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Literature Review of Experimental Asset Markets with Insiders

Robert Merl

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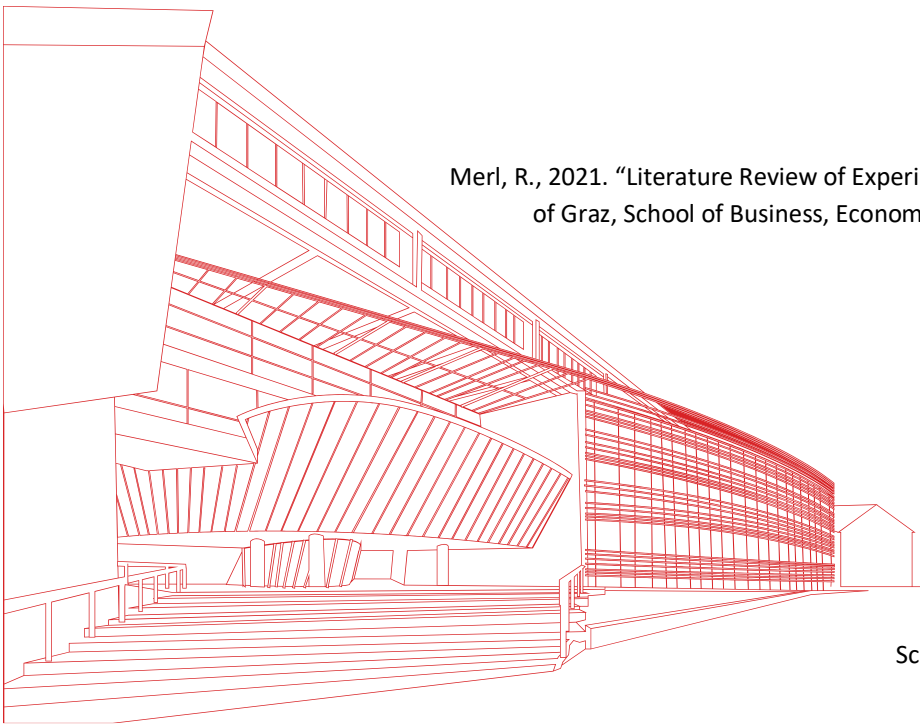

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Robert Merl
University of Graz, Institute of Banking and Finance
Corresponding author: robert.merl@edu.uni-graz.at

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Many researchers have conducted experiments to study different aspects of insider trading. Experimental laboratory asset markets allow the researcher to control parameters that are impossible to control or even measure in empirical data (e.g., fundamental value of the asset, quality and quantity of information traders receive). This paper provides an exhaustive overview of the results from experimental economics on asset markets with asymmetrically informed participants.

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Literature Review of Experimental Asset Markets with Insiders*

Robert Merl[§]

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[§]University of Graz, Institute of Banking and Finance, Universitätsstrasse 15, 8010 Graz, Austria, e-mail: robert.merl@edu.uni-graz.at

1. Introduction

Insider trading is a widely researched topic with many papers deploying theoretical models, undertaking empirical work and conducting experiments. While some have written literature reviews focusing on the empirical research concerning insider trading (Clacher et al., 2009), experimental asset markets in general (Sunder, 1995; Nuzzo and Morone, 2017) or the pros and cons of insider trading (Bhattacharya, 2014), I am the first to provide an exhaustive review of experimental asset markets with insiders. Researching the role of insiders using experimental asset markets has many advantages over other methodological approaches. One of the greatest advantages is that the experimenter controls the quality and quantity of information traders receive. As insider trading is forbidden and the trading of company insiders in their company stock is restricted in many countries, gathering empirical data about these activities is difficult. Furthermore, the experimenter can determine and manipulate the fundamental values of the companies in an experiment, while this is not possible in asset markets outside of the lab.[1] The main areas researched so far experimentally with insiders are the comparison of theoretical models, the market structure, the information structure, the price efficiency, the information dissemination, the trading behaviour, the liquidity, the profits, the ethics, the market observers and the detection of insiders.

Before I start reviewing the literature, I will define insiders and insider information, describe the experimental designs of the reviewed literature and further delineate the exact scope of this paper.

2. General Description of the Asset Market Experiments

2.1. Insiders and Inside Information

In this review I define insiders as participants in the experiment with superior information.[2] For information to be superior, it cannot be public and has to be asymmetrically distributed. For example Plott and Sunder (1988) endow each trader privately with an information signal (i.e., the exclusion of one of three possible states of nature determining the value of the asset), that differs among traders (i.e., half of the participants receive one signal, the other half the other), but the quality of information is the same for every participant. Therefore, no trader

[1] In his literature review about experimental asset markets within finance, Duxbury (1995) provides a short overview about the methodology of experiments.

[2] Throughout this paper I use insiders and informed traders as synonyms.

has superior information. The distribution of information is heterogenous but not asymmetric. I classify trading on asymmetrically distributed information as *insider trading.* Insider trading is forbidden in most capital markets around the world, but many studies reviewed in this paper allow for insider trades in their experimental asset markets to analyse the impact of these trades on a wide range of aspects of the market.[3] Insider trading needs to be differentiated from company insiders like employees legitimately trading in their company's stock. Company insiders are often allowed to trade their company's stock as long as they do not do so based on privileged information. However, they have to report their transactions. Information about these trades is publicly available for example in the EDGAR Database of the U.S. Securities and Exchange Commission (SEC) and is a data resource for empirical research. The disadvantage of the empirical approach is that illegal insider trades (both by company insiders and by persons tipped off by company insiders) based on not yet publicly available, material information (e.g., annual financial statements that can influence the stock's price), are usually not reported. Even if all trades (including the illegal ones) would be reported, researchers employing the empirical approach still often cannot determine with certainty which trades are based on not yet publicly available, material information.

2.2. Experimental Designs

The experimental designs of the reviewed literature differ in many aspects. Here I outline which aspects they typically share and where the main differences lie.

Participants

The persons taking part in the experiments are usually students. An exception is for example Flood et al. (1998), who use professional securities traders. Most experimenters compensate participants depending on their actions and success in the experiment.

Roles

The different roles (i.e., informed traders, dealers, observers, etc.) of the participants are mostly determined exogenously before the start of the experiment. Besides the literature including the possibility for traders to purchase information, two of the exceptions are

[3] Trading on asymmetrically distributed information does not need to be *insider trading* and thereby illegal in capital markets outside of the lab. If for example only some traders collect information from publicly available sources, while others choose not to get informed, the information is distributed asymmetrically, but trading on it is not illegal. For the purpose of this paper, I define *insider trading* more broadly, as the reason for providing asymmetrically distributed information in experiments is often to study the effects of insider trading, and even when it is not, the results may still offer interesting insights concerning insider trading.

Marsden and Tung (1997) and Hornung et al. (2015), where traders can decide endogenously whether they want to become informed traders with the risk of being exposed as insiders and facing a penalty.

According to the no-trade theorem, no transactions would take place between rational informed and rational uninformed traders, when the uninformed traders do not have an exogenous incentive to trade. Therefore, some studies include liquidity traders with certain transaction goals. In recent studies there are often no liquidity traders, because experience shows that there is trade despite the applicability of the no-trade theorem (e.g., Qi and Ochs (2009)). Another way of incentivising traders are different trader types, as described below.

Many conduct a within-subject design while most employ between-subjects designs. Some change the roles of traders, while some do not change them throughout the experiment, depending on their research goals. For example Banks (1985) and Sunder (1992) change the identity of insiders throughout the experiment to study whether earlier results remain valid after this design change.

Market

In many of the earlier papers, participants trade the experimental asset in an oral double auction. In those markets traders can – without dealers as intermediaries – post bid or ask prices orally, i.e., both offer to buy or sell the asset and accept outstanding offers to buy or sell throughout the whole trading period. Later, as many stock exchanges started to employ computerized trading, researchers conducted more and more computerized continuous double auctions in their experiments, usually facilitated by dedicated experimental software such as z-Tree (Fischbacher, 2007). Besides the continuous (oral or computerized) double auctions, many studies also employed call auctions or dealer markets.

Transparency

The order books are mostly open for all market participants to view outstanding offers and information about transaction prices. Most of the papers do not disclose the identity of the informed traders.

The Asset

Participants can usually trade the asset of one fictitious company on one market. Exceptions are for example Qi and Ochs (2009), where one asset is traded on two markets, or Tung and Marsden (2000), where traders can buy and sell six different assets. In most experiments participants can trade the assets without taxes or fees.

Fundamental Value of the Asset

In most designs, the asset has an exogenously-determined fundamental value consisting of either dividends or a liquidation value or both, depending on the life of the asset (i.e., whether the asset has a life longer than one period). While some define a range of possible values for the asset's fundamental value (e.g., between 30 and 85 currency units, in steps of 0.1, in Palan and Stöckl (2017)), many experiments use state-dependent dividends or liquidation values, such that there are only few distinct possible realizations (e.g., 0 or 100 in Nöth and Weber (1996)). Another line of literature changes the fundamental value of the long-lived asset throughout the asset's life. In addition, some papers include different trader types that receive different dividends or liquidation values as payouts. This system not only incentivises participants to trade, but also lets the researchers analyse allocative efficiency. However, calculating the fundamental value and thereby the benchmark for price efficiency is not straightforward in such designs.

Price Efficiency

Price efficiency is measured differently depending on the experimental design. In simple market structures, with one liquidation value or equal dividends for all traders, and with insiders knowing the exact fundamental value (perfect information), the price is more efficient the closer it is to this liquidation value or dividend. In more complex designs, with for example different trader types, different payouts for each type, and imperfect information, researchers use models to define an efficient benchmark. This efficient benchmark is usually derived under the assumption that all available information is disseminated and incorporated in the asset's price.

Allocative Efficiency

Some papers calculate allocative efficiency as a measure for market efficiency. In papers with different trader types, allocative efficiency is higher when more members of the trader type whose valuation of the asset in a certain period is highest hold the asset at the end of that period. In experiments with only one type of trader, no allocative efficiency can be calculated. Many of the experiments with only one trader type, without taxes and without dealers, constitute a zero-sum game. This is relevant for the analysis of profits, as one market participant can only profit at the expense of another. The zero-sum game nature is common in the experimental asset market literature.

Period

The life of the asset is often one period and periods are usually considered independent, with traders being newly endowed each period. Most researchers endow the participants with assets and cash and do not give them the possibility to sell short or buy on margin.

A different approach, with assets living longer than one period, is employed for example by Ackert and Church (1998), Stöckl and Kirchler (2014) and the literature based on the market design of Smith et al. (1988) researching bubbles experimentally (reviewed by Palan (2013)). In this so-called SSW design, the asset usually pays an uncertain dividend each period and has no liquidation value at the end of the experiment. The fundamental value (i.e., the sum of the expected dividends) thus decreases over time. This design is prone to producing price bubbles, which has been replicated many times. Here I review only those papers in the SSW design that include asymmetric information.

Information

The superior information insiders receive mostly concerns the fundamental value (i.e., the dividend, the state of nature, or the liquidation value). This information (signal) can reveal the fundamental value with certainty (perfect information), with a certain probability of error, or to the extent that it excludes for example only one of the states of nature when there are more than two states (both imperfect information). Most of the literature I review uses two levels of informedness for traders – informed and uninformed –, others analyse the effects of more levels (reviewed in section 3.4.2). In most of these latter articles, traders with higher information levels (better informed traders) receive information on the fundamental value earlier than traders with a lower level (worse informed traders), while some traders remain uninformed.

Special market designs

Tucker (1997) employ a special experimental design in which insiders cannot trade, but sell their imperfect information with different quality to traders. Budescu and Maciejovsky (2005), who let participants trade four different cards, is another example of a special design. Only when the right combination of cards is in a traders' possession do the cards yield a dividend. Insiders in their setting receive information on the right combination.

2.3. Scope of this Review

This paper presents an exhaustive review of all experimental asset markets with asymmetric information.[4] A strand of literature I exclude are papers with computerized informed traders (e.g. Bloomfield and O´Hara (1999)) or comparisons of computerized markets with markets where humans act as traders (Hauser et al., 2009; Angerer et al., 2014), as the aim of this review is to concentrate on how human participants with superior information influence various aspects of the asset market. I further exclude natural experiments, because my focus lies on experiments with a high level of control over certain variables, as is only possible in a laboratory setting. I include papers that shed light on interesting topics concerning trading on insider information, even if they might not be associated with insider trading at first glance (e.g., papers that offer traders the possibility to acquire costly superior information).

3. Stylized Results

3.1. Observers and Insider Detection

Observation 1. For traders and market observers, certain market measures facilitate the detection of insiders in the market.

Stöckl and Palan (2018) find human market observers to be significantly more successful in identifying informed traders than a chance process (i.e., zero-intelligence observers). Their paper reports that, to detect informed traders, observers mainly use information on (i) the volume of shares offered for trade using limit orders, (ii) the volume of shares bought and sold, and (iii) the average transaction prices. Observers in their experiment correctly concentrate on (i) and (ii), as informed traders do submit significantly higher volumes via limit orders and buy more shares. In addition, Stöckl and Palan find that insiders' transaction sizes (i.e., the volume per trade) are significantly greater than those of uniformed traders, a fact that observers seem to have missed. Circumstances that could help participants to identify insiders are when the fundamental value assumes the high state and when the number of

[4] The process of choosing relevant literature is based on three steps. As a first step, I searched online engines with keywords like "asymmetric information", "insider", "insider trading", "experiment" and "asset market". Then I went through the citations of the resulting articles and books for more sources that match the goal of this paper. Finally, I went through the first 100 results of Google Scholar for each of the combinations "insider trading experiment", "insider trading asset market experiment", "asymmetric information experiment" and "asymmetric information asset market experiment" to further decrease the possibility of relevant literature not being included in this paper.

insiders in the market is known with certainty (Nöth and Weber, 1996). To detect the presence of insiders, Bruguier et al. (2010) argue that market participants could make use of the finding that the autocorrelation of the absolute size of price changes (i.e., positive values of price changes) is correlated with the number of insiders in a market. The correlation between the absolute values of the price changes and previous absolute price changes increases significantly in the number of informed traders in a market (Bruguier et al., 2010).

3.2. Model Comparison

The aim of certain experiments with insider information is the comparison of theoretical models' predictions of the asset's price, and in some cases the comparison of theoretical models' predictions of the price and the distribution of information on the information market. Table 1 serves as an overview of the models and their predictions.

Table 1: Model Predictions

Model	Asset Price	Information Market
Fully revealing rational expectations (FRE) (cf., Plott and Sunder (1982))	The FRE equilibrium builds on the concept of the strong form of the efficient market hypothesis (EMH), contending that the asset's price includes all information and participants can derive the state of nature from the price. Information is incorporated immediately.	The value of information is zero. Because of the immediate information dissemination, traders cannot generate a profit with information. Informed and uninformed traders earn the same net profits. The FRE model predicts a random allocation of costly information.
Prior information (PI) (cf., Plott and Sunder (1982))	Traders do not extract information from the price, but the price instead settles on the expected value based solely on the private information received before trading starts.	

Non-revealing rational expectations (NRE) (cf., Copeland and Friedman (1991))	In the semi-strong form efficient NRE model, no private information of other traders is incorporated. The NRE model, in contrast to the PI model, allows prices not only to incorporate private, but also public information.	The price of information is the highest possible profit a trader can make. Trader types that can profit most from the information buy it.
Partial rational expectations (PRE) (cf., Copeland and Friedman (1991))	The PRE model allows for partial revelation of private information through trading.	Partial revelation of information leads to prices for information between the predictions of the NRE and the FRE model.
Noisy rational expectations (Noisy-RE) (cf., Sunder (1992))	The Noisy-RE model allows for exogenous noise in the final equilibrium price. The Noisy-RE equilibrium never incorporates all information.	
Bayesian Nash equilibrium (BNE) (cf., Bossaerts et al. (2014))	In the BNE, prices do not incorporate all available information immediately, but do so eventually.	

Notes: Theoretical models' predictions of the asset's price and theoretical models' predictions of the price and allocation of information on the information market.

Observation 2. The FRE model describes the asset's price better than most models because traders extract (almost) all available information from the price.

The FRE model serves as a benchmark for many papers when comparing predictions of models. The seminal paper here is that of Plott and Sunder (1982). Plott and Sunder report that the FRE model describes the behaviour of the asset's price better than the PI model, especially in later periods when traders have gained experience. However, the experience of traders (Copeland and Friedman, 1992), the market design (Copeland and Friedman, 1992), the common knowledge of the presence or absence of insiders (Qi and Ochs, 2009), and the

variation of who is an insider from one period to the next (Banks, 1985)[5] influence the success of the FRE model over the PI model.

The NRE model is less successful in predicting the asset's price than are both the FRE and the PI models (Copeland and Friedman, 1992). The FRE model outperforms the PRE and the NRE models regarding the asset's price efficiency (Copeland and Friedman, 1991). Only Bossaerts et al. (2014) and Sunder (1992) report that the Noisy-RE model performs better than the FRE model in predicting the asset's final price, as the Noisy-RE model allows for noise in the final equilibrium price and information revelation is not perfect in their markets.[6] For the same reason, the BNE model does worse than the Noisy-RE model in predicting the asset's final price in Bossaerts et al. (2014). Also Page and Siemroth (2017) report imperfect aggregation of information and thus support neither the FRE nor the BNE model.

Observation 3. The PRE model's predictions for the information market generally outperform the FRE model's prediction.

The PRE model explains the price for information and the distribution of information purchases better than the FRE model and the NRE model (Copeland and Friedman, 1991). The reason for the success of the PRE model over the FRE model could stem from the fact that informed traders are mostly unable to recover the information costs and end up with either similar (King, 1991; Copeland and Friedman, 1992; Sunder, 1992) or smaller net profits than do uninformed traders (Tucker, 1997; Page and Siemroth, 2017; Ackert et al., 2018; Halim et al., 2019).

Observation 4. In later periods and in less complex environments, the FRE model predicts the information market's behaviour better than does the NRE model.

In Copeland and Friedman's (1992) later periods the price for information follows the predictions of the FRE model. However, in the more complicated environments of Copeland and Friedman (1992) with different states for different trader types, the NRE model does better at describing the price and allocation of the information purchased, since the price for information does not converge to 0 and trader types that can profit most from the information tend to buy it. Sunder (1992) finds that the predictions of the FRE model do well when the amount of information available for purchase is fixed. In this setting, as the price of the asset converges to the FRE price, the price for the information simultaneously converges to zero.

[5] Banks varies the identity of the insiders from one period to the next prevent traders from identifying the insiders. He confirms the results of Plott and Sunder, but he finds the results to be weaker.

[6] Sunder observes this result in the markets with a fixed price for information.

3.3. Market Structure

3.3.1. Call Market vs. Continuous Market

Observation 5. Many of the results on the comparison of the call auction markets and continuous double auction markets with asymmetric information are contradictory.

One example of a measure that produces conflicting results is price efficiency. It is higher in the continuous double auctions of Krahnen et al. (1999) and Sakurai and Akiyama (2017), while it is higher in the call auctions of Brünner and Levínský (2020), and on a similar level in both market designs of Schnitzlein (1996). Another example is the performance of traders. Returns for (computerized) uninformed traders are higher in the call market of Schnitzlein (1996). In the experiments of Hornung et al. (2015), which feature both continuous and call markets, insiders accumulate their profits mainly in the continuous double auctions (in line with Schnitzlein). At the same time, insider profits are slightly higher in the call auctions of Krahnen et al. (1999) and Morone and Nuzzo (2019).

Further results on the comparison of the two market designs are mixed. The trading volume is lower and the process of balancing the portfolios takes longer in the call market (Krahnen et al., 1999).[7] Information mirages (see section 3.7.3 for the definition) are more likely to occur in the continuous double auction (Morone and Nuzzo, 2019), and allocational efficiency is higher in the call market in the case of a higher probability of asymmetric information distribution (Brünner and Levínský, 2020).[8]

3.3.2. Dealer Markets

This section reviews results on experimental dealer markets in combination with asymmetric information. In most dealer markets, only dealers post bid and ask prices for the asset. Thus, traders who wish to buy or sell the asset have to interact with dealers and accept these prices.

Observation 6. Dealers set wider spreads and their profits decrease when insiders are in the market. However, also other factors influence the spread dealers set and the dealer profits.

The results indicate that dealers set narrower spreads when traders have the possibility of direct transactions between each other (Lamoureux and Schnitzlein, 1997), when there is pre- and post-trade transparency regarding quote- and transaction-disclosure (Flood et al., 1998),

[7] The balancing of portfolios is specific to the experiment of Krahnen et al. , where they endow half of the participants with only cash and the other half with only assets.

[8] Participants in Morone and Nuzzo (2019) and Brünner and Levínský (2020) do not know whether there are better-informed traders in the market.

when there is no possibility of communication between dealers (Cason, 2000), and when none of the traders have more information than the dealers (Krahnen and Weber, 2001). Furthermore, the possibility of direct transactions between traders (Lamoureux and Schnitzlein), the pre- and post-trade transparency (Flood et al.), and the presence of informed traders in the market (Krahnen and Weber) lead to smaller dealer profits.

Further results show that when the number of insiders is not disclosed, "[...] insiders delay their trades and dealers have difficulty identifying them" (Schnitzlein, 2002, p. 1107). Price efficiency is higher when there is the possibility of direct transactions between traders (Lamoureux and Schnitzlein), when there is pre- and post-trade transparency (Flood et al.), when there is no possibility of communication between dealers (Cason) and when there is disclosure of the number of insiders when two insiders (compared to zero and one insider) are in the market (Schnitzlein, 2002). Schnitzlein attributes this final point to insiders trading more aggressively when their number is disclosed. There is also evidence that competition of dealers decreases uninformed traders's losses (Krahnen and Weber), and that insiders – in an effort to mislead the market – trade more against their information when dealers are transparent (Bloomfield and O'Hara, 2000).[9]

3.3.3. Regulation

Observation 7. Regulation of insider trading decreases price efficiency and increases insider profits (before penalty payments), but can lead to less insider trading overall.

An obligation for insiders to disclose their trades and hold their assets for two periods (Halim and Riyanto, 2020) and a prohibition of insider trading (Palan and Stöckl, 2017) decrease price efficiency. In addition, Palan and Stöckl find that markets are less liquid when insider trading is prohibited. Insiders can exploit this inefficiency of the market and increase their profits before penalty payments (Palan and Stöckl, 2017). This result may seem counterintuitive, but is supported by Grégoire and Coupland (2018) and Chelley-Steeley et al. (2015), who both report that in their respective datasets, regulation leads to higher informed trader profits.

Certain insider trading regulations can decrease insider trading. These are increasing penalty rates, increasing monitoring rates (Hornung et al., 2015), or a higher level of transparency regarding the order book (Marsden and Tung, 1997).

[9] Bloomfield and O'Hara have high and low transparency dealers in their markets. While high transparency dealers disclose their trades to all market participants, low transparency dealers do not.

Further results show that participants systematically misreport earnings values to increase their profits (Del Brio et al., 2016), and giving a company insider (manager) the possibility to trade the company's assets leads to greater effort by the manager (Bao et al., 2020).[10]

3.4. Information Structure

3.4.1. Market for Information

The experiments I review in this section offer the participants costly information, either through information auctions or for a fixed price.

Observation 8. Buying information is not profitable. Traders learn this through repetition.

King (1991), Copeland and Friedman (1992) and Sunder (1992) report that in their experiments, insider profits exceed uninformed traders' profits approximately by the cost of information, leading to similar net profits for informed and uninformed traders. In contrast, Morone (2008), Page and Siemroth (2017), Ackert et al. (2018), Tucker (1997) and Halim et al. (2019) report that informed traders are not able to recover the information costs and end up with smaller net profits than uninformed traders. One reason for these conflicting findings could be that the latter five papers offer their traders imperfect information, while the first three offer perfect information. One counterexample, where the acquisition of imperfect information significantly reduces the probability of net losses, is Alfarano et al. (2006). However, buying more information does not necessarily increase traders' net profits in their experiment. Generally speaking, traders seem to learn that the purchase of information does not lead to higher net profits and act accordingly (Huber et al., 2011).[11]

Further results show that more information sharing leads to less information acquisition, lower acquisition costs, lower dispersion in profits, and higher profits overall (Halim et al., 2019). As one would expect, price efficiency is lower with higher information prices in Huber et al. (2011), because fewer traders buy the information. Interestingly, this is not the case in Morone (2008). In Morone's experiment, participants purchase more information when the price for information is higher, which in turn leads to higher price efficiency. Morone

[10] Del Brio et al. (2016) conduct an experiment in which the informed trader is the manager of a fictitious company and can decide what value of earnings (of the fictitious company) he wants to report to the uninformed traders. There is no punishment if the reported earnings value does not coincide with the real value.
In Bao et al. the fundamental value of the asset depends on the effort of the manager.

[11] In Huber et al. (2011), traders who pay more receive more information than traders who pay less. Huber et al. find that uninformed traders, followed by best informed traders, earn more than traders with any other of the five information levels after accounting for the information cost. Traders in their experiment learn this pattern and act accordingly (either choose no information or the best information level) in later periods.

attributes this result to traders' strategic consideration that, given more expensive information, fewer participants will buy the information and that the traders will thus be able to profit more from their own purchase. In addition, Morone reports that the profit distribution has more outliers when the price of information is higher. Certain circumstances lead to a price for information that converges (close) to 0. A price for information of 0 is in line with the prediction of the FRE model described in section 3.2. Through experience of traders (Copeland and Friedman, 1992; Sunder, 1992; Ackert et al., 1997; Tucker, 1997), a simple market design (Copeland and Friedman, 1992), additional public information and higher informational efficiency (Tucker, 1997), the price for information converges (close) to 0 and thus to the prediction of the FRE model. Finally, Perotti and Rindi (2006) find that when they disclose the identity of those traders who buy information, fewer traders buy information.

3.4.2. Levels of Information

Observation 9. A higher information level (i.e., higher quality, greater amount or earlier information arrival) does not guarantee a higher profit.

One early study of Tung and Marsden (1998) with three different information levels finds a positive relationship between the quality of information and the profits of the informed traders. Later on, many experiments show that a higher level of information does not necessarily lead to higher (net) profits (Huber et al., 2005; Alfarano et al., 2006; Huber et al., 2007; Huber, 2007; Huber et al., 2008; Kirchler, 2010; Huber et al., 2011; Stöckl and Kirchler, 2014; Page and Siemroth, 2017). Only the best-informed traders significantly outperform traders with other information levels (Huber et al., 2007; Huber, 2007; Huber et al., 2008). In Huber (2007) the worst-informed traders even outperform moderately informed traders. Huber et al. (2008) and Kirchler (2010) argue that the worst-informed traders do better by trading randomly than they would trading on their inferior information. Huber (2007) offers more detail regarding this phenomenon when he reports that the worst-informed traders perform well in fundamental value trend reversals, where the worst-informed traders' outdated information is closer to the fundamental value than the moderately informed traders' information.

Further results show that the arrival of new information causes volatility clustering (i.e., time spans with low volatility interrupted by time spans with very high volatility) and fat-tailed

returns (Kirchler and Huber, 2007, 2009).[12] Furthermore, uninformed traders contribute more to the fat-tailed returns than do informed traders (Kirchler and Huber, 2009).

3.5. Trading Behaviour

3.5.1. Trading Behaviour of Uninformed Traders

Observation 10. Uninformed traders are more cautious when they suspect or know that insiders are in the market.

Uninformed traders wait longer to trade at the beginning of the period and place more limit orders when they know that other market participants have superior information (Sutter et al., 2012). The reason could be that uninformed traders wait until the price reveals information. Most uninformed traders wait to submit offers for that reason in Qi and Ochs (2009). Some traders take part in disadvantageous trades with better-informed participants anyway. Why uninformed traders are willing to trade with insiders (and why the no-trade theorem does not hold) is an open question for Qi and Ochs. Brünner and Levínský (2008) find that a higher probability of an insider being in the market leads to less noise in the behavior of uninformed traders (i.e., uninformed traders act according to the predictions of Brünner and Levínský 's model).

Further results are that uninformed traders trade less when the quality of insider information is higher (Plat, 1997), that uninformed traders predict future price movements better in markets where the identity of insiders is disclosed (Perotti and Rindi, 2006), and that uninformed traders act as contrarian traders, who buy shares after they observe negative returns and sell shares after they observe positive returns (Bloomfield et al., 2009b).

3.5.2. Choice of Market

Observation 11. Traders prefer markets with insiders over markets without.

Traders prefer markets with insiders not only when they have a chance of being informed themselves (Bodoff et al., 2006), but also when they do not (Nöth and Weber, 1996). Nöth and Weber explain this preference with the overconfidence of uninformed traders (i.e., that uninformed traders believe they can extract information from the price and can then outperform other traders). Furthermore, uninformed traders prefer markets with more than

[12] In particular, it is a higher "heterogeneity of fundamental information" (i.e., a higher difference of the expected dividend of the long-lived asset for the different information levels) that causes fat tails and volatility clustering in Kirchler and Huber (2007). This "heterogeneity of fundamental information" takes form through the arrival of new information to the market.

one insider over markets with one insider, and uninformed traders prefer markets with public knowledge about the number of insiders over markets without such knowledge (Nöth and Weber, 1996).

3.5.3. Endowment effect

Observation 12. The endowment effect exists for both informed and uninformed traders.

Traders tend to keep more assets (cash) in their portfolio when they are endowed with only assets (cash) at the beginning of the experiment (Krahnen et al., 1999). Krahnen et al. interpret this as evidence for the endowment effect. Whether this effect is stronger for informed or uninformed traders is unclear, as in Krahnen et al. the effect is stronger for uninformed traders and in Güth et al. (1997) the effect is stronger for informed traders. Güth et al. further find that the endowment effect is weaker for uninformed rich (i.e., more highly endowed) traders than for uninformed poor traders.[13]

3.6. Liquidity

3.6.1. Limit Orders vs. Market Orders

Observation 13. Insiders provide liquidity at the beginning of the period and uninformed traders take over towards the end, as the price becomes more efficient throughout the period. The evidence on who provides more liquidity overall is inconclusive.

Many experiments show that insiders trade mainly via market orders at the beginning of the trading period (Cason, 2000; Bloomfield et al., 2005; Majois, 2008; Bloomfield et al., 2009a; Chelley-Steeley et al., 2015), while uninformed liquidity traders prefer limit orders (Cason, 2000; Bloomfield et al., 2005).[14] This pattern reverses towards the end of the period. Liquidity traders thus provide liquidity mainly at the beginning, while informed traders take over towards the end. Bloomfield et al. (2005) attribute this effect to the continuous decrease of the value of information throughout the period, as the price of the asset converges to the fundamental value. Stöckl (2014) reports a different finding. He observes that insiders' choice between limit and market orders depends on the current outstanding offers relative to the fundamental value. When the fundamental value is inside (outside) the current bid-ask spread, insiders prefer to place limit (market) orders. Stöckl also reports that insiders prefer

[13] Güth et al. endow their participants with either cash or assets. In their experiment, rich traders receive either a higher amount of cash or assets than poor traders.

[14] Bloomfield et al. (2005) observe this effect for large liquidity traders. Large liquidity traders have a higher target number of transactions within a period than do small liquidity traders.

market orders whenever both order types lead to profitable trades, seeming to prefer realizing profits as soon as possible. Whether informed or uninformed traders place more limit orders and thus provide more liquidity is not clear (Stöckl and Kirchler, 2014; Bloomfield et al., 2015; Gozluklu, 2016).[15]

Further findings are that order book depth decreases when the fundamental value is more extreme (i.e., the number of shares at the best bid or ask price decreases when the fundamental value is farther from its expected value) (Bloomfield et al., 2009a), and that informed traders act as market makers when the designated market makers' attention is lower, leading to greater insider profits not only through the exploitation of the information advantage, but also of the bid ask-spread (Cabrera, 2017).

3.6.2. Volume

Observation 14. Whether asymmetric information in the market increases or decreases trading volume is inconclusive. However, better informed traders trade more than do less informed traders.

Similar to the results presented in the previous section, Camerer and Weigelt (1991) report that trading is concentrated at the beginning of the period when insiders are present in the market. Overall however, trading in Camerer and Weigelt is less intense when insiders are present. Alfarano et al. (2006) and Lin and Rassenti (2012) support this latter result, while Brünner and Levínský (2008), Chmura et al. (2019), Duxbury (2005) and Tung and Marsden (2000) find evidence against it. Interestingly however, better informed traders transact more assets than do less informed traders (Plat, 1997; Duxbury, 2005; Huber et al., 2008). Only Tung and Marsden (2000) do not find significant differences in the transaction volumes of assets with different levels of quality of insider information. Furthermore, different probabilities for being detected or different levels of punishment do not affect the assets' trading volumes in Tung and Marsden.

Further results show that trading volume is higher and price efficiency is lower when the period length is randomly determined (and unknown to the participants), compared to markets with constant period lengths and to markets with random but known period lengths (Duxbury, 1997, 2005). This effect of a higher volume and lower price efficiency in randomly

[15] In Stöckl and Kirchler , the uninformed traders provide more liquidity, while in Bloomfield et al. insiders are the group of traders who provide slightly more liquidity. In Gozluklu , insiders provide as much liquidity through limit orders as do large (uninformed) liquidity traders.

determined periods is especially strong in the beginning of the period with a higher amount of informationally inefficient trades (Duxbury, 1997). Further circumstances that influence the trading volume in markets with asymmetric information are price efficiency (Corgnet et al., 2020), regulation (Ackert et al., 2001; Grégoire and Coupland, 2018), after time has elapsed within a period (Kirchler, 2010), and the number of traders in a market (Lundholm, 1991).

3.6.3. Spread

Section 3.3.2 includes the results on dealers' spreads, while here I review the results on spreads that are the outcome of traders' bid and ask offers.

Observation 15. Asymmetric information causes wider spreads. However, the competition of more insiders leads to narrower spreads.

Greater numbers of insiders in a market are associated with narrower spreads (Majois, 2008; Hornung et al., 2015; Palan and Stöckl, 2017). However, when comparing markets with and without insiders, asymmetric information causes wider spreads (Heilmann et al., 2001; Lin and Rassenti, 2012; Gozluklu, 2016). Heilmann et al. attribute this to participants acting as market makers in that they set both bid and ask prices and widen their spreads when insiders participate in the market.

Further research shows that spreads are wider in the presence of less risk averse traders (Ang and Schwarz, 1985). Reports on whether the disclosure of insiders' identities influences spreads are inconclusive (Perotti and Rindi, 2006; Majois, 2008).

3.6.4. Volatility

Observation 16. Volatility increases with increasing asymmetry in the distribution of information, but shrinks with more information in the market.

Asymmetrically distributed information increases volatility (Gozluklu, 2016) and volatility clustering (Kirchler and Huber, 2007), but a higher quality of information in the market, a higher quantity of information in the market, or both reduce volatility (Hey and Morone, 2004; Alfarano et al., 2006; Majois, 2008; Morone, 2008; Bossaerts et al., 2014; Chmura et al., 2019). One reason for this interesting effect could be the competition between insiders, which leads to a faster incorporation of insider information and thereby lower volatility (Majois, 2008; Bossaerts et al., 2014). Another reason for this effect could be the different nature of asymmetric information. In some of these studies information asymmetry means that additional (inside) information is in the market, while in other studies fewer traders hold the available information. Additional asymmetrically distributed information could reduce

volatility, while the same amount of information distributed asymmetrically could increase it. This could explain why inside information in the markets of Alfarano et al. and Chmura et al. reduces volatility.

Further results show that not only the spread is bigger, but also the volatility is greater for less risk averse traders (Ang and Schwarz, 1985) and that the disclosure of insiders' identities reduces volatility (Perotti and Rindi, 2006).

3.7. Efficiency and Information Dissemination

3.7.1. Price Efficiency

Observation 17. Futures and options markets operating alongside asset markets increase price efficiency.

The presence of a futures market (Friedman et al., 1984) or an options market (Jong et al., 2006), in addition to the continuous double auction market, increases price efficiency. Friedman et al. attribute this increase to a faster leakage of insider information through the additional derivatives market.

Observation 18. Price efficiency increases in the number of insiders.

Many papers report that price efficiency increases with increased competition between insiders (Nöth and Weber, 1996; Ackert and Church, 1998; Majois, 2008; Morone, 2008; Huber et al., 2011; Bossaerts et al., 2014; Stöckl, 2014; Palan and Stöckl, 2017; Corgnet et al., 2020). Furthermore, Bloomfield et al. (2009a) observe that efficiency decreases when more uninformed traders are present in the market.

Observation 19. Higher quality and quantity of information in the market increases price efficiency.

More information (Huber et al., 2011; Alfarano et al., 2015; Page and Siemroth, 2017) and a higher quality of information (Ackert et al., 1997; Morone, 2008; Alfarano et al., 2015) in a market increases price efficiency. Two rare counterexamples are Barreda-Tarrazona et al. (2017), where increasing the number of imperfect signals does not increase price efficiency, and Duxbury (2005), where more accurate information does not lead to more efficient prices. Barreda-Tarrazona et al. explain this with traders relying too much on their private information and extracting less information from the price, when they receive more imperfect signals.

Observation 20. Public Information can diminish price efficiency.

When (high-quality) public information is provided, traders buy less private information (Tucker, 1997; Alfarano et al., 2015). This can lead to decreasing price efficiency (Alfarano et al., 2015), but does not do so necessarily (Tucker, 1997). The authors do not provide any reason for these conflicting results. Tucker even excludes one potential reason, that could explain why in his experiment price efficiency increases with public information in the market, even though traders buy less private information. In Tucker's experiment, insiders sell their information with different levels of quality to uninformed traders. When public information provision increases, insiders could sell information with a higher quality, which could explain the different results of Alfarano et al. and Tucker, but Tucker does not find such an effect.

Observation 21. Experience increases price efficiency.

Many papers find evidence for learning. This learning takes place within periods (Stöckl, 2014), across periods (Duxbury, 2005; Bloomfield et al., 2009a; Barreda-Tarrazona et al., 2017), or when traders have participated in the same experiment before (Ackert et al., 1997; Ackert and Church, 1998) and leads to a declining pricing error. Two rare exceptions are Bouattour and Martinez (2019) and Kirchler (2010). In Bouattour and Martinez, price efficiency does not improve across periods, and Kirchler detects increased price efficiency neither across periods nor across repetitions with the same participants and information structure.

Observation 22. The effect of asymmetric information on price efficiency is inconclusive.

Some papers report higher price efficiency in the presence of informational asymmetry (Qi and Ochs, 2009; Sutter et al., 2012; Barreda-Tarrazona et al., 2017; Corgnet et al., 2020). In contrast, Kirchler (2009) and Bouattour and Martinez (2019) find that their respective symmetric information treatments are characterized by more efficiency, while Lin and Rassenti (2012) and Heilmann et al. (2001) report that price efficiency is not higher in their asymmetric treatments. In the markets of Brünner and Levínský (2020), the dissemination of asymmetric information depends on whether the participants trade the asset in a continuous double auction or in a call auction market. Note that in some of these studies information asymmetry means that additional (inside) information is in the market (e.g., Barreda-Tarrazona et al.), while in other studies fewer traders hold the available information (e.g., Corgnet et al.). Even though the nature of information asymmetry is different, it does not seem to influence these conflicting results.

Observation 23. The market structure can influence price efficiency.

Marsden and Tung (1999) find that the process of information dissemination may depend on the market structure, as prices in their simplified markets with less monitoring, lower penalties and only two instead of three levels of information (uninformed and imperfectly informed) reflect insiders' information better than their more complicated market setting. Ackert et al. (2001) find that circuit breakers do not seem to affect price efficiency. They conclude that circuit brakers only temporarily delay prices from moving in the direction they had moved in prior to the interruption. Vorsatz et al. (2020) compare two sequential markets with one asset on each market. The dividend of the two assets is correlated in one treatment, while in the other treatment the dividend outcome is independent. The results of Vorsatz et al. indicate that correlation reduces price efficiency. (See section 3.3.2 of the present paper for results on the circumstances that increase the price efficiency of dealer markets.)

Observation 24. Undervaluation and overvaluation affect price efficiency.

Some experiments exhibit bubbles or consistent overvaluation of the asset (Brünner and Levínský, 2020; cf. the literature in section 3.7.3). In such cases the possibility of short selling can increase price efficiency (Veiga and Vorsatz, 2008). Also, changes in participants' endowments can drive under- or overvaluation. Caginalp (2002) finds that a high (low) cash to asset ratio can lead to excessively high (low) prices and can thus decrease price efficiency. Furthermore, news arrival and traders' expectations can also cause over- and undervaluation. The results here are inconclusive. Brandouy et al. (2003) find that price efficiency increases in response to bad but not to good news. This is in contrast to the findings by Keser and Markstädter (2014) and Kirchler (2009). Prices in Keser and Markstädter are more efficient in good-state markets (high probability of a high dividend) than in bad-state markets (high probability of a low dividend). Kirchler observes that bullish markets (i.e., where the fundamental value is on average higher than its expected value) are more efficient than bearish markets, because the observed underreaction is smaller in bullish than in bearish markets. This leads to a smaller undervaluation of the asset in bullish and a greater overvaluation of the asset in bearish markets.

Observation 25. Whether transparency increases or decreases price efficiency is inconclusive.

Flood et al. (1998) observe that price efficiency increases with transparency regarding quote disclosure. In contrast, Gozluklu (2016) reports that the price is more efficient in a market with

the possibility of undisclosed orders, because insiders provide liquidity more aggressively. In a similar setting, Bloomfield et al. (2015) find no significant differences in price efficiency between less and more opaque markets. Only at the beginning of the period do Bloomfield et al. report that the more transparent market has higher efficiency.

Halim and Riyanto (2020) find that the obligation for insiders to disclose their trades and hold their assets for two periods decreases the informativeness of the price. The disclosure of the presence or the number of insiders leads to more efficient prices in Schnitzlein (2002) and Brandouy et al. (2003). However, Stöckl (2014) does not support this result, as in his experiment price efficiency does not change significantly when the number of insiders is public knowledge.

Other Findings

Further research shows that the asset's price converges to the expected value faster in markets with less risk averse traders (Ang and Schwarz, 1985), with more insiders (Bossaerts et al., 2014) or with fewer traders (Lundholm, 1991). A more extreme fundamental value increases price efficiency in Bossaerts et al. (2014), while it decreases efficiency in Chelley-Steeley et al. (2015) and in Palan and Stöckl (2017). Traders with a higher CRT score (cf., Frederick (2005)), a measure of cognitive reflection, produce more efficient prices (Corgnet et al., 2020). Many papers report that prices partially, but not fully, reflect informed traders' private information (Ackert et al., 2002; Bossaerts et al., 2014; Del Brio et al., 2016; Page and Siemroth, 2017).

3.7.2. Manipulation

The papers presented here define a manipulative action as insiders trading against their information in an attempt to mislead other traders regarding the asset's value.

Observation 26. Insiders use transparency to mislead the market. This manipulation does not necessarily lead to higher insider profits.

The results of Bloomfield and O'Hara (2000) and Hornung et al. (2015) suggest that insiders use transparency to mislead the market. Bloomfield and O'Hara report that insiders trade more against their information with transparent dealers, who disclose their trades, than with intransparent dealers. In Hornung et al., trading in a continuous double auction market is preceded by either a transparent or a non-transparent (regarding the order book) opening call auction. Hornung et al. observe that insiders manipulate prices in their transparent call auction markets. Linked with this finding is their result of insiders preferring to place small

instead of large orders. Hornung et al. interpret this as evidence that insiders try to avoid drawing attention. Grégoire and Coupland (2018) find indications for insiders manipulating the price of the asset they have information on, by trading against their information in this asset in an attempt to profit more from traders in a correlated substitute asset. Qi and Ochs (2009) shed light on whether these manipulative actions increase insiders' net profits. To manipulate prices, insiders in Qi and Ochs buy above and sell below a certain equilibrium price, which causes insiders to incur losses. Qi and Ochs find that insiders who initiate manipulative actions hardly profit sufficiently from the following trades to compensate them for the loss incurred. Insiders in the market can, however, profit greatly from manipulative actions by other insiders.

3.7.3. Herd Behaviour, Mirages and Bubbles

Observation 27 Herd behaviour causes irrational actions of traders in the market.

Ackert et al. (1997) find irrational behavior in one of their markets for information, where the price of information increases over time even though many other papers report a decreasing price for information (as pointed out in section 3.4.1). Ackert et al. attribute this to a certain group dynamic indicating herd behavior. They conclude that more research is needed on this topic. The results of one of the latter papers suggest that higher quality and quantity of information in the market reduces volatility and thereby herd behavior. The authors argue that a lower volatility implies less herd behaviour (Hey and Morone, 2004).

Observation 28. Information mirages can occur in markets where the presence of insiders is unsure. However, many different factors can decrease the probability for such an occurrence.

Traders deriving a false state of nature from the asset's price can cause an information mirage (i.e., a situation where traders erroneously believe that superior information is in the market), because they falsely believe insiders are leaking information even when no insiders are in the market (Camerer and Weigelt, 1991).[16] The probability of the occurrence of such an information mirage seems to be lower in call auction markets (Morone and Nuzzo, 2019), in markets with less risk averse traders (Ang and Schwarz, 1985), in markets with higher quality

[16] To control for mirages, researchers can take a closer look not only at the price, but also at which trader type holds the assets. In auctions with trader types that have different payouts, the FRE equilibrium predicts only trader types with the highest payout (in the drawn state of nature) hold the asset in the end of the period. Therefore, beside the asset's price moving to an inefficient equilibrium, another indication for a mirage is if the wrong traders (according to the FRE model) hold the assets.

of information (Copeland and Friedman, 1991), and when traders are experienced (Camerer and Weigelt, 1991; King, 1991). The introduction of a transaction tax (Morone et al., 2020) or circuit brakers (Ackert et al., 2005) does not seem to influence the occurrence of information mirages. However, Noussair and Xu (2015) observe more mirages in their experiment than do Camerer and Weigelt. Noussair and Xu attribute this to their experimental design leading to the transmission of sudden price movements from one market to another.[17]

Observation 29. Whether asymmetric information distribution hinders or facilitates bubble formation is unclear. However, higher information quality, experience and communication between traders can lessen bubble formation.

Imperfect inside information (Copeland and Friedman, 1991), the irrationality of traders and the uncertainty about the rationality of other traders (Camerer and Weigelt, 1991) are factors that cause bubbles. Besides a higher quality of information, the possibility of communication between traders (Oechssler et al., 2011) and the experience of participants (Camerer and Weigelt, 1991; King, 1991) can decrease the probability for the occurrence of bubbles. However, the monopoly of an insider can hinder this latter effect (Oechssler et al., 2011).

On the role of asymmetric information, the literature produces inconclusive results. Additional asymmetrically distributed information does not eliminate bubbles in Oechssler et al. (2011) and King (1991), and even facilitates bubble formation in Oechssler et al.. Contrary to these findings, Sutter et al. (2012) and Chmura et al. (2019) report that bubbles are less prone to form when they distribute information asymmetrically, compared to all traders having the same level of information. The results of Sakurai and Akiyama (2017) indicate that asymmetric information promotes bubbles in the call market, while it abates bubbles in the continuous double auction. It thereby depends on the market design in their experiment whether asymmetric information provision influences bubble formation.

3.7.4. Allocative efficiency

Observation 30. The papers analysing allocative efficiency report mixed findings.

Fewer papers analyse the allocative efficiency than the price efficiency, because in experiments with only one type of trader, no allocative efficiency can be calculated (as described in section 2.2). These papers report mixed findings. A greater number of insiders

[17] Noussair and Xu conduct an experiment with two simultaneously-traded assets with a life of two periods. The two assets can be independent, positively, or negatively correlated in the second period. In half of the repetitions, insiders are informed about the type of correlation. Camerer and Weigelt 's experiment employs one market with one asset, different trader types and Camerer and Weigelt inform insiders about the state of nature.

(Budescu and Maciejovsky, 2005) and a higher quality of insider information (Ackert et al., 2002; Duxbury, 2005) increase allocative efficiency. Reports on whether asymmetric information increases or decreases allocative efficiency is inconclusive (Bodoff et al., 2006; Qi and Ochs, 2009).[18] Variable period duration seems to influence allocative efficiency negatively only when the insider information is perfect (Duxbury, 1997, 2002). Pouget (2007) compares a call market and a Walrasian Tatonnement. In the Walrasian Tatonnement, the auctioneer announces prices for the asset and transactions take place as soon as supply equals demand at a certain announced price. Both markets do well in terms of price efficiency, but only the Walrasian Tatonnement provides allocative efficiency through replication. Pouget sees price uncertainty in the call market as the reason for preventing allocative efficiency.

3.8. Profits

In general, insiders are able to exploit their superior information leading to significantly higher profits. Yet there are many exceptions and factors influencing the success of informed traders. I review them in this section.

Observation 31. Higher (lower) price efficiency decreases (increases) insider profits.

Informed traders obtain higher profits when markets are less efficient (Sunder, 1992; Krahnen et al., 1999; Huber et al., 2008; Bloomfield et al., 2009a; Qi and Ochs, 2009; Gozluklu, 2016; Palan and Stöckl, 2017). In the experiment of Palan and Stöckl, insiders earn more the greater the distance between the liquidation value and the expected value of the asset. As the inefficiency of their markets is also greater in markets with a greater such distance, Palan and Stöckl conclude that insiders exploit the inefficiency of the market. This is in line with Observation 7, which states that certain insider trading regulations decrease price efficiency and thus increase insider profits. In the more complicated market setting of Marsden and Tung (1999), insiders succeed in outperforming uninformed traders (only before penalty payments), but after a simplification of the market (with less monitoring, lower penalties and only two instead of three levels of information), Marsden and Tung no longer observe significant differences in the profits of informed and uninformed traders. Marsden and Tung attribute this to better information dissemination in the simplified markets.

[18] Asymmetric information increases allocative efficiency in Qi and Ochs (2009), but decreases it in Bodoff et al. (2006) when insiders receive perfect information.

Observation 32. Experience of traders leads to higher price efficiency and to lower profits for insiders.

Increased experience of traders in later periods (Plott and Sunder, 1982; Ackert and Church, 1998; Ackert et al., 2001; Bodoff et al., 2006; Huber et al., 2008; Kirchler, 2010) and after time has elapsed within a period (Dittrich and Maciejovsky, 2002) decrease insider profits and uninformed (worse informed) traders' losses. Dittrich and Maciejovsky find that insiders can exploit their information only at the beginning of the period and that insiders do not earn significantly higher profits overall. Dittrich and Maciejovsky attribute this to the fast information dissemination in their markets. Huber et al. and Kirchler see the reason for decreasing losses of worse informed traders over time in an improved trading strategy of worse informed traders. Specifically, these traders no longer trade on their outdated information but rather randomize, since random trading yields them higher profits (Kirchler, 2010). These results, in combination with Observation 21 and Observation 31, thus show that experience leads to higher price efficiency and lower insider profits. Similar to the results above, Chmura et al. (2019) report that when uninformed traders gain experience, the inequality of the profit distribution decreases.

Observation 33. Higher quality of insider information increases insider profits.

In general, insiders earn more when the accuracy of information is higher (Ackert et al., 1997; Plat, 1997; Ackert et al., 2002). Furthermore, as mentioned in Observation 8, purchasing information is not profitable, especially when the quality of information is low. Only the results of Morone and Caferra (2020) suggest that the average profit inequality is lower in the case of a high quality signal (received by one fourth, half or all of the traders in their experiment).

Observation 34. The market structure can affect insider profits.

Cason (2000) finds informed traders to earn more in the continuous double auction market than in the dealer market with or without dealer communication. King et al. (1993) observe informed traders only outperforming other participants when short selling and buying on margin is possible. Morone and Caferra (2020) find in their treatments with lower precision of the information, that a higher degree of asymmetry (i.e., only one fourth of the traders holding the information, compared to half and to all traders) seems to lower the profit inequality. Interestingly, circuit breakers do not seem to influence traders' profits (Ackert et al., 2001).

Observation 35. Transparency reduces insider profits.

Insiders profit more (less) when the transparency regarding the disclosure of orders is low (high) and traders can (cannot) hide their orders (Flood et al., 1998; Bloomfield et al., 2015; Gozluklu, 2016). Banks (1985) reports that changing the identity of the insiders across periods increases insider profits, as it hinders uninformed traders to identify insiders. Furthermore, informed traders earn more in markets without public knowledge about the number of insiders (Nöth and Weber, 1996) and when the market they are active in is not common knowledge (Qi and Ochs, 2009). One surprising exception where transparency does not influence insider profits is Majois (2008). He does not find a significant difference in traders' profits through the disclosure of informed traders' IDs. Majois claims that it is not the identification of insiders, but bid and ask offers, that help uninformed traders best uncover insider information.

Observation 36. Competition decreases insider profits.

A monopolistic insider, unsurprisingly, earns higher profits than more competing insiders (Gozluklu, 2016; Palan and Stöckl, 2017). Lamoureux and Schnitzlein (2004) report that dealers earn more (at the expense of uninformed traders) when they are in direct competition with each other in three assets than when they compete directly in one asset, while informed traders earn the same in each setting. Halim et al. (2019) observe that the dispersion in profits decreases when insiders have to share the information with more traders.

Other findings

As reviewed in section 3.4.1, traders who buy costly information earn similar or even smaller net profits than do uninformed traders. As stated by Observation 9, only the best-informed traders significantly outperform traders with other information levels, while some moderately informed traders perform even worse than the entirely uninformed. A more cautious approach by uninformed (liquidity) traders, to meet their transaction goals mainly at the end of the period where the price is closer to the fundamental value, can decrease uninformed traders' losses (Bloomfield et al., 2005). Bodoff et al. (2006) find that informed traders benefit at the expense of the uninformed in the case of bad news, but not in the case of good news. Kirchler (2010) reports that overconfidence is not a reason for less informed traders to perform worse. He even finds less informed traders tending towards being underconfident.

3.9. Ethics

The three experiments presented in this section analyse participants' trading based on their score in the Defining Issue Test (DIT) or the Defining Issue Test-2 (DIT-2). These tests are used to measure moral reasoning. (cf., Rest (1979))

Observation 37. Insider trading increases in participants' scores in the DIT and DIT-2 tests.

Traders who engage in insider trading score lower in the DIT (Abdolmohammadi and Sultan, 2002) and significantly fewer participants with high DIT-2 scores accept insider information (Fletcher-Brown et al., 2012).[19] Participants with high DIT scores profit less when they receive insider information (and are therefore asked to refrain from trading), indicating that higher DIT scores lead to less insider trading (Gaa et al., 2006). Furthermore, Gaa et al. find indications for cultural differences between participants in Canada and the Philippines. In the Philippines sample, more participants followed the rules and refrained from insider trading when forbidden.

4. Concluding Remarks

In this paper I review all relevant literature concerning asset market experiments with insider information. The greatest challenge is to summarize all the main findings in one article, as there are many different hypotheses analysed, the designs of the experiments vary greatly and to include every single result would go beyond the scope of this paper. Nevertheless, this article is intended as a helpful tool for exploring what research has been carried out so far in the field of experimental asset markets with insiders. Future experimental research can broaden and deepen our understanding of the role insiders play in asset markets, as some results presented here lack reliable explanations and certain topics have not been covered by existing experiments yet. In my opinion, ethics is one of the most interesting and promising fields for future experimental research. Specifically, exploring the reasons that drive traders to not comply with insider trading laws could help governments around the world to adapt their regulations.[20]

[19] Participants in the experiment of Abdolmohammadi and Sultan (2002) and Fletcher-Brown et al. (2012) can actively decide to use or to refrain from insider trading, i.e., from accessing information classified as being illegal.

[20] Beams et al. (2003) investigate this topic with a questionnaire. Their results could serve as a basis for the exploration in an experimental asset market.

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