



# KONFERENCIAKÖTET

## Conference Proceedings

**Nemzetközi tudományos konferencia  
a Magyar Tudomány Ünnepe alkalmából**  
International Scientific Conference  
on the Occasion of the Hungarian Science Festival

**Sopron, 2025. november 6.**  
6 November 2025, Sopron

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FENNTARTHATÓSÁGI ÁTMENET IDŐSZAKÁBAN**

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Szerkesztők / Editors:

RESPERGER Richárd, SZÉLES Zsuzsanna, TÓTH Balázs István

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# **Behavioral Finance for Rational and Sustainable Decision-Making Capital Markets - An Analysis of Investor Behavior Using the Example of Wirecard AG**

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## **Abstract:**

This paper discusses rational and sustainable decision-making, particularly in relation to the capital market, and how concepts from the field of Behavioral Finance can support this. The theoretical backgrounds and explanations (developed as part of a literature review) are illustrated by an analysis of investor behavior using Wirecard AG as an example. Using the event study methodology, a total of 60 events from the history of Wirecard AG between 2005 and 2020 were examined. Specifically, the question arises as to what form of market efficiency is present in this case, whereby the analysis has shown that it is the semi-strong form of information efficiency. Furthermore, the speed of information processing was examined, which has increased over time. In this context, the reaction of the capital market participants to the publication of different kinds of information is analyzed (distinction between ‘good news’ and ‘bad news’). It has been shown that positive reports initially had a slightly greater impact on Wirecard's share price than negative ones. This effect then reversed over time, and with an increasing number of critical reports (from January 2019 onwards), the ‘bad news’ led to stronger reactions in the share price. Finally, investor behavior is interpreted using explanatory approaches from Behavioral Finance in order to derive recommendations for action for a better, more sustainable and more rational decision-making.

**Keywords:** rational investment decisions, behavioral finance, investor behavior, event study, Wirecard AG

**JEL Codes:** G11, G41, G14

## **1. Introduction**

The concept of rational decision-making can be traced back to the 18th century in the history of economic thought. As early as 1776, A. Smith described the market participant as a rational actor who makes decisions based on sufficient information and is consistently driven by the maximization of individual utility (Smith, 1776). Over time, this idea evolved into the theoretical model of Homo oeconomicus which attributes specific characteristics and behavioral traits to human beings. Subsequently, concepts such as E. F. Fama's Efficient Market Hypothesis (EMH) were developed to describe the information-processing process in financial markets (Fama, 1970). Complementary to this, various mathematical methods (e.g. Game Theory) and theoretical frameworks (e.g. Behavioral Theory) have been established to model decisions that depend on the actions of other market participants (von Neumann & Morgenstern, 1944).

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Over the years, however, it has become evident that these theoretical models and constructs are only of limited applicability in real-world settings. Various criticisms have been raised against models of rational decision-making, such as the limited information-processing capacity of the human brain and the influence of emotional and social factors. Other economists, for instance, have developed alternative theories, including the concept of Bounded Rationality proposed by H. A. Simon (1972). More recent approaches are increasingly grounded in psychological and socio-economic foundations. The field of Behavioral Finance, for example, is characterized by the application of psychological and behavioral economic principles to explain capital market phenomena (Daxhammer & Facsar, 2018). Such approaches allow for the analysis and interpretation of partially irrational behavior among market participants, thereby helping to prevent future misjudgments and suboptimal decisions.

This publication first provides a concise overview of the concept of rational decision-making, including early theoretical foundations, alternative concepts, and more recent approaches. It then explains why the decisions made by market participants are not entirely rational in practice. In this context, the significance of E. F. Fama's (1970) EMH is highlighted, as it pertains to the informational efficiency of markets. In this context, 60 selected events in the corporate history of Wirecard AG were analyzed using the event study methodology in order to assess the impact of these events on the company's share price. This example aims to demonstrate that psychological factors play a role in decision-making and, as a result, erroneous decisions and potential financial losses may occur. Drawing on concepts from Behavioral Finance, various heuristics are presented to explain the partially irrational behavior of market participants in the case of Wirecard. Building on these findings, general recommendations are derived to promote more rational, informed and sustainable decision-making. The study concludes with a critical assessment of Behavioral Finance Theory addressing both its limitations and its practical relevance.

The central research question of this paper is therefore as follows: Which recommendations should capital market participants consider in order to make better, more rational, and sustainable (investment) decisions? Furthermore, the study examines the extent to which Behavioral Finance Theory contributes to understanding rational decision-making and where its potential limitations lie. In conducting the Wirecard event study, two underlying research questions were primarily addressed. These concerns, first, the assessment of market information efficiency in general (including the speed of stock price adjustment) and second, the share price reactions to both positive and negative news reports (for details, see chapter 3).

## **2. Literature Review**

### ***2.1. Rational Decision-Making***

As mentioned in the introduction, the first historically relevant publications on rational decision-making date back to the 18th century. With his seminal work in 1776, A. Smith laid the foundation for modern economics, characterizing the market participant as an actor guided by reason and self-interest (Smith, 1776). Another publication that can be assigned to the classical theories was authored by J. Bentham. The market participant is portrayed as a utility maximizing individual and the author outlines the theory of the so-called utilitarianism (Bentham, 1789). In the subsequent phases of economic thought, numerous academics have addressed this topic from various perspectives, and over the years, the theories, assumptions and concepts have been examined and further developed.

About 70 years later, J. S. Mill published a work in which he further developed the concept of rationality. According to J. S. Mill, rational action is no longer characterized solely by the maximization of utility but also encompasses morally reflective behavior (Mill, 1848). In another publication W. S. Jevons still describes the maximization of individual utility but also

elaborates the theory of marginal utility and emphasizes the importance of mathematical modeling in economics (Jevons, 1871). Furthermore, A. Marshall's publication should be mentioned, in which the author connects classical approaches with neoclassical ideas. Rational decision-making, therefore, involves not only objective information but also habits and subjective evaluations (Marshall, 1890). The work of J. von Neumann & O. Morgenstern also focuses on rational decision-making, defining rational behavior as consistent and goal-oriented action that takes into account the behavior of other agents - marking the beginning of modern game theory (von Neumann & Morgenstern, 1944). Finally, M. Friedman's publication must be noted, as it had a profound impact on the methodology of economic research. The author argues that a theory should not be evaluated by the realism of its assumptions but by the accuracy of its predictions (Friedman, 1953).

Against the backdrop of these rather classical approaches, the work of H. A. Simon deserves particular mention. In his 1955 publication, the author emphasizes the need to redefine the concept of rationality and proposes the integration of psychological factors into economic reasoning (Simon, 1955). In his subsequent book, H. A. Simon further explores various aspects of rational human behavior in depth (Simon, 1957). In 1972, H. A. Simon introduced the concept of so-called Bounded Rationality, arguing that market participants are unable to take all available information into account due to their limited information-processing capacity. Moreover, access to information may be restricted, and individuals are often required to make decisions within a limited time frame. Consequently, instead of selecting the optimal solution, they frequently opt for a merely satisfactory alternative (Simon, 1972).

In addition to the publications mentioned above, several other authors have examined the concept of rationality in relation to human decision-making behavior. L. Festinger, for instance, describes the phenomenon of cognitive dissonance (Festinger, 1962), while G. A. Akerlof focuses specifically on the issue of information asymmetry (Akerlof, 1970). J. Rawls links rational decision-making to ethical and societal considerations (Rawls, 1971), and G. S. Becker extends economic assumptions to other areas of life, such as family and education (Becker, 1976).

Overall, a clear trend can be observed: classical models (such as *Homo economicus*, perfect rationality and utility maximization) have been progressively expanded to include psychological and social factors, in order to depict the decision-making behavior of market participants as realistically as possible.

Furthermore, individuals are subject to various cognitive biases and systematic errors in reasoning. For instance, the availability heuristic suggests that decisions are based on information that is easily retrievable rather than on objective probabilities. Another key concept is Prospect Theory, developed by D. Kahneman & A. Tversky, which posits that the risks associated with an investment are evaluated differently depending on whether they are framed as potential gains or potential losses (Kahneman & Tversky, 1979).

Another relevant publication in the context of behavioral economics is authored by R. Thaler. He critically examines the presumed rationality of market participants and offers possible explanations for deviations from rational behavior, such as the endowment effect (Thaler, 1980). More recent contributions to this field include the work of E. Fehr & K. M. Schmidt, who integrate social preferences into economic decision-making models (Fehr & Schmidt, 1999). R. Shiller provides a comprehensive analysis of financial markets, focusing among other aspects on historical speculative bubbles (Shiller, 2000). Another key publication is by A. W. Lo, who argues that rationality and efficiency are not constant but vary depending on factors such as market conditions and risk structures (Lo, 2004). The Behavioral Finance Theory, including its emphasis on heuristics, has likewise been examined and critically discussed by various economists (Gigerenzer, 2008; Mathis & Steffen, 2015). A critical assessment of Behavioral Finance Theory will be presented in chapter 4.3 of this study.

## 2.2. Rationality of Markets

In chapter 2.1 above, the theoretical foundations of rational decision-making by market participants have been outlined. These foundations are central to the present study, as the objective is to develop recommendations for more rational and sustainable decision-making - particularly in the context of investment decisions. To arrive at such recommendations, an empirical investigation was conducted, beginning, however, from a different analytical standpoint.

In this context, the second relevant area is the rationality of markets, which includes different aspects. A market is generally considered rational when asset prices reflect all available information accurately and in a timely manner. This corresponds to the notion of an efficient capital market, which E. F. Fama defines as follows: “A market in which prices always fully reflect all available information is called ‘efficient’.” (Fama, 1970). In addition to this informational aspect of efficiency, several other factors are relevant in characterizing rational markets. These include, for example, the scope and limits of arbitrage, the assessment and compensation of risk, and market stability and the absence of speculative bubbles. For the purposes of the present analysis, however, the primary focus lies on the informational efficiency of capital markets. One of the most important theories in this context is E. F. Fama’s Efficient Market Hypothesis (EMH). The following section first outlines the economic foundations of the EMH before providing a more detailed discussion of the theory itself. Building on this, potential limitations and subsequent developments of the hypothesis are then summarized.

Similar to the rationality of market participants, the rationality of the market itself was examined at an early stage. An important foundation of the EMH is the so-called Random Walk Hypothesis, which posits that stock prices move randomly and that future price movements cannot be predicted using past price data. The first publication on this topic appeared as early as 1900, although it received little attention at the time (Bachelier, 1900). Years later, the idea was revisited when the author, analyzing economic time series, concluded that price changes are independent and not forecastable (Kendall & Bradford Hill, 1953). In the years that followed, various publications and empirical studies examined the predictability and randomness of price movements (Alexander, 1961; Mandelbrot, 1963; Roberts, 1959). The robustness of the Random Walk Theory was subsequently investigated in greater depth by several economists using advanced statistical methods (Fama, 1965; Lo & MacKinlay, 1988; Samuelson, 1965).

Building on this body of research and empirical evidence, E. F. Fama developed his Efficient Market Hypothesis, with the first major publication on the topic appearing in 1970. The following section provides a brief summary of the fundamental principles of E. F. Fama’s EMH.

The concept of information processing in capital markets concerns the extent to which asset prices incorporate all information available to market participants. According to Fama, prices in an efficient market must at all times reflect the information available to market participants. Building on this definition, Fama distinguishes three forms of market efficiency, each corresponding to a different level of information integration within asset prices (Fama, 1970).

- Weak-form efficiency: current security prices fully incorporate all historical price and volume information.
- Semi-strong form efficiency: in addition to past data, all publicly available information is reflected in current market prices.
- Strong-form efficiency: beyond past and publicly available information, even private or insider information is fully incorporated into market prices.

Even before E. F. Fama first formulated the EMH, several studies had been published that later came to be associated with the different forms of market efficiency. For example, an investigation by R. Ball & P. Brown focuses on the semi-strong form of informational efficiency by examining the impact of earnings announcements on security prices, (Ball & Brown, 1968) while M. C. Jensen analyzes the performance of investment funds and the relevance of insider information, thereby addressing the strong form of informational efficiency (Jensen, 1968).

Since its initial formulation, the EMH has been extensively examined, refined, and debated. E. F. Fama continued to engage with the ideas and criticisms surrounding the EMH, and six years later published another paper in which he reconsidered the theory from a different angle and addressed the critical position of S. F. LeRoy (1976) (Fama, 1976). In the following years, additional papers by E. F. Fama appeared, repeatedly revisiting the topic (Fama, 1991; Fama, 1998).

At this point, it is also important to refer once again to the publication by D. Kahneman & A. Tversky. Although the authors primarily examine the decision-making behavior of market participants, Prospect Theory simultaneously provides a potential explanation for market anomalies (Kahneman & Tversky, 1979). Another relevant publication is by S. J. Grossman & J. E. Stiglitz, who argue against the notion of fully informationally efficient markets: “We have argued that because information is costly, prices cannot perfectly reflect the information which is available, since if it did, those who spent resources to obtain it would receive no compensation.” (Grossman & Stiglitz, 1980, p. 405). Another economist who argues against the EMH is R. Shiller, who empirically examines stock price fluctuations (Shiller, 1981). W. F. M. De Bondt & R. Thaler likewise investigate the market’s reaction to unexpected events and document systematic overreactions, which again contradicts the notion of fully rational markets (De Bondt & Thaler, 1985). Two additional influential publications from the 1990s further contribute to this line of research. First, the existence of excess returns generated by momentum strategies is documented (Jegadeesh & Titman, 1993). Second, the limits to arbitrage (and the resulting market anomalies) are analyzed (Shleifer & Vishny, 1997).

Similar to the case of individual decision-making, psychological and social factors also play a role in shaping market rationality. For example, under- and overreactions can be explained through overconfidence and biased self-attribution (Daniel et al., 1998). In 2004, A. W. Lo combined the classical EMH with elements of Behavioral Finance and developed the so-called Adaptive Market Hypothesis (Lo, 2004). A recent example of research in this area is provided by the publication of N. Barberis, L. J. Jin & B. Wang, who examine capital market efficiency and link Prospect Theory to various stock market anomalies (Barberis et al., 2021).

All in all you could say that among economists, there is a broad consensus that the strong form of market efficiency does not hold in practice, as certain information (such as internal company data) is not accessible to all market participants (Grossman & Stiglitz, 1980). By contrast, the validity of the weak and semi-strong forms remains contested: while some studies provide empirical support for these forms, others present evidence challenging their applicability (Lo & MacKinlay, 1988; Malkiel, 2003; Rösch et al., 2017).

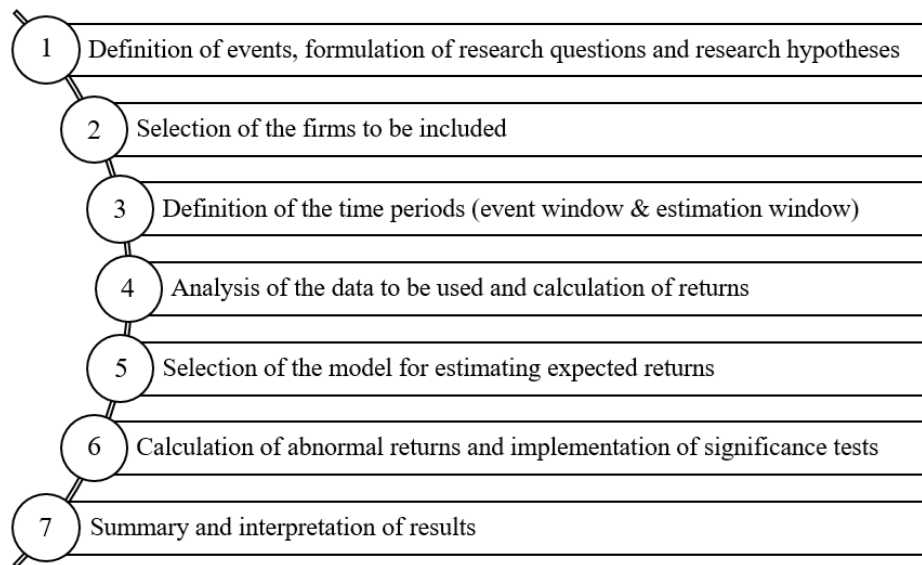
### **3. Methodology and Data Sources**

In the preceding chapters, the theoretical foundations of capital market rationality (particularly with regard to information processing) and the principles of rational decision-making by market participants were outlined. Building on this framework the semi-strong form of information efficiency defined above can be empirically examined by using the event study methodology. This approach enables researchers to quantify the impact of various events (particularly the release of information) on a firm’s value, as reflected in its share price. S. J. Brown & J. B. Warner define the subject of an event study as follows: “The impact of particular types of firm-specific events (e.g., stock splits, earnings reports) on the prices of the affected firms’ securities has been the subject of a number of studies. A major concern in those ‘event’ studies has been to assess the extent to which security price performance around the time of the event has been abnormal - that is, the extent to which security returns were different from those which would have been appropriate, given the model determining equilibrium expected returns.” (Brown & Warner, 1980).

The following section describes the methodological approach employed in the Wirecard event study, which was conducted to examine the informational efficiency of the capital market.

For 60 selected events in the company's history, the processing of information was analyzed as reflected in the share price, and the results were used to draw conclusions regarding investor behavior among market participants (see also Berner & Stockhaus, 2024; Berner & Stockhaus, 2025). These insights, in turn, provide the basis for deriving recommendations aimed at fostering more rational and sustainable decision-making.

Although the specific procedures employed in an event study may vary slightly depending on the individual case, the general approach remains consistent and typically follows the steps outlined below.



**Figure 1: Implementation of an Event Study**

Source: Adapted from MacKinlay (1997); Holler (2016); Gehrke (2022)

In the following sections, the methodological approach of the Wirecard event study (as illustrated in *Figure 1*) is briefly described. The analysis was conducted using R and RStudio.

In implementing an event study, the first step involves defining the events to be examined, including the precise event date - also referred to as the event day (MacKinlay, 1997). For the Wirecard event study, 60 events from the company's history were selected, ranging from E1 on 08.09.2005 to E60 on 18.06.2020 (see *Attachment*). In addition, the underlying research questions and hypotheses are formulated:

- *Research question and hypothesis 1:* How can the informational efficiency of the capital market in the case of Wirecard AG be assessed, and does the degree of market efficiency change over the course of the accounting scandal? It is assumed that, for Wirecard AG, the semi-strong form of market efficiency applies throughout the observation period. Furthermore, it is conceivable that, as the company's public profile increased, the speed of price adjustment likewise accelerated over time.
- *Research question and hypothesis 2:* How does the share price of Wirecard AG react to positive and negative media reports (from the company's perspective)? In this context, it is hypothesized that positive reports (good news) initially exert a stronger absolute impact on Wirecard's share price, as negative reports (bad news) are at first largely dismissed by investors. Over time, however, this effect may reverse and with an increasing number of negative reports, their influence on the share price could intensify, reflecting a growing base of critical investors and a loss of confidence in Wirecard AG.

In the second step, firms to be included in the sample are selected based on various criteria (e.g., belonging to a specific industry or inclusion in a selected stock index). As the present study focuses exclusively on Wirecard AG, the sample in this case comprises only a single firm (MacKinlay, 1997).

In the third step, the implementation of an event study requires the defining of two distinct time periods:

- Event window: The event window typically spans only a few days and includes the event day, which generally lies at the center of the window (MacKinlay, 1997). In practice, event windows commonly cover 1, 3, 5, or 11 days (Holler, 2016). For the Wirecard event study, a 5-day event window was defined.
- Estimation window: The estimation window is considerably longer than the event window, usually ranging between 100 and 250 trading days in empirical applications (Gehrke, 2022). This period immediately precedes the event window and is used to estimate the expected (or normal) returns (MacKinlay, 1997). In the Wirecard event study, a 250-day estimation window was used.

For the implementation of an event study, both the historical share price data for the firms included in the sample and the price data of a stock market index serving as the market benchmark are required. In the fourth step, the daily closing prices of Wirecard AG and the EURO STOXX 50 index were obtained from the financial database Refinitiv (Refinitiv, 2023). To model the expected returns within the event window, daily returns for both the stock and the market index are required. These can be calculated using either continuous returns or discrete returns. In empirical research, continuous returns are typically preferred, as they exhibit slightly more favorable statistical properties (Holler, 2016). Since the event study methodology relies on various mathematical and statistical techniques, the underlying dataset must satisfy certain statistical assumptions. Compliance with these requirements is verified through descriptive and exploratory analyses. In this study, the continuous returns were subjected to a range of graphical and computational tests, which confirmed that the dataset was suitable for conducting an event study (Holler, 2016).

In the fifth step of the event study, the model for estimating expected returns is selected. In general, a distinction is made between statistical and economic models. For the Wirecard event study, the so-called market model was employed, which is also the most widely used approach in empirical research (Holler, 2016). The market model assumes a linear relationship between the returns of a security and those of the overall market (represented by a market index). The expected return  $E(R)$  of security  $i$  at time  $t$  is calculated as follows:  $E(R_{it}) = \alpha_i + \beta_i * R_{mt}$  (where  $\alpha_i$  = unsystematic risk of the security,  $\beta_i$  = systematic risk of the stock,  $R_{mt}$  = market return) (MacKinlay, 1997).

Following the estimation of expected returns, the sixth step involves calculating the abnormal returns. The abnormal return (AR) for security  $i$  at time  $t$  is determined as the difference between the actual observed return and the expected return:  $AR_{it} = R_{it} - E(R_{it})$  (where  $R_{it}$  = actual observed return) (Holler, 2016). Subsequently, the results are subjected to various statistical significance tests. In this context, a distinction is generally made between parametric (distribution-dependent) and non-parametric (distribution-free) test procedures. Within the framework of the event study, this allows an assessment of whether a given event had a statistically significant impact on Wirecard's share price - and, if so, on which specific day within the event window (Gehrke, 2022). In the Wirecard event study, abnormal returns were tested using both the parametric t-test and the non-parametric CR-test, with t- and p-values computed at the significance level of  $\alpha = 5\%$ .

In the seventh and final step, the results are summarized and interpreted. Before these are presented in detail in chapter 4, an illustrative explanation of the calculations is provided using event 32 (30.01.2019 - first critical report in the Financial Times) as an example.

**Table 1: Results for Event 32 (30.01.2019) & t-test**

Date	Abnormal Return (AR)	Standard Error (se)	t-test t-value	t-test p-value
28.01.2019	0.00822088	0.02443023	0.33650447	0.73677504
29.01.2019	-0.01093497	0.02443023	-0.44759981	0.65483276
30.01.2019	-0.12384477	0.02443023	-5.06932400	0.00000078
31.01.2019	-0.02464971	0.02443023	-1.00898378	0.31396583
01.02.2019	-0.24277646	0.02443023	-9.93754130	0.00000000

Source: Own representation

Table 1 shows that the abnormal return (AR) on the event day (30.01.2019) amounts to -0.12384477, while the standard error (se) remains constant across the entire event window (0.02443023). For the event day, this yields a t-value of -5.06932400 and a p-value of 0.00000078. As the p-value is substantially below the chosen significance level of 5%, the event on 30.01.2019 had a statistically significant impact on Wirecard's share price. Furthermore, two days after the event day, a similarly large negative abnormal return is observed, again with a p-value below 5%. However, it should be noted that 01.02.2019 also corresponds to the event day of event 33 (second critical report in the Financial Times), meaning that the event windows overlap in this instance. Consequently, for event 33, a statistically significant effect on Wirecard's share price is likewise observed on 01.02.2019.

#### 4. Results and Findings

In the following chapters, the results of the Wirecard event study are presented, and the two research questions are addressed. Furthermore, investor behavior in the case of Wirecard AG is interpreted using various heuristics from the field of Behavioral Finance.

To answer the research questions, the events were divided into two distinct time sections:

- Time section 1: E1 on 08.09.2005 (acquisition of XCOM Bank AG) (Stöckl, 2005) to E31 on 05.09.2018 (Wirecard AG's inclusion in the DAX index) (Deutsche Börse, 2018).
- Time section 2: E32 on 30.01.2019 (first critical report in the Financial Times) (McCrum & Palma, 2019) to E59 & E60 on 18.06.2020 (insufficient audit evidence for funds in trustee accounts and the dismissal of J. Marsalek) (Wirecard AG, 2020; Stöckl, 2020).

Furthermore, a distinction was made between positive reports (good news) and negative reports (bad news), with the assessment conducted from Wirecard's perspective. It should also be noted that four of the 60 events could not be included in the final analysis (E3, E24, E26, and E42). The reason for this is that, although the events occurred at the respective points in time, no explicit announcement was made on the corresponding event day (the reports were published only retrospectively). Consequently, these events could not have had any impact on the share price within the event window.

##### 4.1. Capital Market Efficiency in the Wirecard Case

The first research question of the event study concerns the assessment of capital market informational efficiency in the case of Wirecard AG. In addition, it addresses whether market efficiency – specifically, the speed of information processing – changed over the course of the accounting scandal. To answer this question, the abnormal returns on the event day ( $t = 0$ ) and the two subsequent days ( $t = 1$  and  $t = 2$ ) were examined. For each event, it was then analyzed on which day within the event window the corresponding market reaction occurred (i.e., a positive abnormal return for good news and a negative abnormal return for bad news). For event

32, for example, the publication of a critical report in the Financial Times is considered a negative event from Wirecard's perspective. *Table 1* shows that the abnormal return is already negative on the event day, so  $t = 0$ .

Using the event study methodology, it is generally possible to test for the semi-strong form of market efficiency. In the case of Wirecard AG, it can be concluded that publicly available information is, in most instances, efficiently incorporated into the share price, to some extent with a slight delay. Considering all events, a corresponding market reaction is observed no later than two days after the event day. Although the results are not statistically significant for every individual event, the semi-strong form of informational efficiency appears to hold in the case of Wirecard AG. The conclusion that semi-strong informational efficiency can be observed in this context is derived from the analysis of Wirecard's share price dynamics. Nevertheless, it is essential to consider more thoroughly whether the large-scale accounting fraud uncovered at Wirecard may, in fact, constitute evidence of market failure and pronounced information asymmetries. Addressing this issue would require a closer examination of the inability of institutions and market participants to identify these irregularities at an earlier stage. The absence of timely detection may also be linked to cognitive heuristics and systematic biases, which will be discussed below.

The second part of the research question concerns the speed of the share price reaction to the release of new information. To address this question, the day within the event window ( $t = 0 / t = 1 / t = 2$ ) on which the corresponding price reaction occurred is analyzed. *Table 2* provides a summary of the results.

**Table 2: Market Efficiency and Speed of Price Adjustment (Wirecard AG)**

Time Period Events	Time Section 1 E1 - E31		Time Section 2 E32 - E60	
Share Price Reaction after ... Days	Number of Events	% of Events	Number of Events	% of Events
$t = 0$	15	48.39%	24	82.76%
$t = 1$	8	25.80%	3	10.34%
$t = 2$	5	16.13%	1	3.45%
Excluded	3	9.68%	1	3.45%
Ø Duration of Price Adjustment	0.64 days		0.18 days	

Source: Own representation

First, the events were divided into the two previously defined time sections. In the second step, they were further segmented according to the number of days from the event day until the corresponding share price reaction occurred ( $t = 0 / t = 1 / t = 2$ ). *Table 2* shows that, in the first period, 15 events exhibited a market reaction already on the event day, corresponding to 48.39% of events. In the second time period, this number rises to 24 events (82.76%), indicating a considerably faster adjustment of share prices in response to the release of new information. This is further reflected in the average duration until price adjustment (time section 1 = 0.64 days; time section 2 = 0.18 days). Thus, the initial hypothesis (that new information is incorporated into share prices more quickly over time) can be confirmed in this case. The more efficient processing of new information in the share price may, for example, be explained by the increasing public profile of Wirecard AG.

#### 4.2. Share Price Reaction to Positive and Negative News

The second research question concerns the different types of reporting, specifically whether, from Wirecard AG's perspective, the coverage is positive or negative. In this context, the extent to which new information affected Wirecard's share price was analyzed, with the informational

impact measured by the magnitude of the abnormal return (i.e., the larger the absolute value of the abnormal return, the greater the effect). *Table 3* provides a summary of the results for research question 2.

**Table 3: Share Price Reactions Wirecard AG (Good News vs. Bad News)**

Time Period Events	Time Section 1 E1 - E31	Time Section 2 E32 - E60
	$\Sigma$ 20 events	$\Sigma$ 13 events
<b>Good News</b>	$\emptyset$ abnormal return: 0.037596	$\emptyset$ abnormal return: 0.076731
	median abnormal return: 0.020633	median abnormal return: 0.070090
	$\emptyset$ days price adjustment: 0.80 days	$\emptyset$ days price adjustment: 0.23 days
	$\Sigma$ 8 events	$\Sigma$ 15 events
<b>Bad News</b>	$\emptyset$ abnormal return: -0.036619	$\emptyset$ abnormal return: -0.221831
	median abnormal return: -0.019881	median abnormal return: -0.104219
	$\emptyset$ days price adjustment: 0.25 days	$\emptyset$ days price adjustment: 0.13 days

Source: Based on own representation

*Table 3* shows that the events were first assigned to the two defined periods and subsequently categorized as either good news or bad news. For each event, the day within the event window on which the corresponding share price reaction occurred ( $t = 0 / t = 1 / t = 2$ ) was then determined, and the abnormal return for that day was included in the subsequent calculations. For both periods and types of reporting, various summary statistics were calculated, including the mean and median of the abnormal returns, as well as the average number of days to the price reaction.

A first observation from *Table 3* is that, in the first period, considerably more positive reports (20 events) were published than negative company announcements (8 events). The average abnormal returns (in absolute value) are roughly similar for good news and bad news (0.037596 for good news and 0.036619 for bad news). In this period, good news therefore appears to have had a slightly greater impact on Wirecard's share price than bad news. This initial observation is further supported by the median abnormal returns (median AR of 0.020633 for good news and 0.019881 for bad news). One possible explanation is that market participants initially maintained a high level of confidence in Wirecard AG, leading to a stronger reaction to positive announcements than to negative ones. Moreover, external institutions (e.g., BaFin) frequently acted in Wirecard's favor during this period (e.g., market manipulation investigations by BaFin as short-seller attacks on Wirecard were suspected).

In the second period, more pronounced differences in the magnitude of the average abnormal returns are observed (0.076731 for good news and 0.221831 for bad news). As initially expected, negative reports now exert a stronger impact than positive announcements, a trend that is also confirmed by the median ARs (0.070090 for good news and 0.104219 for the median absolute value of bad news). With the increasing frequency of negative reports (particularly from the Financial Times) the absolute size of the negative abnormal returns also rises. Market participants appear to have become more critical of Wirecard AG, and the release of bad news accordingly triggers a stronger share price reaction than good news.

In addition to the magnitude of abnormal returns, research question 2 examines the time taken for the corresponding share price reaction to occur (measured as the average number of days until a price adjustment). In the first period, it takes, on average, 0.80 days for positive news to be reflected in the share price, whereas for negative news, the average is only 0.25 days. A similar pattern is observed in the second period, with an average adjustment time of 0.23 days for good news and 0.13 days for bad news. In summary, negative corporate announcements were generally incorporated into Wirecard's share price more quickly than positive reports.

### 4.3. Reference to Various Heuristics from the Field of Behavioral Finance

At the conclusion of chapter 4, the results of the event study described above are related to various heuristics and cognitive biases from the field of Behavioral Finance. This aims to interpret and explain investor behavior. Heuristics are understood as mental shortcuts or rules of thumb that enable quick decisions or conclusions in a complex environment, and under time pressure. Fundamentally, heuristics can have either an emotional or cognitive origin and can be situated within different stages of the information and decision-making process (information perception, information processing / evaluation, investment decision) (Daxhammer & Facsar, 2018). *Table 4* provides an overview of five selected heuristics that can be applied to the Wirecard case.

**Table 4: Heuristics in the Wirecard Case**

Heuristic	Origin	Phase	Explanation
Availability heuristic	Cognitive	Information perception	Positive German-language reports (e.g., internal ad-hoc announcements) were more easily accessible than negative English-language reports (e.g., external coverage in the Financial Times) and were therefore more frequently noticed.
Selective perception	Cognitive	Information perception	Investors focused on positive news, which led to comparatively higher share price relevance in the early stages of the company's existence than negative reports.
Framing effect	Cognitive	Information perception	Investors' risk perception is influenced by the way information is presented. Positive reporting, as well as discussions and occasionally euphorically phrased growth prospects, affected the behavior of Wirecard's investors.
Herding behavior	Emotional	Information perception	Investors are influenced by the opinion of the majority and do not conduct an independent, objective analysis of the available information. Although critical reports on Wirecard AG increased from 2015 onwards, the share price initially continued to rise, and investors continued to invest.
Reversal of risk preference	Emotional	Information processing	The stock moved from a profit position (risk-averse behavior) to a loss position, and investors' attitudes shifted towards risk-seeking. As a result, Wirecard shares were retained and not sold even during further losses.

Source: Own representation, adapted from Daxhammer & Facsar (2018); Orgeldinger (2022)

In general, the economic phase of Behavioral Economics and, subsequently, Behavioral Finance can be traced back to the 1980s. This period is characterized by the integration of psychological and behavioral-economic principles into the explanation of capital market phenomena (Daxhammer & Facsar, 2018). Behavioral Finance thus provides a means to address several limitations of classical models (for example, the assumption of fully rational decision-making by market participants). At the same time, however, Behavioral Finance entails its own set of constraints. The following section summarizes several central considerations and lines of argumentation on both sides and refers to selected publications by various scholars in economics and finance.

As noted at the outset, Behavioral Finance enables a more realistic modeling of human decision-making and thus offers a more empirically grounded alternative to many classical approaches. By incorporating psychological components (e.g., emotions, biases, heuristics), it becomes possible to explain systematic deviations from theories such as Expected Utility Theory or Bayesian updating. As an alternative framework, D. Kahneman & A. Tversky developed Prospect Theory (Kahneman & Tversky, 1979), and W. F. M. De Bondt & R. Thaler provided

empirical evidence of overreactions in capital markets, which further supports the role of psychological distortions (De Bondt & Thaler, 1985). Moreover, various heuristics and cognitive biases can be used to account for observed market anomalies. A prominent example is the Post-Earnings-Announcement-Drift, first documented in 1968 by R. Ball & P. Brown. Their study showed that stock prices tend to rise for weeks or even months after an earnings announcement - contradicting the notion of immediate and complete information processing as posited by the Efficient Market Hypothesis (Ball & Brown, 1968). R. A. Olsen also examines over- and underreactions as well as herding behavior (Olsen, 1998). Likewise, N. Barberis, A. Shleifer, & R. Vishny develop a model to explain mispricing, specifically overreaction and underreaction patterns (Barberis et al., 1998). In addition, more extreme capital market phenomena (such as speculative bubbles and crashes) can be accounted for using Behavioral Finance approaches (Shiller, 2000; Shiller, 2003). Behavioral Finance also deepens the understanding of decision-making processes, which can be valuable for banks, insurance companies, and regulatory institutions. For example, portfolio recommendations can be optimized accordingly, and robo-advisors can be programmed and implemented based on behavioral insights. Financial education programs may likewise be designed using evidence from Behavioral Finance.

Despite these advantages and opportunities, Behavioral Finance also entails several limitations. The most frequently cited criticism is that Behavioral Finance does not constitute a unified theory; rather, it consists of a collection of isolated biases and models. Furthermore, heuristics, for instance, are primarily suitable for explaining observed anomalies *ex post*, while their capacity to generate reliable predictions is limited (Barberis & Thaler, 2003; Roßbach, 2001). One potential explanation lies in the heterogeneity of psychological effects and biases. These vary considerably across individuals, contexts, and cultures, making the integration of psychological factors into general traditional models (e.g., CAPM or multifactor models) challenging.

Another limitation arises from methodological issues in empirical research. In his 1977 publication, R. Roll argues that widely used testing procedures are prone to error and that several apparent contradictions may be attributable to these methodological shortcomings (Roll, 1977). E. F. Fama has also published extensively on this topic (partly in collaboration with co-authors). For example, five risk factors (pertaining to stock and bond returns) were identified that can account for a large number of anomalies, thereby reducing the need for psychological explanations (Fama & French, 1993). In another study, E. F. Fama placed particular emphasis on long-term return anomalies, concluding that the assumption of market efficiency remains robust in this context (Fama, 1998). Empirical research also faces challenges stemming from so-called Data-Snooping, which refers to the repeated use or examination of a dataset to identify patterns, models, or hypotheses. This practice leads to statistical distortions because the resulting findings generally lack external validity (White, 2000). In the context of Behavioral Finance, this presents a significant challenge, as the reliability of results (such as the existence of anomalies) must be critically reassessed (Sullivan et al., 1999). Finally, the ability of market mechanisms to offset individual irrationality is often cited as an argument against Behavioral Finance. The actions of a few irrational market participants are typically insufficient to induce persistent mispricing, as short-term over- or underpricing would, for instance, be corrected by arbitrageurs. However, counterarguments must also be considered, such as the various limits to arbitrage (Shleifer & Vishny, 1997).

In summary, Behavioral Finance represents a significant extension of traditional financial theory by systematically explaining empirically observed decision-making errors and market anomalies, and by developing more realistic models of individual behavior. At the same time, it is frequently criticized for its lack of a unified theoretical framework and the limited predictive power of its models. Additional challenges arise from the risk of methodological distortions and from the difficulty of incorporating individual irrationality into broadly consistent market models.

Moreover, the future development of Behavioral Finance Theory remains difficult to predict. As early as 1999, R. H. Thaler forecasted the eventual end of Behavioral Finance - not because its ideas and assumptions would lose relevance, but because he expected its core concepts (particularly psychological factors) to become routinely integrated into mainstream financial theory. In R. Thaler's view, Behavioral Finance would no longer need to exist as a distinct field once its insights had been fully absorbed into standard finance (Thaler, 1999). More recent publications examine, for example, the opportunities and limitations of the theory (Hirshleifer, 2015; Thaler, 2016). In another contribution, N. Barberis, L. J. Jin, & B. Wang develop a new asset pricing model grounded in the core assumptions of Prospect Theory, that accounts for 23 well-known stock market anomalies. The model is more suitable for explaining certain anomalies (e.g., momentum and volatility anomalies) and less suitable for others (e.g., value and size anomalies). Overall, the model is a noteworthy advancement, as it links a classical asset-pricing framework with the psychological elements of Prospect Theory, enabling a robust explanation of many anomalies. Based on the findings, one may further infer that investors' subjective risk perception is a central determinant of several anomalies. A deeper understanding of risk perception could therefore improve the predictability of anomalies - or potentially even contribute to their avoidance (Barberis et al., 2021).

## **5. Conclusions and Suggestions**

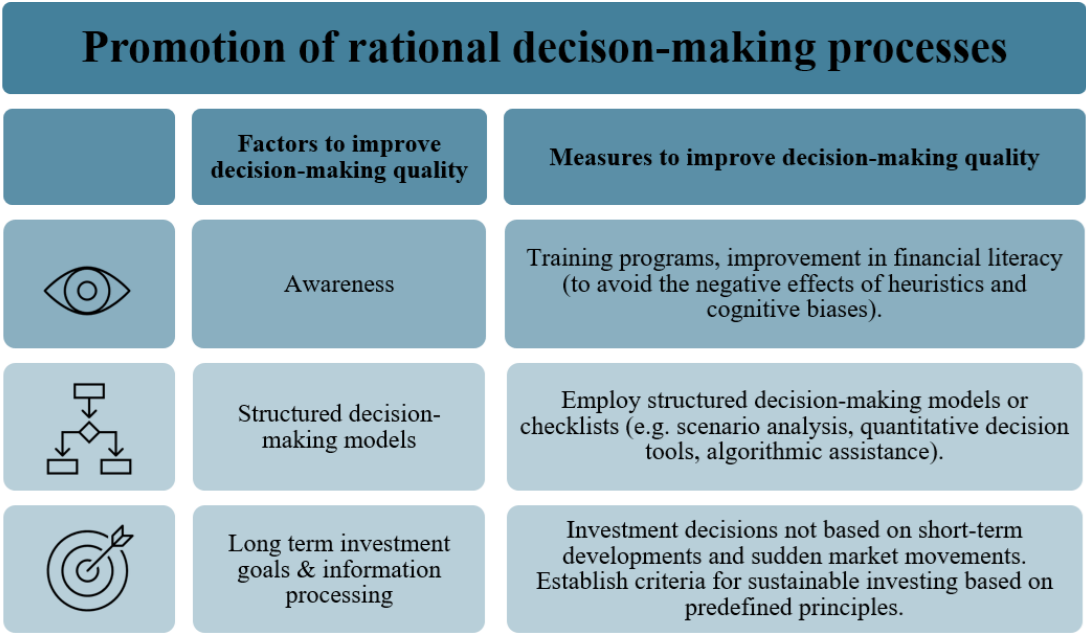
In summary, (capital) market participants do not make fully rational decisions. There are several reasons for this. On the one hand, information availability is limited (e.g., insider information). At the same time, decision-makers are confronted with vast amounts of information, resulting in numerous alternatives and increased decision complexity. Moreover, the information-processing capacity of (capital) market participants is limited, and decisions often must be made under time pressure. For these reasons, individuals subconsciously rely on various heuristics to simplify decision-making, which in turn implies that psychological and social factors play a significant role.

Furthermore, it should be noted that information processing in (capital) markets is neither fully rational nor fully efficient. As a result, classical theories have only limited applicability in practice, and contemporary approaches (such as Behavioral Finance) must be considered alongside traditional frameworks. On this basis, certain irrational decisions and market anomalies can be explained and potentially even avoided in the future. The following section presents a selection of recommendations aimed at fostering better, more sustainable, and more rational investment decisions.

### ***5.1. Recommendations for Better, more Sustainable and Rational Investment Decisions***






The first recommendation concerns the promotion of rational decision-making processes (see *Figure 2* below). In this context, it is essential to first raise awareness of the existence of heuristics and cognitive biases. Training programs or workshops for retail investors could address common heuristics explicitly. The use of reliable online sources for financial and investment guidance (such as videos, podcasts or other educational content) may also be beneficial. In this context, measures related to financial literacy must also be mentioned, as this area is gaining increasing importance and is becoming an ever more frequent subject of scientific investigation (Goyal & Kumar, 2020; Ingale & Paluri, 2022; Kaiser & Lusardi, 2024; Stolper & Walter, 2017). Furthermore, employing structured decision-making models or checklists as decision aids can support more deliberate choices. Scenario analysis can be used to outline potential future developments and systematically evaluate them with respect to risks and returns. Another possibility is the use of quantitative decision support tools, including financial and valuation models as well as algorithmic assistance, such as robo-advisors. Finally, investors should focus on long-term investment goals and strategies rather than short-term developments and market

reactions. Integrating sustainability criteria into one’s investment approach may also be a worthwhile consideration.



**Figure 2: Recommendations – rational decision-making processes**  
 Source: Own representation





The next area focuses specifically on dealing with various heuristics and biases, as well as on measures that can help mitigate them (see *Figure 3*). To counteract the availability heuristic, it is advisable to use diverse information sources as well as data aggregation tools that collect and consolidate information from multiple datasets. Examples that can enhance informational diversity include financial data platforms, news aggregators, and AI-driven tools. To avoid selective perception, organizations and investors can implement so-called devil’s advocate processes to deliberately consider opposing information and viewpoints. Here as well, the use of structured decision-making models can support a more systematic evaluation of alternatives. With respect to the reversal of risk preference, it is recommended to define an exit strategy in advance. Once a specific metric exceeds or falls below a predetermined threshold, the investment is sold to limit loss aversion. Conducting an objective performance analysis based on measurable indicators and comparisons (both over time and across different investments) represents an additional mitigating measure. To reduce susceptibility to framing effects, the linguistic presentation of reports should be critically examined. From a corporate perspective, information should always be communicated in a standardized and neutral manner. To prevent herding behavior, the individual competencies of market participants should be strengthened. Moreover, algorithmic tools that prioritize fundamental values over general market sentiment may be employed.

Measures to deal with various heuristics & biases		
	Availability heuristic	Use diverse information sources & data aggregation tools (financial data platforms, news aggregators, AI-tools).
	Selective perception	Devil's advocate processes to consider opposing information & use of structured decision-making models.
	Reversal of risk preference	Define an exit strategy in advance to limit loss aversion, objective performance analysis.
	Framing effect	Critical examination of linguistic presentation of reports, standardized and neutral reporting from companies.
	Herding behavior	Strengthen individual competencies of market participants, focus on fundamental values.

**Figure 3: Recommendations – dealing with heuristics and biases**

Source: Own representation

The third and final set of recommendations relates to enhancing the rationality and transparency of financial markets (see *Figure 4*). To begin with, information asymmetries should be reduced as much as possible, for example by improving corporate reporting (through regulatory requirements for financial disclosures, quarterly or semiannual reports, enhancing readability and thus comprehensibility of information, increasing ESG transparency). To preserve or expand diversity of opinions, independent external reporting and information sources should be supported. Another measure involves reducing transaction costs, which can be achieved through more efficient trading structures and the promotion of digital trading platforms. Lastly, various mechanisms that facilitate the rapid correction of price inefficiencies (such as algorithmic arbitrage) should be emphasized.

Enhancing rationality & transparency of financial markets		
	Factors to improve the rationality of markets	Measures to improve the rationality of markets
	Reduce information asymmetries	Improve corporate reporting (e.g. regulatory requirements for financial data, readability & comprehensibility, ESG transparency).
	Preserve / expand diversity of opinions	Support and extend independent external reporting and information sources.
	Reduce transaction costs	More efficient trading structures & promotion of digital trading platforms.
	Rapid correction of price inefficiencies	E.g. establishment of algorithmic arbitrage.

**Figure 4: Recommendations – rationality & transparency of financial markets**

Source: Own representation

## 5.2. Further Need of Research

In conclusion, the results of the event study provide interesting indications regarding investor behavior in the Wirecard case; however, the analysis is limited to one single firm, indicating that future studies should expand the sample to enhance the generalizability of the findings.

In the context of rational decision-making and the influence of psychological and social factors, several thematic areas and research questions emerge that warrant further investigation. As noted above, fields such as Behavioral Finance do not yet constitute self-contained economic theories capable of reliably predicting developments. Future research could examine human-machine interaction in greater depth, particularly regarding the use and impact of artificial intelligence. It would also be of interest to assess the extent to which training data introduce biases into algorithmic systems and how such biases, in turn, affect capital markets. Another central line of inquiry could focus on information availability (including the influence of social media, information overload, and real-time communication). Additionally, the development of new integrative or dynamic valuation and decision-making models may be worthwhile (for example, models that incorporate rationality, emotion, and ethical considerations, capture learning processes, and account for adaptation over time). Lastly, the effectiveness of financial literacy initiatives on long-term decision quality could be investigated.

In sum, future research must adopt an interdisciplinary approach that integrates multiple domains: economics, psychology, computer science and ethics. Only through such integration can the dynamic evolution of rationality be explained within the interplay of market participants, technology, and market structures.

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*Web resources were last accessed on 31 March 2026.*

## Attachment: Results Event Study (Abnormal Returns)

Event No.	Event Description	Date	t-Test				
			Abnormal Return	Standard Error	t-Value	p-Value	Significance
E1	Acquisition of XCOM Bank AG	06.09.2005	-0.013631	0.025158	-0.541815	0.588433	no
		07.09.2005	-0.077466	0.025158	-3.079227	0.002309	yes
		08.09.2005	-0.040055	0.025158	-1.592164	0.112622	no
		09.09.2005	0.057913	0.025158	2.301999	0.022164	yes
		12.09.2005	0.028773	0.025158	1.143727	0.253840	no
E2	Completion of the XCOM Bank take-over and launch of Wire Card Bank AG	30.01.2006	0.001783	0.026979	0.066106	0.947347	no
		31.01.2006	-0.014995	0.026979	-0.555827	0.578830	no
		01.02.2006	-0.009214	0.026979	-0.341516	0.733004	no
		02.02.2006	0.020032	0.026979	0.742525	0.458472	no
		03.02.2006	-0.002527	0.026979	-0.093682	0.925437	no
E3	Renaming of Wire Card AG to Wirecard AG	15.06.2006	-0.008989	0.033576	-0.267703	0.789151	no
		16.06.2006	0.059036	0.033576	1.758255	0.079938	no
		19.06.2006	-0.006190	0.033576	-0.184356	0.853885	no
		20.06.2006	0.025059	0.033576	0.746334	0.456173	no
		21.06.2006	-0.005702	0.033576	-0.169811	0.865297	no
E4	Inclusion in the TecDAX index	04.09.2006	-0.000867	0.032721	-0.026497	0.978882	no
		05.09.2006	0.000014	0.032721	0.000432	0.999656	no
		06.09.2006	-0.015312	0.032721	-0.467949	0.640232	no
		07.09.2006	0.018723	0.032721	0.572199	0.567705	no
		08.09.2006	0.004280	0.032721	0.130798	0.896041	no
E5	Announcement of an additional service offering for airlines	22.01.2007	-0.013678	0.033651	-0.406463	0.684753	no
		23.01.2007	-0.027395	0.033651	-0.814114	0.416360	no
		24.01.2007	-0.006439	0.033651	-0.191342	0.848414	no
		25.01.2007	0.041699	0.033651	1.239178	0.216451	no
		26.01.2007	-0.013308	0.033651	-0.395482	0.692827	no
E6	Cooperation with TUI Leisure Travel	17.05.2007	-0.006660	0.031497	-0.211439	0.832719	no
		18.05.2007	-0.004834	0.031497	-0.153464	0.878157	no
		21.05.2007	0.011302	0.031497	0.358817	0.720037	no
		22.05.2007	0.011436	0.031497	0.363074	0.716859	no
		23.05.2007	0.009588	0.031497	0.304417	0.761065	no
E7	Establishment of Wirecard Asia Pacific	11.12.2007	0.044388	0.028181	1.575086	0.116511	no
		12.12.2007	-0.033290	0.028181	-1.181283	0.238622	no
		13.12.2007	-0.019622	0.028181	-0.696291	0.486899	no
		14.12.2007	-0.030775	0.028181	-1.092064	0.275865	no
		17.12.2007	-0.023440	0.028181	-0.831765	0.406342	no
E8	Contribution posted in the Wallstreet Online stock market forum	29.04.2008	-0.004084	0.030375	-0.134447	0.893158	no
		30.04.2008	0.015189	0.030375	0.500051	0.617483	no
		02.05.2008	-0.016509	0.030375	-0.543511	0.587266	no
		05.05.2008	0.000851	0.030375	0.028029	0.977662	no
		06.05.2008	0.015271	0.030375	0.502763	0.615577	no
E9	Annual general meeting of Wirecard AG	20.06.2008	0.022990	0.030781	0.746898	0.455833	no
		23.06.2008	0.005808	0.030781	0.188676	0.850501	no
		24.06.2008	-0.020140	0.030781	-0.654291	0.513531	no
		25.06.2008	-0.022016	0.030781	-0.715239	0.475134	no
		26.06.2008	-0.303767	0.030781	-9.868706	0.000000	yes
E10	Response to criticism issued by the SdK (shareholders' association)	25.06.2008	-0.021875	0.030833	-0.709458	0.478707	no
		26.06.2008	-0.303902	0.030833	-9.856352	0.000000	yes
		27.06.2008	-0.065820	0.030833	-2.134731	0.033764	yes
		30.06.2008	0.008764	0.030833	0.284238	0.776465	no
		01.07.2008	0.090959	0.030833	2.950023	0.003481	yes
E11	Chairman of SdK held a short position in Wirecard shares	25.07.2008	-0.026153	0.044816	-0.583571	0.560039	no
		28.07.2008	0.012036	0.044816	0.268556	0.788494	no
		29.07.2008	-0.055968	0.044816	-1.248840	0.212901	no
		30.07.2008	0.073283	0.044816	1.635188	0.103278	no
		31.07.2008	0.012743	0.044816	0.284340	0.776387	no
E12	No evidence of misleading statements in the 2007 financial statements (EY)	06.10.2008	-0.058467	0.048236	-1.212117	0.226621	no
		07.10.2008	-0.081077	0.048236	-1.680853	0.094050	no
		08.10.2008	0.004963	0.048236	0.102884	0.918138	no
		09.10.2008	0.193258	0.048236	4.006542	0.000082	yes
		10.10.2008	0.058112	0.048236	1.204750	0.229448	no
E13	First dividend distribution	16.06.2009	-0.027122	0.053116	-0.510610	0.610078	no
		17.06.2009	0.027941	0.053116	0.526032	0.599336	no
		18.06.2009	0.004837	0.053116	0.091074	0.927508	no
		19.06.2009	-0.040331	0.053116	-0.759293	0.448398	no
		22.06.2009	0.023699	0.053116	0.446169	0.655864	no
E14	Management board changes at Wirecard AG	29.01.2010	-0.081067	0.027528	-2.944921	0.003537	yes
		01.02.2010	0.005037	0.027528	0.182996	0.854951	no
		02.02.2010	-0.023924	0.027528	-0.869074	0.385647	no
		03.02.2010	0.040203	0.027528	1.460449	0.145432	no
		04.02.2010	-0.030068	0.027528	-1.092274	0.275772	no

Event No.	Event Description	Date	t-Test				
			Abnormal Return	Standard Error	t-Value	p-Value	Significance
E15	Wirecard counters negative media coverage	26.03.2010	-0.000420	0.026655	-0.015766	0.987434	no
		29.03.2010	-0.027760	0.026655	-1.041456	0.298678	no
		30.03.2010	-0.207452	0.026655	-7.782805	0.000000	yes
		31.03.2010	0.139993	0.026655	5.251984	0.000000	yes
		01.04.2010	-0.005280	0.026655	-0.198096	0.843132	no
E16	Publication of positive news (Q3 2011)	15.11.2011	0.003121	0.023972	0.130183	0.896527	no
		16.11.2011	-0.012417	0.023972	-0.517991	0.604926	no
		17.11.2011	0.007553	0.023972	0.315081	0.752965	no
		18.11.2011	0.044562	0.023972	1.858906	0.064225	no
		21.11.2011	0.035003	0.023972	1.460145	0.145516	no
E17	Announcement of a cooperation with Deutsche Telekom	10.08.2012	-0.003385	0.019436	-0.174182	0.861865	no
		13.08.2012	0.000072	0.019436	0.003727	0.997029	no
		14.08.2012	-0.003757	0.019436	-0.193296	0.846885	no
		15.08.2012	-0.012806	0.019436	-0.658904	0.510568	no
		16.08.2012	0.005836	0.019436	0.300279	0.764216	no
E18	Execution of a capital increase	24.02.2014	-0.003728	0.016270	-0.229131	0.818956	no
		25.02.2014	0.005874	0.016270	0.361011	0.718398	no
		26.02.2014	-0.029637	0.016270	-1.821617	0.069718	no
		27.02.2014	-0.009452	0.016270	-0.580938	0.561810	no
		28.02.2014	0.034569	0.016270	2.124758	0.034596	yes
E19	Acquisition of the Turkish company 3pay	01.09.2014	-0.010485	0.019197	-0.546171	0.585439	no
		02.09.2014	0.001833	0.019197	0.095507	0.923989	no
		03.09.2014	-0.001830	0.019197	-0.095304	0.924150	no
		04.09.2014	-0.018293	0.019197	-0.952905	0.341566	no
		05.09.2014	0.021233	0.019197	1.106080	0.269763	no
E20	Financial Times series "House of Wirecard"	23.04.2015	-0.017881	0.016887	-1.058912	0.290670	no
		24.04.2015	-0.016340	0.016887	-0.967632	0.334171	no
		27.04.2015	-0.011630	0.016887	-0.688689	0.491663	no
		28.04.2015	0.016714	0.016887	0.989780	0.323246	no
		29.04.2015	-0.029001	0.016887	-1.717379	0.087158	no
E21	Announcement of the planned acquisition of the Great Indian Retail Group	23.10.2015	-0.006818	0.018545	-0.367674	0.713430	no
		26.10.2015	0.011802	0.018545	0.636432	0.525082	no
		27.10.2015	0.000493	0.018545	0.026587	0.978811	no
		28.10.2015	-0.010896	0.018545	-0.587538	0.557377	no
		29.10.2015	0.039025	0.018545	2.104378	0.036352	yes
E22	Critical report by J Capital Research	28.10.2015	-0.011020	0.018516	-0.595137	0.552294	no
		29.10.2015	0.038902	0.018516	2.100997	0.036651	yes
		30.10.2015	0.015406	0.018516	0.832021	0.406197	no
		02.11.2015	0.005960	0.018516	0.321895	0.747804	no
		03.11.2015	-0.008372	0.018516	-0.452123	0.651576	no
E23	Publication of the Zatarra report	22.02.2016	-0.010841	0.022275	-0.486679	0.626916	no
		23.02.2016	0.005370	0.022275	0.241090	0.809685	no
		24.02.2016	-0.156508	0.022275	-7.026313	0.000000	yes
		25.02.2016	-0.012525	0.022275	-0.562311	0.574412	no
		26.02.2016	0.024747	0.022275	1.110987	0.267650	no
E24	BaFin market-manipulation investigation	17.03.2016	-0.030037	0.025836	-1.162606	0.246107	no
		18.03.2016	-0.038036	0.025836	-1.472198	0.142235	no
		21.03.2016	0.000141	0.025836	0.005451	0.995655	no
		22.03.2016	-0.035104	0.025836	-1.358716	0.175471	no
		23.03.2016	0.030704	0.025836	1.188419	0.235805	no
E25	Wirecard Singapore becomes a principal member of Visa	10.05.2016	0.003896	0.025961	0.150089	0.880816	no
		11.05.2016	-0.009590	0.025961	-0.369423	0.712127	no
		12.05.2016	0.016791	0.025961	0.646796	0.518362	no
		13.05.2016	-0.000675	0.025961	-0.025987	0.979288	no
		17.05.2016	0.069396	0.025961	2.673151	0.008013	yes
E26	Filing of a criminal complaint with the public prosecutor	21.04.2016	0.023517	0.025943	0.906503	0.365549	no
		22.04.2016	0.034284	0.025943	1.321493	0.187555	no
		25.04.2016	0.039904	0.025943	1.538132	0.125291	no
		26.04.2016	-0.025023	0.025943	-0.964538	0.335716	no
		27.04.2016	0.006265	0.025943	0.241478	0.809384	no
E27	Acquisition of Citi Prepaid Card Services	27.06.2016	0.092974	0.026141	3.556702	0.000450	yes
		28.06.2016	-0.108369	0.026141	-4.145630	0.000047	yes
		29.06.2016	-0.008525	0.026141	-0.326108	0.744617	no
		30.06.2016	0.010711	0.026141	0.409734	0.682355	no
		01.07.2016	0.009074	0.026141	0.347131	0.728787	no
E28	Negative coverage by manager magazin	21.02.2017	-0.004882	0.023068	-0.211618	0.832579	no
		22.02.2017	-0.021919	0.023068	-0.950193	0.342939	no
		23.02.2017	-0.036251	0.023068	-1.571500	0.117341	no
		24.02.2017	0.004351	0.023068	0.188629	0.850538	no
		27.02.2017	-0.008087	0.023068	-0.350562	0.726214	no
E29		09.03.2017	0.012070	0.021081	0.572586	0.567444	no
		10.03.2017	0.028168	0.021081	1.336186	0.182713	no

Event No.	Event Description	Date	t-Test				
			Abnormal Return	Standard Error	t-Value	p-Value	Significance
	Acquisition of Citi-group's customer portfolio	13.03.2017	0.028471	0.021081	1.350579	0.178061	no
		14.03.2017	-0.001793	0.021081	-0.085060	0.932283	no
		15.03.2017	-0.002429	0.021081	-0.115237	0.908350	no
E30	Announcement of changes in the executive leadership	10.07.2017	0.024186	0.019079	1.267716	0.206088	no
		11.07.2017	0.026681	0.019079	1.398464	0.163223	no
		12.07.2017	-0.000806	0.019079	-0.042266	0.966320	no
		13.07.2017	0.009111	0.019079	0.477553	0.633389	no
		14.07.2017	-0.003467	0.019079	-0.181703	0.855964	no
		03.09.2018	0.012934	0.020246	0.638826	0.523526	no
E31	Inclusion of Wirecard AG in the DAX index	04.09.2018	-0.002099	0.020246	-0.103663	0.917520	no
		05.09.2018	-0.019957	0.020246	-0.985728	0.325227	no
		06.09.2018	0.002084	0.020246	0.102943	0.918092	no
		07.09.2018	0.031717	0.020246	1.566597	0.118484	no
E32	Critical Financial Times report (alleged contract forgery)	28.01.2019	0.008221	0.024430	0.336504	0.736775	no
		29.01.2019	-0.010935	0.024430	-0.447600	0.654833	no
		30.01.2019	-0.123845	0.024430	-5.069324	0.000001	yes
		31.01.2019	-0.024650	0.024430	-1.008984	0.313966	no
E33	Critical Financial Times report (alleged balance-sheet manipulation)	01.02.2019	-0.242776	0.024430	-9.937541	0.000000	yes
		30.01.2019	-0.123727	0.024405	-5.069748	0.000001	yes
		31.01.2019	-0.024520	0.024405	-1.004711	0.316015	no
		01.02.2019	-0.242662	0.024405	-9.943183	0.000000	yes
E34	BaFin market-manipulation investigation	04.02.2019	0.077392	0.024405	3.171157	0.001710	yes
		05.02.2019	0.034299	0.024405	1.405402	0.161153	no
		31.01.2019	-0.024019	0.025632	-0.937060	0.349640	no
		01.02.2019	-0.242075	0.025632	-9.444126	0.000000	yes
E35	Critical Financial Times report (alleged revenue fabrication)	04.02.2019	0.035120	0.025632	1.370132	0.171885	no
		06.02.2019	-0.020719	0.025632	-0.808316	0.419683	no
		05.02.2019	0.036898	0.030306	1.217516	0.224565	no
		06.02.2019	-0.020081	0.030306	-0.662621	0.508188	no
E36	Police raid at Wirecard Singapore	07.02.2019	-0.098786	0.030306	-3.259617	0.001272	yes
		08.02.2019	-0.176534	0.030306	-5.825084	0.000000	yes
		11.02.2019	0.066985	0.030306	2.210290	0.027999	yes
		06.02.2019	-0.020049	0.030303	-0.661601	0.508841	no
E37	BaFin imposes a short-selling ban on Wirecard	07.02.2019	-0.097325	0.030303	-3.211688	0.001494	yes
		08.02.2019	-0.176190	0.030303	-5.814211	0.000000	yes
		11.02.2019	0.066243	0.030303	2.185981	0.029752	yes
		12.02.2019	-0.035064	0.030303	-1.157092	0.248348	no
E38	Public prosecutor investigates Dan McCrum	14.02.2019	0.026375	0.033115	0.796479	0.426515	no
		15.02.2019	-0.058410	0.033115	-1.763874	0.078984	no
		18.02.2019	0.144557	0.033115	4.365362	0.000019	yes
		19.02.2019	0.045257	0.033115	1.366687	0.172961	no
E39	Doubts regarding the acquisition of GI Retail Group	20.02.2019	-0.068096	0.033115	-2.056372	0.040793	yes
		14.02.2019	0.026375	0.033115	0.796479	0.426515	no
		15.02.2019	-0.058410	0.033115	-1.763874	0.078984	no
		18.02.2019	0.144557	0.033115	4.365362	0.000019	yes
E40	Critical Financial Times report (suspected fraud)	19.02.2019	0.045257	0.033115	1.366687	0.172961	no
		20.02.2019	-0.068096	0.033115	-2.056372	0.040793	yes
		12.03.2019	-0.067034	0.035328	-1.897482	0.058926	no
		13.03.2019	-0.045883	0.035328	-1.298794	0.195221	no
E41	Investigation conducted by an external law firm	14.03.2019	-0.074546	0.035328	-2.110127	0.035849	yes
		15.03.2019	-0.083783	0.035328	-2.371598	0.018476	yes
		18.03.2019	0.014191	0.035328	0.401707	0.688246	no
		19.03.2019	0.015955	0.036235	0.440328	0.660083	no
E42	BaFin files a criminal complaint against the Financial Times	20.03.2019	-0.007982	0.036235	-0.220277	0.825837	no
		21.03.2019	-0.055081	0.036235	-1.520100	0.129760	no
		22.03.2019	0.011382	0.036235	0.314118	0.753696	no
		25.03.2019	-0.003710	0.036235	-0.102385	0.918534	no
E43	Announcement of a cooperation with SoftBank Group	22.03.2019	0.011580	0.036349	0.318570	0.750321	no
		25.03.2019	-0.003458	0.036349	-0.095134	0.924285	no
		26.03.2019	0.213415	0.036349	5.871193	0.000000	yes
		27.03.2019	-0.008853	0.036349	-0.243563	0.807771	no
E44	BaFin files a criminal complaint against the Financial Times	28.03.2019	-0.000535	0.036349	-0.014720	0.988267	no
		08.04.2019	-0.005319	0.039291	-0.135368	0.892431	no
		09.04.2019	-0.012790	0.039291	-0.325507	0.745072	no
		10.04.2019	0.020069	0.039291	0.510765	0.609970	no
		11.04.2019	-0.001822	0.039291	-0.046360	0.963061	no
E45	Announcement of a cooperation with SoftBank Group	12.04.2019	-0.001249	0.039291	-0.031797	0.974659	no
		18.04.2019	-0.034886	0.039440	-0.884553	0.377254	no
		23.04.2019	0.022017	0.039440	0.558238	0.577186	no
		24.04.2019	0.085728	0.039440	2.173651	0.030678	yes
		25.04.2019	-0.024028	0.039440	-0.609224	0.542934	no

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			Abnormal Return	Standard Error	t-Value	p-Value	Significance
		26.04.2019	0.019353	0.039440	0.490693	0.624078	no
E44	Critical Financial Times report (profits from third-party partners)	18.04.2019	-0.034886	0.039440	-0.884553	0.377254	no
		23.04.2019	0.022017	0.039440	0.558238	0.577186	no
		24.04.2019	0.085728	0.039440	2.173651	0.030678	yes
		25.04.2019	-0.018488	0.039440	-0.609224	0.542934	no
		26.04.2019	0.019353	0.039440	0.490693	0.624078	no
E45	Wirecard issues its first investment-grade bond	10.09.2019	-0.023644	0.040011	-0.590925	0.555109	no
		11.09.2019	0.003886	0.040011	0.097118	0.922711	no
		12.09.2019	-0.007466	0.040011	-0.186601	0.852126	no
		13.09.2019	-0.018488	0.040011	-0.462075	0.644432	no
		16.09.2019	0.039742	0.040011	0.993279	0.321542	no
E46	Cooperation agreement with SoftBank signed	16.09.2019	0.039894	0.039979	0.997883	0.319309	no
		17.09.2019	-0.010071	0.039979	-0.251899	0.801328	no
		18.09.2019	0.034982	0.039979	0.875013	0.382414	no
		19.09.2019	-0.047918	0.039979	-1.198577	0.231836	no
		20.09.2019	-0.031118	0.039979	-0.778356	0.437101	no
E47	Financial Times report (fabricated revenue figures)	11.10.2019	-0.016190	0.038606	-0.419376	0.675304	no
		14.10.2019	-0.008384	0.038606	-0.217165	0.828258	no
		15.10.2019	-0.144194	0.038606	-3.735038	0.000233	yes
		16.10.2019	-0.004156	0.038606	-0.107642	0.914367	no
		17.10.2019	-0.022338	0.038606	-0.578624	0.563368	no
E48	Allegations made by the Financial Times dismissed	14.10.2019	-0.008140	0.038490	-0.211475	0.832690	no
		15.10.2019	-0.143881	0.038490	-3.738102	0.000230	yes
		16.10.2019	-0.003894	0.038490	-0.101168	0.919499	no
		17.10.2019	-0.022091	0.038490	-0.573924	0.566539	no
		18.10.2019	-0.047466	0.038490	-1.233189	0.218673	no
E49	Announcement of a share buy-back program	16.10.2019	-0.003232	0.039542	-0.081734	0.934924	no
		17.10.2019	-0.021701	0.039542	-0.548825	0.583620	no
		18.10.2019	-0.047043	0.039542	-1.189699	0.235302	no
		21.10.2019	0.050390	0.039542	1.274345	0.203734	no
		22.10.2019	-0.023520	0.039542	-0.594827	0.552502	no
E50	Announcement of an external investigation by KPMG	17.10.2019	-0.021614	0.039530	-0.546770	0.585028	no
		18.10.2019	-0.046956	0.039530	-1.187875	0.236019	no
		21.10.2019	0.050445	0.039530	1.276138	0.203101	no
		22.10.2019	-0.023448	0.039530	-0.593183	0.553599	no
		23.10.2019	-0.011699	0.039530	-0.295943	0.767521	no
E51	Article in the Financial Times on the 2017 annual financial statements	05.12.2019	-0.003033	0.038992	-0.077788	0.938059	no
		06.12.2019	-0.027596	0.038992	-0.707744	0.479769	no
		09.12.2019	-0.003063	0.038992	-0.078561	0.937445	no
		10.12.2019	-0.042962	0.038992	-1.101820	0.271608	no
		11.12.2019	-0.060702	0.038992	-1.556780	0.120798	no
E52	Changes in the supervisory board of Wirecard AG	08.01.2020	0.001361	0.039075	0.034828	0.972245	no
		09.01.2020	-0.021060	0.039075	-0.538971	0.590390	no
		10.01.2020	0.006472	0.039075	0.165632	0.868581	no
		13.01.2020	0.025812	0.039075	0.660588	0.509490	no
		14.01.2020	0.043910	0.039075	1.123728	0.262215	no
E53	KPMG special audit partially completed	10.03.2020	0.084185	0.029955	2.810364	0.005343	yes
		11.03.2020	-0.042940	0.029955	-1.433460	0.152986	no
		12.03.2020	0.001157	0.029955	0.038613	0.969230	no
		13.03.2020	0.006128	0.029955	0.204586	0.838064	no
		16.03.2020	0.028685	0.029955	0.957581	0.339207	no
E54	Further delays in the KPMG special audit	20.04.2020	-0.011964	0.025541	-0.468421	0.639895	no
		21.04.2020	0.059667	0.025541	2.336145	0.020281	yes
		22.04.2020	0.016427	0.025541	0.643169	0.520709	no
		23.04.2020	0.078105	0.025541	3.058042	0.002472	yes
		24.04.2020	-0.014360	0.025541	-0.562252	0.574452	no
E55	Results of the KPMG special audit	24.04.2020	-0.015031	0.025585	-0.587519	0.557390	no
		27.04.2020	-0.034417	0.025585	-1.345225	0.179781	no
		28.04.2020	-0.285468	0.025585	-11.15781	0.000000	yes
		29.04.2020	-0.131748	0.025585	-5.149530	0.000001	yes
		30.04.2020	0.027185	0.025585	1.062561	0.289015	no
E56	Announcement of organizational and personnel changes	06.05.2020	-0.043888	0.032188	-1.363490	0.173964	no
		07.05.2020	0.014516	0.032188	0.450988	0.652392	no
		08.05.2020	0.070090	0.032188	2.177537	0.030383	yes
		11.05.2020	0.004499	0.032188	0.139764	0.888960	no
		12.05.2020	-0.050129	0.032188	-1.557392	0.120653	no
E57	2019 financial statements: publication postponed	21.05.2020	-0.007595	0.032903	-0.230831	0.817636	no
		22.05.2020	-0.002193	0.032903	-0.066661	0.946906	no
		25.05.2020	0.020093	0.032903	0.610668	0.541978	no
		26.05.2020	-0.019012	0.032903	-0.577831	0.563902	no
		27.05.2020	0.019829	0.032903	0.602652	0.547291	no
E58		03.06.2020	0.002292	0.032125	0.071356	0.943172	no

Event No.	Event Description	Date	t-Test				
			Abnormal Return	Standard Error	t-Value	p-Value	Significance
	Criminal complaint against Wirecard filed with BaFin	04.06.2020	0.019816	0.032125	0.616842	0.537904	no
		05.06.2020	-0.104219	0.032125	-3.244189	0.001340	yes
		08.06.2020	0.081897	0.032125	2.549341	0.011396	yes
		09.06.2020	0.007471	0.032125	0.232561	0.816294	no
E59	Insufficient audit evidence (trust accounts)	16.06.2020	-0.011697	0.033444	-0.349741	0.726830	no
		17.06.2020	0.034680	0.033444	1.036959	0.300765	no
		18.06.2020	-0.986238	0.033444	-29.48937	0.000000	yes
		19.06.2020	-0.473147	0.033444	-14.14748	0.000000	yes
		22.06.2020	-0.558851	0.033444	-16.71013	0.000000	yes
E60	Suspension of J. Marsalek	16.06.2020	-0.011697	0.033444	-0.349741	0.726830	no
		17.06.2020	0.034680	0.033444	1.036959	0.300765	no
		18.06.2020	-0.986238	0.033444	-29.48937	0.000000	yes
		19.06.2020	-0.473147	0.033444	-14.14748	0.000000	yes
		22.06.2020	-0.558851	0.033444	-16.71013	0.000000	yes