVID-19 no mercado de ações português (em 2020 e 2021), embora não possamos excluir que possa ter existido em grau relativamente limitado. Globalmente, as instituições nacionais e internacionais podem ter sido suficientemente fortes para lidar, em grande medida, com a pressão colocada no mercado bolsista português.

Palavras-chave: Finanças Comportamentais; Mercado de ações; Portugal; PSI20; Comportamento de manada, dispersão de retorno de capital.

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List of abbreviations

CMVM - Portuguese Securities Market Commission.
 COVID-19 - Coronavirus disease 2019, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).
 CSAD - Cross-sectional absolute deviation.
 CSSD - Cross-sectional standard deviation.
 NPV – net present value.
 OLS - Ordinary Least Square.
 PSI20 – Portuguese stock (market) index.

1.0 Introduction

1.1 General Background

The herding phenomenon can be essentially characterized as the convergence of behaviours: the instinct by which someone reproduces the actions or thoughts of another person in order to achieve what is perceived to be a more beneficial outcome. Evidently, this occurrence can be extended to almost any species at almost any point of their existence. However, the field that this study will focus on is commonly denominated as financial herding - when the occurrence takes place in a financial environment, and one's personal wealth is thought to be maximized by doing so.

The broader herding term is thought to have been initially explored since the late 19th century by social psychologists such as Gabriel Tarde and Gustave Le Bon. In terms of financial herding, names such as Scharfstein & Stein (1990), Bikhchandani *et al.* (1992), Devenow & Welch (1996), Hirshleifer (2001) or Barberis & Thaler (2002) seem to be among the first to cross the mind.

The study of financial herding is a part of Behavioural Finance, a school of thought that departs from the models based on a purely rational investor, including the Efficient Market Hypothesis (Fama, 1970). The critique of this latter model was made by authors such as Shiller (2003), who presented excess market volatility as a major fact that could not be explained by the Standard Finance Model.

Financial herding, defined as the situation in which managers mimic the investment decisions of other managers, ignoring substantive private information (Scharfstein & Stein, 1990), may occur due to one or more of the following factors: belief that other agents hold more relevant information; reputation; compensations systems; scarcity or asymmetry of information; market sentiment (topics to be further discussed below).

It has been speculated that herd behaviour in financial markets is expected to emerge particularly during crisis periods (Christie & Huang, 1995; Chang *et al.*, 2000). Under this view, crisis periods are expected to be associated to market anomalies and significant deviations from stock market efficiency, with important implications for optimum asset allocation, portfolio diversification, and financial stability in general (Economou *et al.*, 2011). However, Hwang & Salmon (2004) presented evidence in an opposite direction – that crises are associated to decreased herding. These latter authors used a model incorporating data from fundamentals. In fact, Christie & Huang failed to confirm the theory with their own data.

This study will try to determine whether the Portuguese stock market was host to this financial phenomenon, analysing data from the PSI 20 index and having as time-frame the years of 2019 to 2021 – a period during which the COVID-19 pandemic played a critical role in the overall economy.

The Portuguese stock market (EURONEXT Lisbon) is a relatively small market, representing 1.43% of the total EURONEXT market capitalization (by end 2021). The Portuguese stock exchange is listed in the Morgan Stanley Capital International MSCI World index (Developed Markets), alongside most developed countries (and not in the Emergent Markets Index)¹.

1.2. Research gaps

Spyrou (2013) reviewed the main evidence concerning financial herding, and concluded that available empirical evidence is not conclusive, in what concerns the existence of herding as a generalized phenomenon in stock markets, since studies that either show or do not show herding exist.

A particular interest exists concerning the still insufficiently studied impact of specific market stress periods, as is the case of the COVID-19 pandemic (with a potential uniqueness of its consequences), on stock market activity.

The COVID-19 pandemic, still ongoing as of the writing of the present text, led to profound changes in large segments of the economic and financial world (S. R. Baker et al., 2020; He et al., 2020). The impact of the pandemic included changes in the available work force, changes in consumer behaviour, and an overall significant impact of the population confinement. Restaurants, airline companies, touristic companies and artistic activities were among the economic sectors more profoundly touched by the pandemic. According to Louhichi *et al.* (2021) demand and supply shocks existed under this pandemic, leading to restrictions on trade, product and service transactions, and capital flow mobility. Several authors described further financial impacts of the pandemic (Ashraf, 2020; Albuлесcu, 2021; Altig et al., 2020). The measures taken by governments included restriction of mobility and commercial activities, and stimulus packages. By end-2021, however, as the economic activity increased in the world, supply-chain disruptions, inflation and labour shortages ranked as major factors influencing global economic sentiment.

¹ Available at: <https://www.msci.com/documents/10199/149ed7bc-316e-4b4c-8ea4-43fcb5bd6523>

Herding behaviour in stock markets during the pandemic were described by Espinoza-Mendéz & Arias (2021), by Kizys et al. (2021), by Wu et al. (2020), by Aslam et al. (2021) and by Bouri et al. (2021). These latter authors used data up to August 2020, and included data from Portugal, amalgamated with the data from Ireland, Italy, Greece and Spain. Ferreruella & Mallor (2021) studied the impact of COVID-19 (up to May, 2021) on the Spanish and the Portuguese stock markets, and found herding in Portugal. Specifically in the Portuguese stock market, the impact of the COVID-19 pandemic is insufficiently characterized, namely in what regards possible herding phenomena up to the end of 2021.

1.3 Research Question

Did the Portuguese stock market suffer from the herding phenomenon more during the years 2020 and 2021 (COVID-19 pandemic, a possible market stress factor), than during the 2019 control year?

Since the pandemic is ongoing, the information on this topic is relatively scarce and evolving, and thus a gap in the present state of knowledge exists.

The research question presented above may help to answer the question if herd behaviour in financial markets does emerge particularly during crisis periods, as hypothesised by several authors (Christie & Huang, 1995; Chang et al., 2000) but denied by other authors (Hwang & Salmon, 2004).

1.4 Originality

The impact of the COVID-19 pandemic (an exogenous and global shock) on the herding phenomenon in the Portuguese stock market is not yet fully characterized. Therefore, this report will constitute an increment in the area.

As this thesis was being written, Ferreruella & Mallor (2021) published a report on the impact of the 2008 and the COVID-19 crises on the Spanish and the Portuguese stock markets. These authors studied the period 2000-May 2021. In the present report, data are presented up to end 2021, thus expanding the period under study.

1.5. Contribution to Knowledge

The contribution to knowledge that the present report affords may be seen under two different perspectives: the academic viewpoint and the viewpoint of management.

From an academic standpoint, the contribution arises from the addition of an empirical study on the phenomenon, with specific characteristics and conclusions, specifically due to the particular time period assessed which does not possess a similar homologous period. An unstudied hypothesis can be tested due precisely to the time frame in question and its uniqueness.

In management terms, several agents or stakeholders could potentially find usefulness in the present study. The Portuguese Securities Market Commission (CMVM) could, for example, gather information on this study in order to adjust potential regulations in regard to future crises. Investors or fund managers could also potentially benefit, by incorporating the present data in trading strategies, whenever the economy exhibits similar characteristics to the ones observed in 2020 and 2021. Finally, companies may use the collected information to better adjust to the new reality in which they operate.

1.6 Outline of the Following Chapters

We will now briefly enumerate the remaining chapters of this work. In Chapter 2, a Literature Review is presented. This chapter ends with the presentation of the hypothesis under evaluation. In chapter 3, the method and data are presented. In chapter 4 the results are presented. The dissertation ends with chapter 5, which corresponds to the conclusions.

2.0 Literature Review

2.1. Definition

Financial herding is the topic of interest for the present report. On an enlarged level, “herding is a form of convergent social behaviour that can be broadly defined as the alignment of the thoughts or behaviours of individuals in a group (herd) through local interaction and without centralized coordination” (Raafat et al., 2009) ². Herding is seen as a form of convergent social behaviour, as a bridge linking agents and the social

² Op. Cit. Page 420

structures (Raafat et al., 2009). Herding occurs in a number of different domains, one of which is Finance, others including mob violence, political choice and consumer preferences (Raafat et al., 2009). This latter definition has a broad scope, encompassing all particular forms of herding. Herding may be due to emotional contagion, a form of involuntary spread of feeling (Raafat et al., 2009). The neuro-psychologic aspects of herding were reviewed by Shamay-Tsoory et al. (2019), and were also studied by Stallen *et al.* (2012).

The concept that herding exists in financial markets is not new. MacKay (1852), writing in the 19th century (text first published in 1841), analysed a number of financial bubbles, namely the Dutch Tulip mania (17th century), the French Mississippi Company and the British South Sea Company (18th century). This author stated that “Men, it has been said, think in herds; it will be seen that they go mad in herds, while they only recover their senses slowly, and one by one”³.

In Finance, the herding phenomenon, or behavioural convergence, can be described, in yet another view, as similarities in behaviour due to interaction between individuals (Hirshleifer & Hong Teoh, 2003). By replicating other’s actions, agents behave in what might appear to be an irrational manner. Additionally, herding can also be stated as the situation where the reception of knowledge from other agents regarding participation in a specific investment induces a change in personal behaviour (Bikhchandani & Sharma, 2000). It is concluded, therefore, that the preferences of first acting investors are of great importance to determine the herd’s direction. Also relevant may be the opposite direction herd where after the arrival of new information investors may want to revise bad investments caused by first herd action and, consequently, change drastically in direction forming a new second herd of opposite direction. These herds are a stimulus to market volatility. Herding, in practical terms, is a situation in which investors choose the same or similar investments based mostly on the fact that many other investors are investing in those stocks. The fear of missing out on good investments, or the fear of being left alone in the market, is often the driving force behind herd instinct.

For the purpose of the present report, we will use the definition of financial herding presented by Chiang & Zheng (2010) - the presence of correlations in trade as a result of interactions between market participants⁴. The choice was made since, coming from

³ Op. cit., Preface, page viii

⁴ Op. cit. page 1911.

relevant authors in the field, it is simple yet conveys the essential elements of herding, and, importantly, points at the possibility of numerical evaluation of the phenomenon.

2.2. Main Theories

2.2.1 Efficient Market Hypothesis

For a significant part of the 20th century, classical finance was considered the prevailing way of thought within the field, consisting of several theories, specifically both the Efficient Market Hypothesis (Fama, 1970) and the Capital Asset Pricing Model. Emphasizing the first, economic agents were thought as of being rational and to have the maximization of their utility or personal well-being as their only drive. Prices were considered to reflect true net present value (NPV) of assets. The market is seen as being able to adjust to new information almost instantly and, consequently, large arbitrages are virtually impossible. Some agents were considered to be irrational, but they were considered to “even out” due to their supposed randomness. In the presence of an eventual herd, rational arbitrageurs would be called upon to correct the possible deviation (Ruppert, 2004).

An efficient market is denoted by a market capable of providing prices that reflect all of the available information; consequently, the available information in period t is utilized in completion in order to determine the expected returns in equilibrium. Moreover, the distinction between the three forms of market efficiency was established – weak, semi-strong and strong. Furthermore, the efficient market is in possession of a great number of rational agents, acting to maximize profit and where current relevant information is available to all agents almost freely (Fama, 1970).

Eugene Fama appears as the main author in this subject, among many others, presenting ideas such as forms of market efficiency, random walks in stock prices and in information appearance. Fama (1970) did describe the existence of anomalies (facts not explainable by the then current theory). This author, however, stated that these are chance results, that apparent overreaction of stock prices to information is about as common as under-reaction, and that post-event continuation of pre-event abnormal returns is about as frequent as post-event reversal indicating markets are indeed efficient at least in some degree.

A strong critique of the Standard Finance Model was presented by various authors. Shiller (2003) presented excess market volatility as a major fact that could not be explained by the Standard Finance Model. According to Shiller (2003), excess volatility implies that changes in prices occur for no fundamental reason at all. The author compared the real dividends paid for companies listed in the Standard & Poor's Composite Stock Price Index, which shows a stable trend, with the corresponding real stock prices, which shows marked changes (Shiller, 2003), to illustrate his point.

Barberis & Thaler (2002) present what they believe are limits to arbitrage, stating that when a mispricing occurs (a deviation from the fundamental value), strategies to correct the mispricing can be both risky and costly. Limits to arbitrage include fundamental risk (further changes in stock value), noise trader ⁵ risk (increase in divergence associated to future price movements), and implementation costs (including commissions and short-sale constraints). Examples showing that arbitrage is indeed limited, according to these authors, include the case of twin shares, Royal Dutch and Shell Transport, which after having merged their interests on a 60:40 basis, had their equity values ratio diverge substantially in both directions ⁶, and the case of Index inclusions (increase in price of stock after inclusion).

2.2.2. Behavioural Finance

Following the aforementioned critiques, Behavioural Finance entered the scene as an alternative way to conceive the overall economic paradigm. This alternative view started stating that the markets are not always efficient, much due to the psychology of its participants (sometimes even appearing to act irrationally), and, consequently, opportunities to benefit from this inefficiency exist. This view is grounded on the idea that agents are in possession of sentiments or personality traits acting as apparent "obstacles" in the process. The efficient portfolio is not the market portfolio and prices reflect psychological choices.

Additionally, and perhaps noteworthy, in light of recent empirical studies, the efficiency of arbitrage is now believed to be much weaker than previously thought - contradicting

⁵ A noise trader is one who is seen as an irrational trader (rational traders being known as "arbitrageurs").

⁶ According to Froot & Dabora (1999), "the difference between the prices of twin stocks appears to be correlated with the markets on which they are traded most, i.e., a twin's relative price rises when the market on which it is traded relatively intensively rises" (op. cit., abstract).

the main backbone of the earlier theory. These psychological behavioural patterns, consequently, can eventually lead to mispricing of assets (Hirshleifer, 2001).

This newer view acts against the “Efficient Market Hypothesis” – a concept under which the market is in equilibrium maintained by the actions of rational investors – a model that would appear to have difficulties in explaining financial market bubbles, as well as market crashes.

Heuristics and biases are psychologic phenomena present in contexts of uncertainty (Tversky & Kanehman, 1974). According to Ritter (2003), common types of biases seen in the financial world include: use of the 1/N rule (money is frequently allocated by dividing the whole sum by the available funds); loss aversion; overconfidence bias (including the consequence of too little diversification); framing (the notion that how a concept is presented matters); the tendency to underweight long-term averages, and putting too much weight on recent data.

Schleifer (2000) stated that behavioural finance theory rests on two major foundations. On the one hand, arbitrage is limited, and therefore, in real world, markets cannot be perfectly efficient. The argument describes that many securities do not have perfect substitutes and, besides that, prices do not converge instantaneously. Although inefficient, we don't know the degree of inefficiency. For that purpose, we will need the second foundation that is investor sentiment. The author indicates that investors form their “beliefs and valuations” and that combined with the limited arbitrage a theory of sentiment may give us an accurate prediction of the behaviour of securities and returns. However, we understand a lot more of the limited arbitrage than of investors sentiment. Advances in this area may have real consequences on financial markets and the public policies towards them.

Hirshleifer (2015), building upon the work of other authors, makes a further development, presenting financial theories based on feelings. Under this concept, the author states that controlling mood swings consequently affects optimism, risk tolerance and market prices. Illustrating this concept, season changes are mentioned, as the length of the day can be correlated with market returns. An amusing example are linked to “feelings of envy” as these feelings can help explain the attraction towards investments with lottery type payoffs, as individuals hear about these high payoffs obtained by others. In terms of Investor Sentiment, the author states: “Investor sentiment is the fluctuating general attitude toward investment categories. It can be associated with shifts in assessments of

expected returns or of risk”⁷. Emotions can change very quickly and, therefore, so do personal preferences towards risk and return ratios. This sentiment is, consequently, responsible for a mispricing of securities. And, as such, these sentiments could be used to predict future abnormal returns. Baker & Wurgler (2006) also wrote an interesting article showing that when sentiment proxies are low, stocks that are difficult to value receive high subsequent returns.

We would like to add a brief note on the comments by Brock (1999), an author who presented the view that technological change is directly and indirectly the culprit responsible for increased market volatility. Technology-based increases in information and in speed of response are associated, according to this author, to an increase in belief correlation.

To what point does Behavioural Finance solve the problems faced by the Efficient Market Hypothesis? Since the theoretical foundations are different, the evaluation of market anomalies, so labelled under the latter concept, is of no particular problem for the former – no matter how important the deviation from the prediction may be. Behavioural finance is able to cope with any degree and kind of stock market volatility (including market bubbles and crashes) – it is a highly resilient model. In fact, as laid out by Khun (1962), a major problem with any major scientific theory is the way in which it handles anomalies. News and information, even if widely available, and therefore reachable in a similar way by many people, are handled in different ways, due to the different backgrounds on which each person acts. This principle will justify any given empirical result.

2.2.3. Herding Theories

Herding refers to the occurrence of investors mimicking the behaviour of other agents when decision-making. In the market setting, agents appear to suppress their own beliefs, abiding to the group even if in disagreement (Kumar & Goyal, 2015). Conformist behaviour is usually considered to be much more frequent than dissenting behaviour (Sunstein, 2003). In the financial world, simply due to how costly gathering valuable information is, agents may believe their peers are better informed and, consequently, disregard their own information and market fundamentals. Financial herding consists of behaviour patterns that are correlated across individuals, meaning that investors are influenced by the decisions of other investors (Devenow & Welch, 1996). Herding may

⁷ Op. cit., page 148

have important implications for financial markets (Kapusuzoglu, 2011). Herding may lead, as an end result, in important information not being reflected on securities prices, making them drive away from their fundamental values. Therefore, herding may lead to higher volatility, and eventually to bubble formation, or even to market crashes. The topic has been reviewed by Spyrou (2013), and we will present the most prominent financial herding theories.

2.2.3.1 Non-rational herding and limits to arbitrage

Early authors, such as McKay and Keynes, assumed investors to be irrational. Rational investors are named arbitrageurs, whereas non-rational investors are named noise traders. For Black (1986), noise is contrasted with information. Noise traders act on noise and hold systematic biases in their action, whereas the former do the work of bringing prices toward fundamentals. Noise traders are believed to trade on the basis of limited information, often under cognitive overload of information and stress; it may be difficult for people to focus on more important information and therefore to make rational decisions. Noise traders make the market unpredictable and risky for all investors.

Schleifer & Summers (1990) expand on the limits to the arbitrage model, recognizing that arbitrage is risky and therefore limited. The risks for arbitrage include fundamental risk and unpredictability of the future resale price. For these authors, changes in investor sentiment are not fully countered by arbitrageurs and so affect security returns.

Hwang *et al.* (2021) described an association between the herding phenomenon with overconfidence about signals of the market outlook, with a corresponding decrease in herding in the case of investor under-confidence.

We will make an additional short comment on non-rational behaviour. According to Pinker (2021), rationality is the use of knowledge (justified true belief) to attain a goal, and therefore is always relative to the goal – the same action may be rational or non-rational, according to the goal. This means that it is not easy to prove that non-rational behaviour is at hand, in any given circumstance.

2.2.3.2. Rational herding

The view that investors are always irrational has not stood the test of time, and many contemporary authors explore the rational basis of what appears, at first glimpse, to be irrational.

Devenow & Welch (1996) analysed different settings in which financial herding may be rational. The external environment may lead to incentive issues or information difficulties - imperfect information, concern for reputation and compensation structures (Bikhchandani & Sharma, 2000) ⁸.

Scharfstein & Stein (1990) argue that herding is inefficient from the social standpoint, but that it can be rational, due to reputational concerns. Managers do not want to stand out alone in the market and therefore copy each other, otherwise they risk being labeled “dumb” (investors who receive purely noisy signals) rather than “smart”. For these authors, both the presence of profitable investments and the similarity concerning the investments of others allows the market to identify a “smart” manager. Managers could also be interested in herding in case bad investment outcomes appear – the “sharing the blame” effect. A similar reasoning exists regarding the compensation of professional investors, who can get better paid if they do not deviate from the average.

Banerjee (1992) developed a sequential decision model to study herd behaviour. For this author, herding may be rational since other people may have information, which is not available to us. For this author, herding leads to a negative effect on the rest of the population – that the author calls “herding externality”. Under this model, investors may infer that previous investors have relevant private information (Spyrou, 2013).

Froot et al. (1990) have discussed the short horizon investment stance (“short-term speculation”), and concluded that investors may herd on the same information, trying to learn what other informed traders also know. This situation is considered to be informationally inefficient. The authors believe that positive informational spillovers may occur for short-term traders, if traders coordinate their attention on the same piece of information, even if that information is less revealing about the asset's long-run value. Long-term investors, on the other hand, face negative spillovers, which ensure informational efficiency, as the number of other identically-informed traders increase.

Investor sentiment, a topic already mentioned above, may also be implicated in financial herding. Barberis et al. (2005) discussed the phenomena of under-reaction (mainly in the short-term) and over-reaction (associated to consistent patterns of news pointing in the same direction).

⁸ Op. cit. page 283.

According to Falkenstein (1996), mutual funds have a significant preference towards stocks with high visibility and low transaction costs, and are averse to stocks with low idiosyncratic volatility.

2.2.3.3. Spurious versus intentional herding

Bikhchandani & Sharma (2000) make a distinction between spurious and intentional herding. Spurious (unintentional) herding is the phenomenon where agents facing the same problems and common information make similar decisions. This type of action is thought as being overall efficient; however, the distinction of the unintentional and intentional herding may be a difficult task.

Intentional herding may occur for several reasons, amongst them information imperfections, reputational considerations or potential compensations. This type of herding includes payoff externalities models, in which the payoff of an agent adopting certain actions is increased by other agents employing the same action, resulting in a positive externality. In principal-agent models, managers in order to gain or maintain their own reputation, in imperfect markets, may choose to either “hide in the herd” or “ride the herd”; benefits of these actions may be not to be evaluable when hiding or to prove one’s quality when riding the herd. Further possible causes of herding include the existence of sanctions applied upon deviants, of preference interactions (case of fashion) or in the case of direct communication (a statement from another person, considered to have credibility) (Hirshleifer & Hong Teoh, 2003).

Cascade models would imply the later agents to follow prior agents continuously disregarding their own private information (Devenow & Welch, 1996). Bikhchandani et al. (1992) discussed informational cascades – when someone copies the behaviour of those before him/her, without paying attention to other information.

Avery & Zemsky (1998) state that informational cascades are not possible if a price mechanism and simple information structures exist (a single dimension of uncertainty), but herding may occur if information structures are complex (more than one dimension of uncertainty).

2.3. Empirical evidence

2.3.1. Studies not showing significant herding

Early studies involving institutional investors in the USA failed to show the presence of herding. Lakonishok *et al.* (1992) studied 769 American equity funds and found that managers herd relatively little in their trades in large stocks; there was some evidence of more herding in smaller stocks. Likewise, Grinblatt *et al.* (1995) studied the purchase of stocks by American mutual funds and found little evidence of herding. Wermers (1999) found little herding by mutual funds in the average stock, but higher levels in trades of small stocks and in trading by growth-oriented funds.

A major breakthrough consisted in looking at aggregate market activity. However, the landmark study by Christie & Huang (1995), introducing the Cross-Sectional Absolute Deviation (CSAD) of returns, using data from the New York Stock Exchange, concluded that herding is not an important factor in determining equity returns during periods of market stress.

In the subsequent study by Chang *et al.* (2000), the authors tried to enhance the model, using the Cross-Sectional Standard Deviation (CSSD) of returns, and found no evidence of herding in the USA and Hong Kong, partial evidence in Japan and evidence of herding for South Korea and Taiwan. The methods described in these two reports, as it happened also with the method of Lakonishok *et al.*, were frequently used in later reports ⁹.

2.3.2. Studies showing significant herding.

The relatively negative initial findings, in what concerns herding, were counter-balanced by reports showing more significant degrees of herding, also in the USA: Nofsinger & Sias (1999), authors who studied changes in institutional ownership and returns; Sias (2004), comparing demand for the same security in subsequent quarters; Choi & Sias (2009), concerning herding across industries.

In what concerns other stock markets, a general image appeared that herding may be more prevalent in smaller markets, after analysing several reports from the United Kingdom, Japan, Germany, Poland, Indonesia and Korea (Spyrou, 2013). Evidence has also been

⁹ The reports by Scharfstein & Stein (Scharfstein & Stein, 1990), by Bikhchandani *et al.* (Bikhchandani *et al.*, 1992) by Banerjee (Banerjee, 1992) and by Devenow & Welch (Devenow & Welch, 1996), mentioned above, did not present empirical data.

presented, that hedge fund managers may herd, and even that reasonable herding levels by hedge funds could stabilize futures prices (Spyrou, 2013). Small investors have also been shown to herd, for instance in China. According to Tan et al. (2008), evidence of herding was seen in A-share markets (mainly domestic individual investors) and B-share markets (mainly foreign institutional investors). Evidence in favour of the existence of herding has been presented by Chen (2021), concerning intraday data and global market investors (35 different countries), with strong evidence of significant herding at the country level (traders tended to follow each other from one country to another). Another report showing herding, namely for institutional investors, was presented by Shyu & Sun (2010), in Taiwan.

Chiang & Zheng (2010), using data from 18 countries, reported the presence of herding in most of them, with the exception of American and Latin American markets, but with herding in American markets during crisis periods. For these authors, during crisis herding activity starts in the country which originates the crisis, and then spreads. Yao *et al.* (2014), from China, also present evidence of herding, especially concerning B-share markets.

Gleason *et al.* (2004) presented evidence that investors do not herd during periods of extreme market movements. As mentioned above, Hwang & Salmon (2004) reported that crises are associated to decreased herding.

2.3.3. Reasons for apparent lack of herding behaviour

A number of reports presented a view of absent or limited degree of financial herding. The reasons presented by some of these authors are as follows. For Lakonishok *et al.* (1992), institutional investors pursue a broad diversity of trading styles that, to a large extent, offset each other. For Grinblatt et al. (1995), herding may not be seen since it is being measured over a sample of investors that is too broad. For Christie & Huang (1995), the predictions of rational asset pricing models are supported by the evidence. For Chang *et al.* (2000) the increased degree of herding seen in developing markets is associated to incomplete information disclosure (paucity of reliable micro-information) and to a high degree of government intervention, perhaps meaning that no herding could be seen in markets with better information disclosure and decreased government intervention. For Ferreruella & Mallor (2021), bullish situations could, in some cases, be associated to lack of herding, unlike bearish situations. However, Chang et al. (2000) documented extreme

price movements to be associated to herding in developing countries but not in developed markets.

In summary, we may state that financial herding is not a universal phenomenon; different methods applied in different countries lead to different results. Information disclosure and government intervention could modulate this phenomenon, as well as the dimension of the market.

2.3.4. Herding and COVID-19

Concerning the impact of the COVID-19 pandemic on financial herding, a number of reports are mentioned in the section “research gaps”, above, and in Supplementary Table 1 (Espinosa-Méndez & Arias, 2021; Kizys et al., 2021; Wu et al., 2020; Aslam et al., 2021; Bouri et al., 2021). Overall, these studies showed the presence of financial herding in the pandemic period, with different degrees of importance. Rubesam & Raimundo (2022) studied ten different countries, and found signs of herding in Italy, Sweden, and the United States. These authors found less herding in association with stricter governmental actions that restrict mobility, and more herding associated with economic support measures.

2.3.5. Herding in the Portuguese stock market

Several previous reports were published concerning herding and the Portuguese stock market. Lobão & Serra (2002, 2007) studied herding in Portuguese mutual funds. Strong evidence of herding was reported, as further described in Table 1; the method of Lakonishok et al. was used; similar findings using the same method were obtained by Barros (2009), studying the PSI-20 index in the period between 1997 and 2007.

Kallinterakis & Ferreira (2006), using the method of Hwang & Salmon (2004), studied herding and feedback trading in the 1993-2005 period. The authors found combined significant presence of both for that period, with signs of clustering during the second half of the 1990s. Herding was shown to rise during periods of “definitive” market direction and to decrease during periods of market fluctuations.

Several authors used the Christie & Huang and derived methods. Furtado (2012) studied the PSI Geral Index and PSI Financials Index in the 2003-2011 period (Christie & Huang method), and found evidence of herding behaviour in PSI Geral index during up market

periods. Santos (2013) studied the Portuguese stock market, and found discrepant results, when the Christie & Huang method (no herding) and the Chang et al. (evidence of herding) method were used. Vieira & Pereira (2015) studied herding behaviour in regard to the PSI 20 index, for the period between 2003 and 2011. Two different approaches were used to measure herding intensity, leading to different results, with herding detected with the Patterson & Sharma method (2006) but not with a method derived from Christie & Huang. Andrikopoulos *et al.* (2017) used an intraday dataset of all trades reported on Euronext's four constituent markets (Amsterdam, Brussels, Lisbon and Paris) between 2002 and 2010. These authors found that herding was significant in the Euronext as a group, and in a significant way in Belgium, France and Portugal, but not in the Netherlands. These authors used a derivative of the method by Chang et al. (Chiang & Zheng, 2010). Carolino (2018) studied the Portuguese stock market, and found that herding behaviour was stronger during down periods and during crisis periods. This author used the Chiang and Zheng method. Economou *et al.* (2011) searched for the presence of herding in four different markets: Portuguese, Italian, Spanish and Greek. Herding was seen in Greece and in Italy and was not seen in Spain, whereas mixed evidence was seen regarding Portugal (1998-2008 period). These authors also used the Chiang and Zheng method. Ferreruella & Mallor (2021) recently published a report on the impact of the 2008 and the COVID-19 crises on the Spanish and the Portuguese stock markets. These authors studied the period 2000- May 2021 and found that herding was detected in Portugal before and after the global 2008 financial crisis, and also during the COVID-19 period (these authors found no herding in Spain in this latter period). These authors used the Christie & Huang and the Chang et al. methods.

The Patterson & Sharma (2006) method, which takes into consideration intraday orders, was used by some further authors. Pereira (2012) studied the PSI 20 index in the period 2003-2011, and found evidence of herding. Leite *et al.* (2018) studied the PSI 20 index values in a 12 year period (1998-2010). These authors also noted the presence of herding in this market.

Finally, the method by Sias (2004), which takes into consideration how the activity of a given quarter covaries with the previous ones, was used by Holmes *et al.* (2013), who studied monthly data on the holdings of individual funds acting in the Portuguese market, and found evidence of intentional herding.

Overall, in good agreement with the idea that herding may be more prevalent in smaller markets (Spyrou, 2013), herding was seen in most published reports. However, the

method used may be of importance, and the Christie & Huang method may be less likely to show herding in this context, when compared to the derived methods (by Chang et al. and by Chiang and Zheng), or to the several alternative methods mentioned above.

Some selected examples of studies on financial herding, with empirical evidence, are presented in Supplementary Table 1, in an international level, during the COVID-19 and in the country under study (Portugal).

2.4 Research Context

Portugal is a country which is part of the European Union and of the Eurozone ¹⁰. The gross domestic product per capita was estimated at 20,840.9 Euros for the year 2019 ¹¹. The inflation rate for 2021 was estimated at 1.3% ¹². The Portuguese stock market is presently represented by Euronext Lisbon, which is, since 2002, a part of the larger Euronext network. Euronext Lisbon trades equities, public and private bonds, participation bonds, warrants, corporate warrants, investment trust units, and exchange traded funds. In the year of 2021, a total number of 54 companies were listed in the Lisbon stock market, of which 18 were considered to be more relevant and were aggregated in the PSI 20 index. Euronext is currently in fourth position in the list of major World stock exchanges, standing after the New York Stock Exchange, Nasdaq and Shanghai Stock Exchange (ordered by market capitalization). The market capitalization, in millions of Euro, was 4 451 299 in the year of 2019, 4 409 881 in the year of 2020 and 5 654 138 by the end of 2021 ¹³.

Euronext Lisbon, in electronic order book and regulated reported deals (single counted, millions of Euro) held a value of 24 300 in 2019, of 29 685 in 2020 and 29 414 in 2021, to be compared to a figure for the whole of Euronext of 2 089 853 in 2019, 2 531 441 in 2020, and 2 173 807 in 2021.

Euronext Lisbon was reported to have in December 2021 a market cap of 81315(.894) million Euro. According to Euronext, PSI 20 was responsible for 75000 million Euros of

¹⁰ The country's population was estimated at 10.344.802 individuals in 2021. Source: Censos 2021, available at https://www.ine.pt/scripts/db_censos_2021.html

¹¹ Source: PORDATA, available at: [https://www.pordata.pt/Portugal/PIB+per+capita+\(base+2016\)-2297](https://www.pordata.pt/Portugal/PIB+per+capita+(base+2016)-2297)

¹² Source: PORDATA, available at: [https://www.pordata.pt/Portugal/Taxa+de+Infla%3%a7%3%a3o+\(Taxa+de+Varia%3%a7%3%a3o+o+%3%8dndice+de+Pre%3%a7os+no+Consumidor\)+total+e+por+consumo+individual+por+objetivo-2315](https://www.pordata.pt/Portugal/Taxa+de+Infla%3%a7%3%a3o+(Taxa+de+Varia%3%a7%3%a3o+o+%3%8dndice+de+Pre%3%a7os+no+Consumidor)+total+e+por+consumo+individual+por+objetivo-2315)

¹³ Source: <https://live.euronext.com/en/resources/statistics/factbook>.

the above value as of 31 of December 2021. In terms of performance, PSI 20 gained 13.70% in 2021, suffered a 6.06% loss in 2020, and showed a 10.20% gain in 2019.

As can be seen in Supplementary Table 2, the companies listed in PSI20 include the areas of energy, electronic communications, banking and distribution. However, traditional economic sectors involving cork and the production of paper (mostly derived from the national forests) are also represented in a significant way.

Historically, the Portuguese stock market displayed a high level of concentration, with the most transacted stocks representing a significant part of the total volume of transactions (Vieira & Vieira, 2002). As can be seen in Supplementary Table 3, regarding the orders received in stock by CMVM, a significant concentration exists in the financial agents involved.

The decision to study the Portuguese market rises from the inquiry of how, in such a period of overall turmoil, a relatively small dimension market is affected and how its investors could alter their decisions based on both emotional and behavioural factors.

Again, due to its small dimension, a study by CMVM stated that the Portuguese investor is not sufficiently informed about the market and its products, in addition to the market's risks. Having this framework in mind, we can initiate by positing some statistics of our market of study. Portugal possesses 9.9% of firms market value in the hands of families/particulars, a value which stands inferior to the European union average which stands at 14%. Specifically, Spain is in possession of a 20% value. Proceeding to foreign investors, 44.8% of the market belongs to this investor class, whereas European union's value rests at 37%¹⁴. It is thought that the remaining equity is in the hands of private financial firms with a value similar to the average, rounding 27%. Analysing these numbers, it should be stressed that Portugal is obviously not in a better position than the European union's average, as expected from a small dimension market.

Portugal is a member of the Eurosystem, which comprises the European Central Bank and the national central banks of those countries that have adopted the single currency. The primary objective of the Eurosystem is to maintain price stability. The Eurosystem, among other actions, contributes to the policies aimed at the stability of the financial system. Thus, Portugal benefits from a stabilizing effect both of Banco de Portugal and of the European Central Bank. By means of promoting fundamental data availability and

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<https://www.cmvm.pt/pt/EstatisticasEstudosEPublicacoes/Estudos/Pages/O%20Perfil%20do%20Investidor%20Particular%20Portugu%C3%AAs.aspx?v=>

of limiting government intervention, Central Banks may lead to decreased levels of herding in the stock market.

The economic impact of the COVID-19 pandemic in Portugal was huge, particularly in the second quarter of 2020 and in the accommodation and catering sectors (Manteu et al., 2020). A decrease in the European Commission Economic Sentiment Indicator was seen, in parallel with a decrease in real gross domestic product in the first quarter of 2020 (Paes et al., 2020).

The European Union deployed support measures, with flexible budgetary rules and a temporary framework for state aid, including fiscal support and liquidity schemes. Additional support included the Recovery and Resilience Facility (672.5 billion Euros in grants and loans), up to 100 billion euros in loans to secure jobs ¹⁵, up to 200 billion Euros in loans to support businesses and up to 240 billion Euros in loans to support financing health costs ¹⁶.

The European Central Bank launched the Pandemic Emergency Purchase Programme, which covered during 2020 the buying of 1850 billion Euros of assets ¹⁷.

The Portuguese reaction to the pandemic included fiscal, monetary and macro-financial aspects.¹⁸ The Portuguese state has released 12,591 million Euros in public grants during the year 2020 ¹⁹, a value much larger than the corresponding figures for 2019 and for 2021²⁰.

During the first year of the COVID-19 pandemic, the Portuguese citizens, enterprises (especially small and medium) and the banking system were protected by a system of moratoria on loan repayments, following guidelines issued by the European Banking Authority ²¹.

In summary, we can state that Euronext Lisbon is a small market, when considered in an international perspective, that it is highly concentrated, that it underwent marked financial

¹⁵ As of 29 March 2022, Portugal received 5.9 billion Euros under the SURE (Instrument for temporary Support to mitigate Unemployment Risks in an Emergency) program.

<https://www.publico.pt/2022/03/29/economia/noticia/bruxelas-empresta-523-milhoes-portugal-preservar-emprego-2000563>

¹⁶ <https://www.consilium.europa.eu/en/infographics/mitigating-the-economic-impact-of-the-covid-19-crisis/>

¹⁷ <https://eurocid.mne.gov.pt/programa-de-compras-de-emergencia-pandemica>

¹⁸ Described at: <https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19#P>

¹⁹ <https://www.igf.gov.pt/infororganizacional/subvencoes/relatoriosintesesubvencoes2020.pdf>

²⁰ <https://eco.sapo.pt/2022/09/15/estado-da-menos-40-de-subvencoes-em-2021-com-queda-de-covid/>

²¹ Available at: <https://www.eba.europa.eu/regulation-and-policy/credit-risk/guidelines-legislative-and-non-legislative-moratoria-loan-repayments-applied-light-covid-19-crisis>

strain during the COVID-19 pandemic, but that it is “protected” by the Eurosystem and by CMVM, or, under more general terms, by the Rule of Law.

2.5 Hypothesis

The hypothesis to be explored is as follows:

H1: Herding is present in the Portuguese stock market in the years 2020 and 2021 to a greater degree than in the control year 2019.

Both data in favour and against the presence of herding in many financial settings exist in the literature (Spyrou, 2013), both before and during the COVID-19 pandemic. Herding could appear in some moments only to disappear at a later stage, given the ever-changing character of factors such as market fundamentals, reputation, compensation, information cascades, investor sentiment or time-frame of investment. Herding may be spurious, may be non-rational but can also be rational. Herding may be evaluated using different methods, which may yield different results.

It has been suggested that herd behaviour in financial markets emerges particularly during crisis periods (Christie & Huang, 1995; Chang et al., 2000) a theory denied by other authors (Hwang & Salmon, 2004). The COVID-19 pandemic was a sudden, global shock to the economies and to financial markets, with high levels of uncertainty (Kizys *et al.*, 2021). Both the economic and the psychological impact of the pandemic could lead to changes in financial behaviour, from the part of numerous actors playing a part in the Portuguese stock market, as previously documented in other crisis contexts (Economou *et al.*, 2011). Increased herding, associated to the COVID-19 pandemic, could pose a threat to financial stability and to the overall efficiency of the financial world (Kizys *et al.*, 2021). Euronext Lisbon is a small market, when considered in an international perspective, it is highly concentrated, it underwent marked financial strain during the COVID-19 pandemic, but it is “protected” by the Eurosystem and by CMVM, or, under more general terms, by the Rule of Law. Herding could depend on: for – small market, concentrated market, government intervention, incomplete information; against – CMVM, Eurosystem, Rule of Law. In short, we will evaluate if national and international institutions are sufficiently strong to deal with the Portuguese market under strain.

3.0. Method and Data used

3.1. Methodological approach

In the present report, a quantitative approach is used. Although both quantitative and qualitative methods are used in social sciences (Gerring, 2017), in the case of stock market analysis, a quantitative method is preferred, given the large volume of data. Following Gerring (2017), we define quantitative studies as those that are expressed in numbers and in statistical models, use large datasets, makes systematic sampling of data, and lead to conclusions that can in some cases be generalized.

3.2. Data in use

The gathered data were the return values and prices of all the companies constituting the PSI 20 index, as well as the collective index returns. The values were gathered in a daily time frame and from the period of study, 2019-2021.

This index functions as a benchmark stock market index, tracking the performance of the biggest companies in Euronext Lisbon Stock Exchange in terms of market capitalization and share turnover. The PSI 20 index is a capitalization-weighted index, where the market capitalization used to calculate the weights is allowed to free float.

The computations were made using secondary data, gathered from Thomson Reuters Eikon database (Refinitiv Eikon). This database is generally held with high regard as a reliable source of information around the globe. Being one of the biggest in the market ²², it possesses well founded Trust principles and was ranked second in Global web index report as the second most trustworthy news brand in the world. This database and the Bloomberg database are usually considered to be of high reliability and the two are market leaders (Adhikari & Ionici, 2021).

The number of COVID-19 cases was obtained from Direção Geral de Saúde, Lisbon, Portugal, an official Portuguese health department, as collected at the database of Rádio Renascença (Lisbon, Portugal) ²³.

²² The Refinitiv Eikon database holds a 19.6% market share, according to:
<https://www.wallstreetprep.com/knowledge/bloomberg-vs-capital-iq-vs-factset-vs-thomson-reuters-eikon/>

²³ Data available at <https://covid19estamoson.gov.pt/estado-epidemiologico-covid19-portugal/>

Missing data, regarding the company's prices, were filled manually with the average value of the previous and the subsequent market values. No specific change in the data was made in the case of outliers.

3.3. Variables in use

In choosing the variables, one has to follow the ones that correspond to the formulas chosen to be used. In the present report, we used some the variables and formulas more frequently used in contemporary research on this topic. We therefore used the following set of variables, in accordance with Economou et al. (2011), in order to calculate the formulas by Christie and Huang (1995) and by Chang et al. (2000), presented below:

- stock return - $R_{i,t}$ is the observed return of stock i on day t , and is defined as follows:

$$R_{i,t} = ((\text{Stock value } (t) / \text{Stock value } (t-1)) - 1)$$

- Number of stocks in the market portfolio (N);
- Cross-sectional average return of the market portfolio ($R_{m,t}$ is the value for day t).

Being an abnormal and unpredictable time period, the usage of this method is justified since it suggests that the phenomenon is most likely to occur in extreme market situations. However, other possible methods could have been employed as the one by Patterson and Sharma (2006) gathering as variables the total number of trades per stock and number of runs. Although this method, as well as other possible ones, could be of interest, the selected one seemed adequate, as mentioned above.

Similarly, hourly or weekly values could have been used, instead of daily values. However, hourly values were not considered to be as good to represent the evolution of the market as daily values and weekly values were considered to present an insufficient picture of the market for the considered time period.

3.4 Main methodology

Scharfstein and Stein (1990), Bikhchandani *et al.* (1992), Banerjee (1992), and Lakonishok *et al.* (1992) used different statistical approaches to study herd behaviour. In recent years, however, the linear model of Christie & Huang (1995) and that of Chang et al. (2000), derived from the former, have gained wide acceptance. The former model is believed to be considerably affected by the existence of outliers (Economou et al., 2011),

unlike the non-linear latter model. The use of a quantitative method is in order, and the method used to test the presence of the herd bias, suggested by Christie & Huang (1995), is based on the following hypothesis: the market alternates between two stages, normal market and market stress (periods of abnormally large average price movements). The argument made is that in the presence of herding behaviour, during market stress, security returns should not digress substantially from the market's return.

To examine the possible herding behaviour, during market stress periods, the authors suggested the estimation of the following linear regression model:

$$CSSDt = \left(\sum_{i=1}^N (R_{i,t} - R_{m,t})^2 \right)^{1/2} / N - 1$$

$$S_t = \alpha + \beta_1 D_t^L + \beta_2 D_t^U + \epsilon_t$$

As can be seen in the expressions above, the former method utilizes two dummy variables (labelled D^L and D^U) signalling the extreme values of market returns while the latter uses variations of the market return variable (market return, absolute value of market return and market return squared). Both methods use a constant α in its calculations.

D^L consists of a dummy variable taking the value 1 if the market returns lay on the extreme lower tail of the return distribution and 0 if otherwise;

D^U consists of a dummy variable taking the value 1 if the market returns lay on the extreme upper tail of the return distribution and 0 if otherwise;

α (α) coefficient represents a constant denoting the average dispersion of the sample excluding the region covered by the dummy variables;

ϵ_t consisting of the error term for return t ;

This formula allows to calculate the cross-sectional standard deviation (CSSD) of returns. Additionally, an extreme market return is defined as one that lies in the one (or five) percent lower or upper tail of the return distribution (Demirer & Kutan, 2006). We used the 5 percent upper and lower limits for the calculations. Rational pricing models would predict positive estimates for the Beta (β) coefficients whereas negative estimates would be consistent with herding behaviour.

Concerning the model by Chang et al., we used the following formulas:

$$CSAD_t = \left(\sum_{i=1}^N |R_{i,t} - R_{m,t}| \right) / N$$

$$CSAD = a + b_1 r_m + b_2 [r_m] + b_3 r_m^2 + \epsilon$$

The beta estimations will be computed by Ordinary Least Square (OLS) method, aiming at providing unbiased (expected value of estimate equals true value) and consistent

estimates ²⁴. Additionally, estimation errors are not correlated with the betas. The statistical software mentioned below was used to produce descriptive statistics Tables for both the CSSD and CSAD values. The Durbin Watson d-statistic was calculated in each case. Furthermore, regression analysis was made for both set of values.

3.5. Software in use

The software in use was Microsoft Excel, version 2011 (Microsoft Corporation, Redmond, Washington, United States of America) and Stata, version 17 (College Station, Texas, United States of America). An earlier version of Stata was found to be reliable when performing calculations (Odeh et al., 2010). Additional calculations were made using EViews 12 software (London, United Kingdom).

²⁴ OLS minimizes the sum of squares, in order to create a linear function of a set of explanatory variables, in regard to the observed dependent variable. OLS makes the assumption that the dependent variable is (at least to some approximation) a linear function of the independent variables. Problems and pitfalls of OLS include the presence of outliers (which cause a disproportionately large effect on the result), the presence of non-linearities, the existence of too many variables, the situation of dependence among variables, a wrong choice of error function, the existence of unequal variances of the residuals over a range of measured values (heteroskedasticity), the selection of wrong independent variables, and the existence of noise (errors) in the independent variables.

4.0 Results

4.1 Data Overview

4.1.1 Descriptive Statistics

Data concerning the PSI 20 companies were extracted from the database indicated above, for the complete years 2019, 2020 and 2021. Missing data were filled manually as indicated above. The data concerning market returns are presented in Table 1. The number of observations was 769, corresponding to 18 different companies. The mean PSI 20 value observed is a positive, relatively small value, as could be expected, although some companies do observe a negative value for the mentioned time period.

Variable	N	Mean	p50	SD	Min	Max	Kurtosis	Skewness
Sonae	769	-.0127269	0	1.715746	-7.232969	9.736632	7.387516	.334082
Amorim	769	-.015728	0	1.609462	-7.87037	9.110867	7.604336	.2713712
BCP	769	.0945647	.1048218	2.517073	-15.9116	17.90175	9.113946	.1439628
EDP	769	-.0505119	0	1.710475	-9.048724	16.05755	16.40297	1.309796
EDPREN	769	-.1142146	-.1256281	1.998074	-7.008368	13.12127	8.152404	.7929372
GALP	769	.090027	.0665779	2.237012	-14.8184	19.78297	14.79902	.4948588
Jeronimo	769	-.0740985	-.0638978	1.604743	-9.298733	12.46422	15.48296	.6388576
MotaEngil	769	.0672438	.1362398	2.692224	-24.42589	17.85714	18.14923	-.4009801
NOS	769	.071195	.0864304	1.685771	-11.875	8.986486	10.81334	.0057455
Altri	769	.0308567	0	2.256094	-10.35281	15.81395	9.485952	.6358123
CTT	769	-.0319567	0	2.191355	-10.38835	12.6257	8.166636	.3600164
Ibersol	769	.083672	0	2.664063	-20.0627	29.43633	37.62198	.253603
Navigator	769	.0273466	-.0714286	1.828741	-8.862559	11.58594	8.024147	.4635546
Novabase	769	-.1000745	0	2.198652	-19.49686	16.29956	23.69527	-1.099812
Pharol	769	.127778	.1926782	2.203186	-14.08163	14.70588	10.42115	-.8862248
Ramada	769	.0385288	0	2.361742	-11.42857	22.72727	19.25128	.8284135
REN	769	.0009868	0	1.106756	-6.20985	10.50228	22.87164	1.874632
Samada	769	.0324946	0	1.946025	-22.13115	11.17936	28.50583	-1.525194
PSI20_retu~s	769	.0076856	0	1.07205	-7.255696	10.81263	28.6191	2.02936

Table 1. Descriptive statistics for the market return (percent values) of the PSI 20 index companies, for the period 2019-2021. N - observations. P50 –median. SD – standard deviation. Min- minimum value. Max – maximum value.

The mean and standard deviation for the PSI 20 in the three years under study are shown in Table 2, below, and the mean monthly values for PSI 20 are shown in Figure 1, also below.

The Supplementary Figure shows the monthly total number of cases of COVID-19 in Portugal, in calendar years 2019-2021.

	Mean PSI20 value	Standard Deviation
2019	5111.021	149.367
2020	4475.632	425.047
2021	5205.566	286.340

Table 2. Mean and standard deviation for PSI 20 index for calendar years 2019-2021.

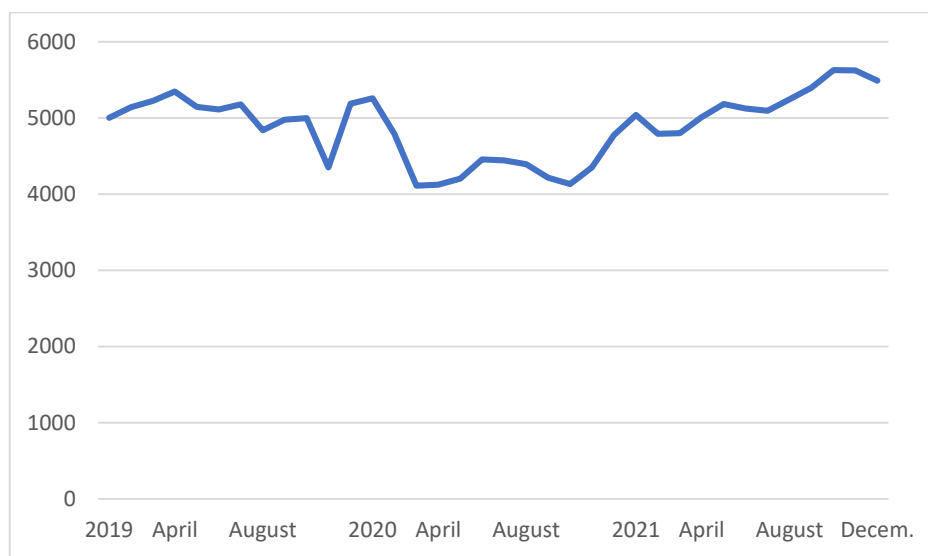


Figure 1. Line graph showing monthly mean values for PSI 20 index, calendar years 2019-2021. For source see text.

As can be seen in Table 2 and in Figure 1, PSI 20 index decreased during calendar year 2020, when compared to 2019, only to surpass the mean 2019 value during the course of 2021.

4.1.2 Autocorrelation and Correlation between Independent variables

Due to the time-series nature of the data used, it is meaningful to test for the presence of autocorrelation. This measure tests for the correlation degree between the variable in usage and a lagged version of the same variable of a previous time period, essentially if a daily value is dependent on the value of the previous day. Of course autocorrelation can

be tested for several orders, or past time periods considered, but for our purposes, testing for autocorrelation of order one or the immediate previous past value is sufficient. The Durbin-Watson statistic is one of the most common ways to test for this first order autocorrelation and, as seen below, it is in fact present and consequently our hypothesis tests are no longer valid unless corrected. In consequence of this, it was opted for the use of the Newey West robust estimator in order to validate the statistical inference.

Regarding correlation between independent variables, we observe in the table below a relatively low value regarding the dependent values of the CCSD method (right and left dummies). Concerning the CSAD method, low values are also observed with exception of the correlation between the variables ret^2 (return squared) and $retabs$ (return absolute value), which is of course to be expected since we are using the same original variable. In consequence of these results, there does not seem to exist strong indication of multicollinearity.

	LEFT_TAIL	RET	RET_2	RETABS	RIGHT_TAIL
LEFT_...	1	-0.4427086...	0.21062622...	0.40493095...	-0.0490943...
RET	-0.4427086...	1	0.34952521...	0.23644404...	0.55570246...
RET_2	0.21062622...	0.34952521...	1	0.82699770...	0.40895484...
RETABS	0.40493095...	0.23644404...	0.82699770...	1	0.54655247...
RIGHT...	-0.0490943...	0.55570246...	0.40895484...	0.54655247...	1

Table 3. Correlation between independent variables. Ret- return; ret_2 - return squared; $retabs$ - return absolute value.

4.1.3 Stationarity

A stationary time series possesses the quality of its properties being unaltered through time. Therefore, its mean, variance and autocorrelation structure remain unchanged throughout the time period, consequently rendering indifferent the moment selected to observe them. In the addendum below are the several Augmented Dickey Fuller (ADF) tests used, having all the null hypotheses being rejected, we conclude all variables are indeed stationary.

4.2 Main results

4.2.1 CSSD

Starting with the first methodology adopted, described in the paper written by Christie and Huang, we observe the two outputs presented below, regarding linear regression. The data are from the year 2019 and 2020-2021, respectively.

set to 0 (90% central interval). The `left_tail_dummy` represents what the standard deviation, on these left tail days, increases by on average in relation to the other “non-extreme” days. The `right_tail_dummy` represents what the standard deviation, on these right tail days, increases by on average in relation to the other “non-extreme” days.

4.2.2 CSAD

Regarding the second method utilized, we again observe below both outputs for the same time periods tested previously:

```
Regression with Newey-West standard errors      Number of obs   =      255
Maximum lag = 1                               F( 3,          251) =      36.08
                                              Prob > F         =      0.0000
```

CSAD	Newey-West		t	P> t	[95% conf. interval]	
	Coefficient	std. err.				
RET	-.0123848	.0181797	-0.68	0.496	-.0481891	.0234194
RETABS	.0123613	.0722331	0.17	0.864	-.1298989	.1546214
RET2	11.46482	3.391946	3.38	0.001	4.784515	18.14512
_cons	.0088026	.0003012	29.23	0.000	.0082095	.0093957

```
Regression with Newey-West standard errors      Number of obs   =      514
Maximum lag = 1                               F( 3,          510) =      33.61
                                              Prob > F         =      0.0000
```

CSAD	Newey-West		t	P> t	[95% conf. interval]	
	Coefficient	std. err.				
RET	-.0327837	.0205046	-1.60	0.110	-.0730677	.0075002
RETABS	.3906935	.0570107	6.85	0.000	.2786887	.5026983
RET2	-.978621	.5634535	-1.74	0.083	-2.085597	.1283545
_cons	.0091633	.0004147	22.10	0.000	.0083486	.009978

Table 5. Cross-sectional absolute deviation (CSAD) of returns, according to the method by Chang *et al.*, for the time periods under study. From top to bottom, 2019 and 2020-2021. For reference see text. Durbin Watson d-statistic values of 1.59 and 1.36 were obtained, respectively. For abbreviations, see previous table.

Initially, we observe the F (3,251) and F (3,514) both with p value < 0.001 indicating the models are globally significant.

Regarding the estimated coefficients, in specific the market return squared, we observe a positive and significant value (11.46381; 0.000) in the first 2019 regression. However, in the second 2020&2021 regression, we observe a negative value (-0.978621; 0.083) indicating non-significant results for significance levels of 1% and 5% but significant results for a significance level of 10% where the model would indicate the presence of herding. Again, due to the negative sign of the coefficient it is statistically significant that standard deviation decreases in the time period considered due to the herding behaviour. Applying the Christie & Huang method, with significance level 0.05 or 0.10, no herding was present in the years considered as a whole (Table 3). Using the Chang *et al.* method, on the other hand, with significance level 0.10, herding was present in the 2020-2021 period, but not in the year 2019 (Table 4).

4.3 Discussion

We found insufficient evidence to definitively establish the presence of herding during the COVID-19 pandemic in the Portuguese stock market (in 2020 and 2021), although we cannot exclude that it may have existed at a relatively limited degree, since only one of the methods used and only with a 0.10 significance level yielded a positive result. The present results do not validate the H1 hypothesis in a definitive way.

These results are in good agreement with our view, presented above, that in a financial system, herding may appear in some moments only to disappear at a later stage, since many of the factors at play are of an ever-changing character. Financial herding may be intermittent, not constant, although the factors leading to it are constant but of a variable intensity.

Why could there be herding in the pandemic period? Information imperfections could be acting in this context, both in what concerns the pandemic itself and, more importantly, concerning the impact on the economic and financial situations of individual companies – the fundamentals for many companies might be uncertain during the pandemic, due to uncertainty in the overall economy. Reputational considerations could also play a part in this setting, since a fear of an overall financial and stock market crash may have been relatively strong during this period, leading many actors to “hide in the herd”. Cascade phenomena could also be at play in this case, particularly involving international stock markets. Existing information flows in a relatively easy way, and so the financial and

stock market impact may have rapidly crossed from Asia to America and then to Europe, including Portugal, however with economic uncertainty, as laid out above.

The data now presented do not point at a major degree of herding in the setting under study. This could mean that institutional factors may have been sufficiently strong to prevent major financial system dysfunction, including the action of CMVM, the Eurosystem and the Rule of Law. Moreover, and as laid out above, further factors limiting herding could be the following: a broad diversity of trading styles by institutional investors (Lakonishok et al., 1992); a small sensitivity of the methods in use (Grinblatt et al., 1995), especially in the case of the Christie & Huang method, considered to be restrictive; the market following the rational asset pricing models at certain given times (Christie & Huang, 1995); more complete information disclosure and lesser degree of government intervention (Chang et al., 2000); economic and market recovery (Ferreruela & Mallor, 2021); stricter governmental actions that restricted mobility (unlike what happened with economic support measures) (Rubesam & Raimundo, 2022); the actions of CMVM and of Central Banks.

5.0. Conclusions

5.1. Main conclusions

In the present report, we studied the PSI20, the major Portuguese stock market index, in the years 2019-2021, in order to try to find evidence of herding behaviour from the part of investors. This period encompassed the first two years of the COVID-19 pandemic.

Two different but related methods were used, both of which take into consideration aggregate market activity data and search for herding towards the market consensus (Spyrou, 2013). Since neither of the two methods under use could be taken as “standard”, to which the second method would be compared, we used the two methods on a similar level.

When the three years under study were evaluated, the use of the Christie & Huang (1995) method failed to yield evidence of herding. By contrast, the use of the Chang *et al.* (2000) method allowed the finding of herding, but only with a 0.10 significance level, in the 2020 and 2021 period.

We therefore conclude that this is insufficient evidence to definitively establish the presence of herding during the COVID-19 pandemic in the Portuguese stock market (in

2020 and 2021), although we cannot exclude that it may have existed at a relatively limited degree.

In summary, both national and international institutions would appear to have been sufficiently strong to deal, to an important degree, with the strain placed on the Portuguese stock market. Although significant sectors of the Portuguese economic life were markedly hit by the pandemic, we witnessed no stock market crash, no bank runs and no popular upheaval. This may have been due, to a large extent, to the measures taken at both national and European levels. According to the present report, investors kept more attention to fundamentals than to what other people were doing.

The present report thus contributes to the knowledge of financial herding in the Portuguese stock market, during an important period, and up to end-2021, and may be of usefulness in the context of future pandemics or other types of financial strain.

5.2. Implications for stakeholders

The COVID-19 pandemic had a marked economic impact and triggered a global fall in financial markets. As presented in Table 2 and in Figure 1, the PSI20 index suffered a marked decrease during most of 2020, when compared both to 2019 and to 2021. However, this seems to have been predominantly due to the impact on economic activities, and not to financial herding.

The COVID-19 pandemic may have made, at the most, a relatively limited impact on financial herding in the Portuguese stock market, leading perhaps to a modest increase in the herding effect. This can be seen as important information for most stakeholders, including CMVM, individual and institutional investors, enterprises, managers, and the Portuguese citizens in general. Herding affects risk/return characteristic of assets and may have an impact on asset pricing models. Given the present results, specific strategies may be put in place by different stakeholders, in the event that a new global shock hits the financial world.

For traders, it may be of interest to understand that herding may exist in a similar setting, however it is likely to be limited or inexistent, even in the setting of a decrease in overall stock market value.

For CMVM, a particular degree of attention to this type of setting is in order, even if a general picture of a reasonable degree of efficiency is apparent. In any event, it could be ill advised to rest on past laurels.

For fund managers, the understanding that such a phenomenon may take place may guide investments, however keeping in mind the limited impact, in the current Portuguese setting.

In general, although investors may be interested in understanding herding as it might create profitable trading opportunities, in the Portuguese case, it may be best to stick to the analysis of the fundamentals of each stock – given that the impact of a pandemic is very different in different economic sectors.

5.3. Limitations

Several important limitations exist concerning this report. Only one database was used. Two different but related methods were used to estimate the presence of financial herding, the method of Christie & Huang (1995) and that of Chang et al. (2000). Other methods, such that of Lakonishok *et al.* (1992) or that of Sias (2004), could have yielded different results.

Limitations exist concerning the methods used. For instance, the Christie & Huang (1995) method employs a fraction of the returns to evaluate herding toward the market consensus (Spyrou, 2013), and is affected by the existence of outliers (Economou et al., 2011). Neither method includes a way to control for changes in fundamentals, and the Chang *et al.* method is believed to be biased against detecting herding (Bohl et al., 2017; Rubesam & Raimundo, 2022).

In the literature review, no attempt was made to evaluate all the reports published on the topics under study, given their large number. A comprehensive view on all the published reports is outside the scope of the present report.

5.4. Further research

Since the pandemic is still ongoing as this report is written, a longer period of time could be evaluated in the future, to better grasp the impact of the pandemic on the financial world, both in Portugal and in other markets. Other aspects of the financial world, including feedback trading (Kallinterakis & Ferreira, 2006) and anti-herding (an over-proportional increase in the level of return dispersion) (Bohl et al., 2017), could also be studied. Other periods of global economic stress, such as wars, can also be studied, and compared to the pandemic period.

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Supplementary Tables

Author(s)	Publication Year	Data Source	Sample of main results
		International	
Lakonishok et al.	1992	769 equity funds from USA	Pension fund managers herd relatively little in their trades in large stocks; there is some evidence of more herding in smaller stocks.
Christie & Huang	1995	New York Stock Exchange	Herding is not an important factor in determining equity returns during periods of market stress.
Chang et al.	2000	USA, Hong Kong, Japan, South Korea, and Taiwan	No evidence of herding in the USA and Hong Kong, partial evidence in Japan and evidence of herding for South Korea and Taiwan.
Gleason	2004	American Stock Exchange	Investors do not herd during periods of extreme market movements using Exchange Traded Funds.
Chiang & Zheng	2010	18 countries	Evidence of herding in advanced stock markets (except the USA) and in Asian markets. No evidence of herding in Latin American markets.
Shyu & Sun	2010	Taiwan Stock Market	Evidence of herding for institutional investors; the intensity of herding is negatively related to firm size.
Yao et al.	2014	China	Herding exists in the B-share markets, is more prevalent at industry-level, is stronger for the largest and smallest stocks, is stronger for growth stocks relative to value stocks, and is more pronounced under conditions of declining markets.
Chen	2021	35 countries	Intraday herding behaviour observed among global market investors; traders tend to follow each other from one country to another. Contribution of uninformed herding is approximately five times greater than that of its informed counterpart.
		COVID-19	
Wu et al.	2020	China	Herding behaviour significantly lower than usual during the COVID-19 period, and is more pronounced for upside market movement, lower market trading volume, and lower market volatility.
Aslam et al.	2021	UK, France, Spain, China, India, Japan	Herding more evident in European than in Asian markets, with a peak during the 2 nd quarter of 2020.
Espinosa-Méndez & Arias	2021	France, Germany, Italy, United Kingdom, Spain	Evidence that COVID-19 pandemic increased herding behaviour in the capital markets of Europe (studied up to June, 2020).
Kizys et al.	2021	72 countries from both developed and emerging economies	Evidence of investor herding in international stock markets (daily stock market data); short-selling restrictions exerted a mitigating effect on herding, as did a greater stringency from governments (as evaluated by the Oxford COVID-19 Government Response Tracker).

		Portugal	
Lobão & Serra	2002	Portuguese Mutual Funds	Strong evidence of herding, affecting both purchases and sales of stocks, with a stronger tendency among medium-cap funds and among funds with less stocks, with a decrease when the stock market is doing well or is more volatile.
Kallinterakis & Ferreira	2006	Portugal	Herding and feedback trading studied in the 1993-2005 period; combined significant presence of both for that period, with signs of clustering during the second half of the 1990s.
Economou et al.	2011	Portugal, Italy Spain and Greece.	Herding in the Greek and the Italian markets, not in the Spanish market; mixed evidence for the case of Portugal.
Ferreruela & Mallor	2021	Spain, Portugal	The study involved both the 2018 crisis and the COVID-19 pandemic. Herding with greater intensity in periods prior to the crisis, disappearing during the financial crisis and reappearing after it. Herding detected in Covid-19 times in Portugal. Herding observed in the market during the pandemic on high volatility days.

Supplementary Table 1. Selected examples of studies on financial herding, including empirical evidence. USA – United States of America. Studies are divided into International data, data from the COVID-19 pandemic period, and data concerning the country under study (Portugal). For references see text.

Altri SGPS	2.87%
Banco Comercial Português	8.85%
Corticeira Amorim	3.74%
CTT Correios de Portugal	3.97%
EDP	10.16%
EDP Renováveis	12.75%
GALP Energia-NOM	8.29%
Greenvolt	1.92%
Ibersol SGPS	0.71%
Jerónimo Martins, SGPS	15.41%
Mota Engil	0.98%
NOS SGPS	5.84%
Novabase, SGPS	0.53%
Pharol	0.39%
REN	7.76%
Semapa	1.97%
SONAE	7.50%
The Navigator Company	5.99%
Ramada	0.38%
Total	100.00%

Supplementary Table 2. Percent of the market capitalization of the PSI20 index for end December 2021²⁵.

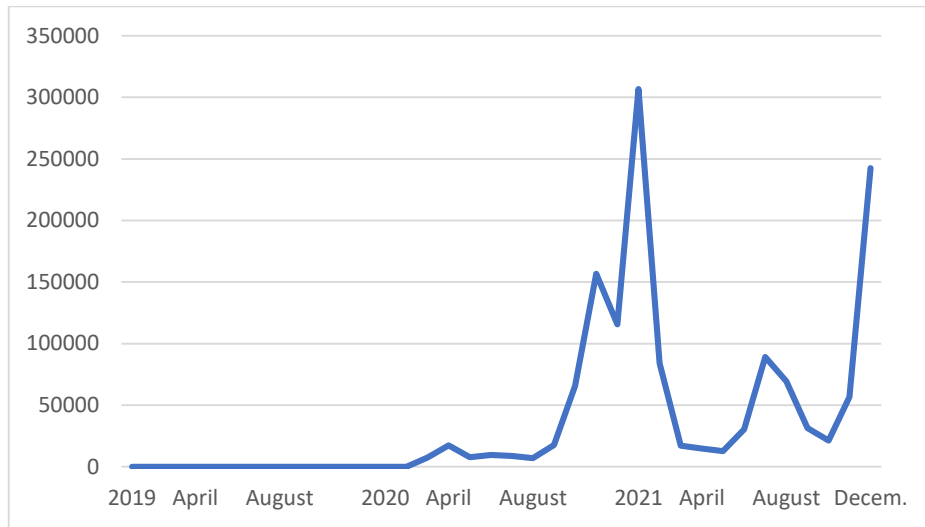
²⁵ Source: Comissão do Mercado de Valores Mobiliários. Available at: <https://www.cmvm.pt/pt/Estatisticas/EstatisticasPeriodicas/IndicadoresMensaisDoMercadoDeCapitaisPortugues/Pages/Janeiro2022.aspx?shpage=IndicadoresMensaisDoMercadoDeCapitaisPortugues>

	Thousand Euros	Percent
Banco Comercial Português, SA	553789	24.5
Banco de Investimento Global, SA	230649	10.2
CaixaBank, S.A. - Sucursal em Portugal	201708	8.9
Banco BPI, SA	189685	8.4
BEST - Banco Electrónico de Serviço Total, SA	120710	5.3
Banco ActivoBank, SA	115724	5.1
Banco Santander Totta, SA	111053	4.9
Banco Invest, SA	110014	4.9
Caixa - Banco de Investimento, SA	97878	4.3
Haitong Bank, SA	97225	4.3
Others	429536	1.9
Total	2257972	100

Supplementary Table 3. Orders received in stocks, by Comissão do Mercado de Valores Mobiliários (CMVM) in November, 2021, according to financial agent ²⁶.

²⁶ Source: CMVM, available at:

<https://www.cmvm.pt/pt/Estatisticas/EstatisticasPeriodicas/RecepcaoOrdens/Pages/novembro2021.aspx?shpage=RecepcaoOrdens>



Supplementary Figure. Line graph showing monthly values of total number of COVID-19 cases in calendar years 2019-2021 in Portugal. For source see text.

Addendum**Augmented Dickey Fuller (ADF) tests used**

Null Hypothesis: CSSD has a unit root

Exogenous: Constant

Lag Length: 3 (Automatic - based on SIC, maxlag=19)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-7.269007	0.0000
Test critical values: 1% level	-3.438672	
5% level	-2.865103	
10% level	-2.568722	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: CSAD has a unit root

Exogenous: Constant

Lag Length: 4 (Automatic - based on SIC, maxlag=19)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.753848	0.0000
Test critical values: 1% level	-3.438683	
5% level	-2.865108	
10% level	-2.568725	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: RIGHT_TAIL has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=19)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-24.53889	0.0000
Test critical values: 1% level	-3.438638	
5% level	-2.865088	
10% level	-2.568715	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LEFT_TAIL has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=19)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-24.98577	0.0000
Test critical values: 1% level	-3.438638	
5% level	-2.865088	
10% level	-2.568715	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: RET has a unit root
 Exogenous: Constant
 Lag Length: 1 (Automatic - based on SIC, maxlag=19)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-17.52125	0.0000
Test critical values: 1% level	-3.438649	
5% level	-2.865093	
10% level	-2.568717	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: RET_2 has a unit root
 Exogenous: Constant
 Lag Length: 7 (Automatic - based on SIC, maxlag=19)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.690533	0.0000
Test critical values: 1% level	-3.438716	
5% level	-2.865123	
10% level	-2.568733	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: RETABS has a unit root
 Exogenous: Constant
 Lag Length: 5 (Automatic - based on SIC, maxlag=19)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.914293	0.0000
Test critical values: 1% level	-3.438694	
5% level	-2.865113	
10% level	-2.568728	

*MacKinnon (1996) one-sided p-values.