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Bayesian approach for the value of ambiguous information: theoretical and empirical evidence

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ABSTRACT

Liquidity traders perceive disclosures of insider trading as ambiguous pieces of information, as they may not be able to assess whether the trades are motivated by significant privileged information related to the true share value, or by other uninformative factors. This paper establishes an algorithm, based on Bayesian inference that represents the rational value of ambiguous information associated with the disclosure of insider trading when market participants subsequently anticipate material information that may or may not follow.

We found that the theoretical value has a statistically significant predictive power for the actual market reaction to these disclosures. We find an overall one-day excess return is in the neighborhood of one percent (and higher for insiders who have a controlling position). However, the ex-post 30- and 90-day single-factor-CAR, are significantly higher, which conforms to the notion of ambiguity.

The small difference between the actual market reaction and the theoretical derivation (0.9674% vs. 1.328%) does **not** necessarily imply that the market underestimates the value of this type of information, as it may be related to the period until the value of the information is nullified because no new confirming information follows the disclosure.

Keywords: Disclosure, Insider trading, Ambiguity
JEL Classification: G02, G14, G32, G34

1. Introduction

Disclosure of insider trading, which has become mandatory in most of the security exchanges worldwide, sends an ambiguous signal to market makers and liquidity traders who attempt to assess the nature of this new information. The notion of ambiguity does not stem from uncertainty regarding standard future-related cash flows projections, as it may represent ambiguous assessments made by uninformed market participants about the nature of the information possessed by insiders. In other words, given the standard underlying distribution of future cash flows, the interpretations of the information content of these disclosures follow a different unrelated unknown distribution and therefore should be construed as ambiguous signals (see e.g., Bossaerts et. al., 2010 who models ambiguity aversion).

Insiders, who are assumed to possess superior privileged information, trade for various reasons, which may be unrelated to their evaluation, unknown to liquidity traders, of the value of the firm. Insiders may trade for reasons such as rebalancing their portfolios, personal money management, and more. Insiders trading may be motivated by a desire to redistribute the firm's value among the shareholders by, for example, changing the power of control[1]. Furthermore, as reported by Hauser and Kriazberg (2003), insiders are contrarian investors acting against the market trend, rather than acting on idiosyncratic new information, while Chowdhury, Howe, and Lin (1993) found that insiders follow the market trend.

Carlton and Fischel (1983) argue that there is no relationship between the value of a firm and the level of corporate insider trading activity in the firm. Hence, given that the signal is ambiguous, liquidity traders may be hesitant to act on the disclosures that follow insider trading. Additionally, liquidity traders may not be able to assess if insiders possess new information, or that a portion of the value of the new information has already been embedded in market prices, especially if insiders' activity, before the disclosure, has affected market prices. This ambiguity is translated into higher volatility of stock returns after the disclosures of insider trading, as reported by Chiang, Chung, and Louis (2017).

A broader spectrum of theoretical issues, such as the social value of information and no-trade theory is intertwined with the issue at hand. Hirshleifer (1971); Jaffe (1975); Ng (1975); Milgrom and Stokey (1982); Hakansson, Kunkel, and Ohlson (1982); Alles and Lundholm (1993); Zhang (2001) and recently, Maurer and Tran (2016, 2018), examine the social value of an unexpected release of public information in a pure exchange economy.

These theories have been applied in the justification of the mandatory disclosure regulations. There is a consensus that the disclosure of insider trading increases the informational efficiency of markets by contributing to the existing information set, held by liquidity traders. This idea is stated by Manne (1966), followed by John and Mishra (1990); John and Lang (1991); Zhang (2001), and Chau and Vayanos (2008).

[1] This is common in stock exchanges worldwide in which control is a prevalent phenomenon and insider trading is hardly an indication of new information regarding the value of the firm.

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Naturally, it raises the issue of the optimal timing in which the disclosures are made, i.e., the optimal trading strategies by insiders (Kyle (1985); Huddart, Hughes, and Levine (2001); Caldentey and Stacchetti (2010) and others). Recently, Bolandnazar, Jackson, Jiang, and Mitts (2020) demonstrate that trading intensity and the pace at which prices incorporate information decrease with the expected delay until public release, but the relation between trading intensity and time elapsed varies with traders' learning process.

It seems that the underlying assumption of the above studies is that insider trading is motivated by new privileged information regarding the overall value of the firm, while potential ambiguity has not been dealt with directly. Perhaps this is one reason (in addition to methodological issues that are discussed below) why the empirical results reported in the literature are not conclusive. There is a vast body of event studies, estimating the pre and post-impact of information after disclosure of insider trading, mostly utilizing the single-factor-CAR as a measure of ex-post market efficiency.

The following studies reported a significant positive long-term abnormal return: Pratt and DeVere (1970) reported a six months (NYSE) CAR of 19.5% for purchases and 8.4% for sales. Jaffe (1974b) reported 0.7% (NYSE), Finnerty (1976) reported an eleven months (NYSE) CAR of 8.61% for purchases, Baesel and Stein (1979) reported a twelve months (Canada) CAR of 7.2% for purchases, Cheuk, Fan and So (2005) (Hong Kong) 0.58% twenty days CAR for purchases, Betzer and Theissen (2007) 3.6% (Germany) for purchases.

The following studies reported a nonsignificant or negative long-term excess return: Finnerty (1976a) reported an eleven months (NYSE) CAR of -4.72% for sales, Bettis, Coles, and Lemmon (2001) reported -2.74%, Friederich *et al.* (2002) -0.89% (UK) for purchases and -0.295% for sales, Hillier and Marshall (2002) -4.62% (UK), for purchases, and -0.47% for sales, Del-Brio, Miguel and Perote (2002) reported zero CAR for purchases, Betzer and Theissen (2007) -3.05% (Germany) for sales, Cheng, Nagar, and Rajam (2007) -0.15% for purchases (S&P) and -0.43% for sales.

The following studies assess the information content of the disclosure of insider trading by measuring the immediate market reaction following the disclosures: Cornell and Sirri (1992) using intra-day data. Damodaran and Liu (1993) state that insiders buying (selling) after they receive favorable (unfavorable) news, elicit significant positive abnormal returns. Seyhun (1986a,b) and Pascutti (1996) find that insiders activity has informative value triggering market reactions. Lakonishok and Lee (2001) state that the informativeness of insiders' activities is associated with purchases only, Jagolinzer, Larcker, and Taylor (2011) assess the relationship between Corporate Governance and the information content of insider trades, Degryse, Long and Lefebvre (2013) find that insider purchases in Germany are followed by significant abnormal returns, especially for purchases made by top executives, Ozkan and Trzeciakiewicz (2014) report the market reaction to insider purchases during the financial crisis. See additional studies in Clacher, Hillier, and Lhaopadchan (2009) that supply an excellent literature review.

There are methodological issues that may explain the variance in the reported finding. Long horizon-CAR may reflect subsequent new unrelated information that was not possessed by insiders at the time of the initial disclosure. The choice of a particular sample period has been shown to have a significant impact. The definition of insiders who possess privileged information is an issue as well. The use of a single-index-CAR is subject to a methodological debate; Lin and Howe (1990) analyzed the performance of insider trading in firms that are traded on the OTC/NASDAQ market, using three different measures of abnormal performance. Recently Ben-David, Bhattacharya, and Jacobsen (2020) challenge the use of the single-index CAR. Finally, as mentioned above, it is not obvious, whether insiders follow/contradict overall market trends, or that they act on new idiosyncratic privileged information.

We believe that the distinction between the immediate short-term market reaction to the disclosures, and the longer-term, so-called ex-post CAR, is important. We argue that the information content, associated with the disclosures of insider trading is ambiguous, and therefore the expected immediate market reaction is very different, then the longer-term reaction, given that material relevant information may or may not follow and confirms the fact that insiders traded on privileged information.

This study differs from previous studies in several respects. First, we rationally model ambiguity of the information content of these disclosures, demonstrating that upon a disclosure, liquidity traders may possess a non-trivial option, thereby ensuring its non-negative value for this ambiguous piece of information. We calculate, utilizing Bayesian analysis, the theoretically derived value and compare it to the empirical finding. We may be able to identify the period until the market realizes that in some cases, an insider trade is not motivated by new private information. This is done by calibrating the theoretical derivation with the actual immediate, empirically observed excess return. Finally, if our derivation is positively correlated with the empirically observed excess returns, it may substantiate our notion of ambiguity. We also test whether other variables, such as market cap, EPS, and power of control, may explain the magnitude of market reaction to insider trading.

2. The setting and definitions

Market participants include rent-seeking insiders who may possess private superior information, active or passive[2]

[2] We identify two market-making regimes. The empirical part of this study is done in the Tel Aviv Stock Exchange. Thus, the role of the market makers is omitted because the market makers in the TASE receive indirect significant benefits for being market makers, which are not related to the traditional direct trading benefits that, for example, market makers in the US may extract. The Israeli SEC enacted the system of market makers in 2003. As of 2017 there were market makers for only 247 securities.
Market makers are obliged to provide bid-ask spreads during the entire trading day, except for a 100-minute break. The required minimal amount for each side of a spread is negligible (2000–20000 NIS) and the spread may not exceed 2%–8%, depending on the category of securities. In exchange, the market makers receive benefits, which are unrelated to the actual trading of the securities that they provide the

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market makers, and uninformed liquidity traders and noise traders [3]. Specifically, the identity of the participants will be characterized by the set of information that they possess.

The period of events is as follows: before time *t*, there is a known set of publicly available information, $\{¶_t\}$,, shared by the liquidity traders and the market makers. Simultaneously, there is a set of information that evolves over time, $\{¶^{\mathrm{I}}_{\tau},\ \tau \leq t\}$ that is possessed by insiders only.

At the time $t-\varepsilon$ an insider decides to trade and subsequently reports it at time *t*. The cumulative executed trades before *t* is Q_t. Insiders optimize their strategy, embedding potential market reaction after the disclosure. This type of framework is established in Kyle (1985); Huddart, Hughes, and Levine (2001), and Caldentey and Stacchetti(2010). The probabilities of the parameters affecting their optimal strategy are unknown to liquidity traders**,** thereby implying ambiguity of the information content of these disclosures. Thus, the focus of this study is to assess the rational market reaction to the disclosures given that the parameters that drive insiders' optimal strategy are unknown. We assume that their trades do not affect market prices before the disclosure, so no portion of the value of their superior information, if any, is captured by the market price. In other words, for our analysis, market makers and liquidity traders have no updated information until the disclosure is made.

Once the news about an insider's trade is disclosed to the public, the newly updated set of information possessed by liquidity traders, $\{¶^*_t\}$ is not identified yet to $\{¶^{\mathrm{I}}_{\tau}\}$ as they are not certain whether the information possessed by insiders is related to the overall value of the firm's equity. At some point in the future, $t+1$ or continuously thereafter, the set of information $\{¶^*_{t+1}\}$ is updated and coincides with $\{¶^{\mathrm{I}}_{\tau}\}$. In other words, the firm discloses a confirming piece of news or that liquidity traders realize that the initial disclosure was uninformative (see the empirical conclusion). Thus, $\{¶^*_t\}$ is the set of information that may lead market makers to update their bid-ask spreads, following the disclosure, which may subsequently attract liquidity traders. Finally, $\{¶^*_{t+1}\}$ is the so-called ex-post set of information, after new confirming information may or may not follow the disclosures.

By definition, the valuations of the underlying prices-per-share, *P*, are:

$$\mathrm{P}^*_{\mathrm{t}} = \mathbb{E}[P \mid ¶^*_t, Q_t] \quad \text{and} \quad \mathrm{P}^{\mathrm{I}}_{\mathrm{t}} = \mathbb{E}[P \mid ¶^{\mathrm{I}}_t, Q_t \mid \mathrm{P}^*_{\mathrm{t}}] \qquad (1)$$

For the liquidity traders and the insiders, respectively, given that insiders embed expected market reaction to the disclosure into their valuations. By assumption, there is no reason to believe that any portion of their superior information, if any, is embedded in market prices before the disclosure.[4]

There is a positive probability that at the time of the disclosures when an insider decides to trade due to what we label as "uninformative" reasons. Yet, the insider needs to embed potential market reaction to the disclosure. Thus, the insider's valuation may still be different than this of the liquidity traders:

$$\mathrm{P}^*_{\mathrm{t}} = \mathbb{E}[P \mid ¶^*_t, Q_t] \quad \neq \quad \mathrm{P}^{\mathrm{I}}_{\mathrm{t}} = \mathbb{E}[P \mid ¶^{\mathrm{I}}_t, Q_t \mid \mathrm{P}^*_{\mathrm{t}}].$$

Finally, we concentrate on the price-per-share rather than on the overall value of the underlying firm, as some of the insider trading's are motivated by their desire to redistribute the firm value among the shareholders,[5] rather than being motivated by privileged information about the overall value of the firm's equity.

2.1 The model

It is assumed that the overall value of the firm's equity, *V*, evolves over time as a Geometric Brownian Motion given the two different initial boundary conditions (1) with the parameters $\mu(¶_t) = \mu(¶^*_t), or,\ \mu(¶_t) = \mu(¶^{\mathrm{I}}_{\tau})$ and $\sigma(¶_t) = \sigma(¶^*_t),\ or,\ \sigma(¶_t) = \sigma(¶^{\mathrm{I}}_{\tau})$, i.e.,

$$dV_t/V_t \mid ¶_t = \mu(¶_t)dt + \sigma(¶_t)dZ_t \qquad (2)$$

Implying that,

$$dP_t/P_t \mid ¶^*_t = \lambda(¶^*_t)dV_t/V_t \qquad (3)$$

Where if $\lambda(¶_t) \neq 1$, it reflects disclosures of insider trading that may be assessed as being informative with respect to redistribution of the firm's equity among the shareholders.[6]

We make the assumption that $dV_t/V_t \mid ¶^*_t$ and $dV_t/V_t \mid ¶^{\mathrm{I}}_t$ are bivariate lognormally distributed. Define, $x_1 = dV_t/V_t \mid ¶^*_t$ and $x_2 = dV_t/V_t \mid ¶^{\mathrm{I}}_t$, and $\mathrm{y}_{i,i=1,2},= g(x_i)$, then the conditional density function, $g(x_1 \backslash x_2)$ is,

$$g\ (x_1 \backslash x_2) = \frac{1}{x_1 \sigma_{y_1 \backslash y_2} \sqrt{2\pi}} \left\{ exp \left[-.5 \left(\frac{\ln x_1 - \mu_{y_1 \backslash y_2}}{\sigma_{y_1 \backslash y_2}} \right)^2 \right] \right\}$$

$\sigma_{y_1 \backslash y_2}$ $\mu_{y_1 \backslash y_2}$

$$Where \quad \mu_{y_1 \backslash y_2} = \mu_{y_1} - \left[\rho \frac{\sigma_{y_1}}{\sigma_{y_2}} (\ln x_2 - \mu_{y_2}) \right] \quad and \quad \sigma_{y_1 \backslash y_2} = \sigma_{y_1} \sqrt{(1-\rho^2)} \qquad (4)$$

With a positive probability that $(x_1 \backslash x_2) = g\ (x_2 \backslash x_1)$, i.e. an insider's trade takes place and yet, $dV_t/V_t \mid ¶^*_t = dV_t/V_t \mid ¶^{\mathrm{I}}_t$.

We wish to derive the rational market reaction to an insider's trade, i.e. what is the "best estimator" and the price of uncertainty associated with the parameters of *g(.)*, given that an insider's decision to trade is an ambiguous piece of information. We will establish, step by step, a framework to obtain the above premium.

a) First, for argument sake, assume that the insider, who decides to make a trade motivated by new undisclosed information, could[7] follow the strategies:

$If \quad P(¶^{\mathrm{I}}_{\tau} \mid \mathrm{P}^*_{\mathrm{t}}) > P(¶^*_t) > P(¶_t)$ In addition to a long position in the underlying shares, he/she could buy an equivalent standard put option, $PT = f(P(¶_t), \tau; \mathrm{P}(¶_t))$ at the pre-disclosure market price, while the insider's valuation is,

bid-ask spreads for. There is an extensive body of literature analyzing the role of market makers in the US, with various assumptions such as risk attitude, horizon, size, etc. See Armstrong (1995) for a good summary.

[3] Black (1986) and DeLong, Shleifer, Summers, and Waldmann (1990) defined noise traders, as distinct from liquidity traders, trade on the basis of what they believe, falsely, is special information.

[4] Regulations in most worldwide exchanges ban insiders from trading if the mandatory disclosure date of their trades follows the date of publicly releasing significant information such as financial reports

[5] Such as the control shifts. In TASE most of the insiders' trades are motivated by this factor.

[6] Computable, for example by using Shapely and Shubik(1954) or Owen(1972)-Teall(1996) power indices.

[7] We emphasize the word "could" because irrespective of whether insiders are actually engaged in this strategy, or could be engaged in this strategy – the unique rational value should be the same.

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$PT = f\left(P\left(¶_t^{\mathrm{I}}\right), \tau; \mathrm{P}(¶_t)\right)$ (i1)

If $P(¶_\tau^{\mathrm{I}} \square \mathrm{P}_{\mathrm{t}}^*) < P(¶_t^*) < P(¶_t)$ In addition to a short position in the underlying shares, buy an equivalent standard call option,

$C = f(P(¶_t), \tau; \mathrm{P}(¶_t)).$ (i2)

These strategies are hypothetical that enable to derive the pricing algorithm, and therefore it is reasonable to assume that if the insider does or does not actually take the option position; it does not alter the public set of information.

Similarly, upon disclosure, a liquidity trader can buy a put option if an insider discloses a buy trade, $PT = f(P(¶_t^*), \tau; P(¶_t^*))$ (**p1**), and a call option $C = f(P(¶_t^*), \tau; \mathrm{P}(¶_t^*))$ if an insider discloses a sale trade (**p2**).

Implementing the call-put parity on (i1) and (p1) implies that upon the above strategy, an insider or a liquidity trader, hold in fact a standard call option and a riskless bond in the amount of $\mathrm{P}(¶_t)e^{-r\tau}$, and implementing the parity on (i2) and (p2) implies that an insider or a liquidity trade hold in fact a standard put option and a short position in a similar riskless bond.

As time evolves following the disclosure date *t*,

$C = f(P(¶_t^*), \tau; \mathrm{P}(¶_t^*)) \Rightarrow C = f\left(P\left(¶_t^{\mathrm{I}}\right), \tau; \mathrm{P}(¶_t^*)\right)$ and

$PT = f(P(¶_t^*), \tau; P(¶_t^*)) \Rightarrow PT = f\left(P\left(¶_t^{\mathrm{I}}\right), \tau; P(¶_t^*)\right)$ (5)

If subsequently new additional confirming information is disclosed to the public, or, in absence of new information, the value of information associated with the disclosure of insider trading is diminished.

b) Utilizing RNVA in a continuous-time framework, and a two-moment framework, the drift is set to be the riskless rate of return and requires only the estimation of the future volatility of the underlying asset. Yet, RNVA is a partial equilibrium framework where the value of the underlying asset is set exogenously. Thus, the change in insiders' set of information that the liquidity traders try to infer must also include the change, if any, in the initial share price, i.e., the initial boundary condition for (2), reflecting the inferred change in the expected rate of return, as well as the change, if any, in the underline volatility.

Our settings about the behavior of the volatility, differ from those in Hull and White (1987) and Heston (1993), as we only need to estimate the **temporal** density function that describes the behavior of the volatility at time *t*, so we do not need to assume its time-dependent stochastic behavior. In other words, there is reason to believe that upon disclosure of insiders' trades, once the liquidity traders set their beliefs about the expected volatility, they do not change their assessment over time in absence of new additional information.

Thus, we take the following avenue: insiders' valuation of the underlying share price, unknown to liquidity traders, $P(\mu^I, \sigma^I; ¶_\tau^{\mathrm{I}}) \square \mathrm{P}_{\mathrm{t}}^*$ is truncated at $\mathrm{P}(¶_t^*)$ and thereby affecting the value of the call or put option that they hold. For example, if they possess positive information, we can order their potential valuations as a monotonically increasing values, starting at $\mathrm{P}(¶_t^*)$. Thus, $\overleftrightarrow{P}(\mu^I, \sigma^I; ¶_\tau^{\mathrm{I}}) \square \mathrm{P}_{\mathrm{t}}^*$ is a vector bundle of potential initial boundary conditions, such that for each point on the vector, *P* is lognormally distributed.

We create a corresponding vector of implied volatilities, $\overleftrightarrow{\emptyset}$, that solves the following set of equations,

$\overleftrightarrow{C}[= f(\overleftrightarrow{P}, \sigma^I, \tau; \mathrm{P}(¶_t)) \square \mathrm{P}_{\mathrm{t}}^*] = \overleftrightarrow{C}_{\emptyset}[= f(P(¶_t), \overleftrightarrow{\emptyset}, \tau; \mathrm{P}(¶_t))]$ (6)

i.e., a point on this vector $\overleftrightarrow{P} \square \mathrm{P}_{\mathrm{t}}^*(\mu^I, \sigma^I; ¶_\tau^{\mathrm{I}}$ corresponds to a point in the vector $\overleftrightarrow{\emptyset}$ where $\overleftrightarrow{\emptyset}$ is solved given the publicly known underlying share price at the time of disclosure. $\emptyset$ is an artificial variable whose relationship to $\sigma^I \square ¶_\tau^{\mathrm{I}}$ is unknown to the liquidity traders. Given the assumed density function for *P(.)*, $\overleftrightarrow{\emptyset}$ is gamma-distributed, $\emptyset \sim \Gamma(\alpha, \beta)$ where the shape and scale parameters, α, β, will be specified below.

c) In absence of any additional new information other than a buy or a sell by an insider, we wish to establish the best estimator of $\emptyset$. Thus, we utilize Bayesian theorem to create this estimator. First, the mean and the variance of the prior $\sigma^2(¶_t)$ are $\mu\left(\sigma^2(¶_t)\right)$ *and* $\widetilde{\sigma^2}\left(\sigma^2(¶_t)\right)$, respectively will serve as the prior information. Asparouhove and Muthen (2010) and Muthen (2010) demonstrate that the shape parameter __ and the scale parameter __, such that $\emptyset^2 \sim I\Gamma(\alpha, \beta)$ are,

$$\alpha = 2 + \frac{\mu\left(\sigma^2(¶_t)\right)^2}{\widetilde{\sigma^2}\,(\sigma^2(¶_t))} \quad and \quad \beta = \mu\left(\sigma^2(¶_t)\right) + \frac{\mu\left(\sigma^2(¶_t)\right)^3}{\widetilde{\sigma^2}\,(\sigma^2(¶_t))} \qquad (7)$$

Where $I\Gamma(\alpha, \beta)$ is the inverse gamma distribution. The posterior probabilities $Pr[\emptyset \square ¶_t^*]$ are,

$$Pr[\emptyset \square ¶_t^*] \propto Pr[\sigma^2 \square ¶_t].\mathrm{Pr}[\emptyset \square ¶_t^* \sim \mathrm{I}\Gamma(\alpha, \beta)] \qquad (8)$$

Thus,

$$\emptyset^* = \mathbb{E}[\emptyset \square ¶_t^*] =$$
$$\mathbb{E}[\sigma^2 \square ¶_t].[\emptyset \square ¶_t^* \sim \mathrm{I}\Gamma(\alpha, \beta)] = [\sigma^2 \square ¶_t]\mathbb{E}[\emptyset \square ¶_t^* \sim \mathrm{I}\Gamma(\alpha, \beta)] \qquad (9)$$

While $\emptyset^* > \sigma^2 \square ¶_t$

With certainty regarding the variance just prior to the disclosure. $\mathbb{E}$(.), the expected value of the implied volatility given the assumptions, does not, yet incorporate the risk associated with uncertain volatility. This will be done in (d).

d) We wish to establish the value of information embedded in the disclosure of insiders trading that should represent the rational market reaction, i.e., the absolute value $|P(¶_t^*) - P(¶_t)|$. We will demonstrate that the absolute value is in fact the value of a certain **additional** option, *CC(.)*, or *CP*(.) whose characteristics will be identified below. If $|P(¶_t^*) - P(¶_t)|$ does not reflect the value of this option, then a liquidity trader, who takes a position upon disclosure, possesses a free option and the strategy of "buy/sell upon disclosure" dominates a "do nothing" approach, and therefore should yield an excess return.

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Proposition 1.

Given the assumptions above, and in particular, the assumption about the temporal distribution of $\emptyset$, then,

If a "buy[8]" disclosure:

$$P(\P_t^*) - P(\P_t) = CC\{P(\P_t), \sigma^2 \,\|\, \P_t, \emptyset^*, \tau; P(\P_t)\}$$

If a "sell" disclosure:

$$P(\P_t) - P(\P_t^*) = CP\{P(\P_t), \sigma^2 \,\|\, \P_t, \emptyset^*, \tau; P(\P_t)\}$$

Where

$$CC\{P(\P_t), \sigma_c^2 \square \P_t, \emptyset^*, \tau; P(\P_t)\} = P(\P_t)\left[N\{0.5(\sqrt{\emptyset^*} - \sigma_c \square \P_t)\tau/\sqrt{\tau}\} - N\{0.5(\sigma_c \square \P_t - \sqrt{\emptyset^*})\tau/\sqrt{\tau}\}\right] \quad (10a)$$

Symmetrically, but with a different standard deviation,

$$CP\{P(\P_t), \sigma_p^2 \square \P_t, \emptyset^*, \tau; P(\P_t)\} = (\P_t)\left[N\{0.5(\sqrt{\emptyset^*} - \sigma_p \square \P_t)\tau/\sqrt{\tau}\} - N\{0.5(\sigma_p \square \P_t - \sqrt{\emptyset^*})\tau/\sqrt{\tau}\}\right] \quad (10b)$$

$$\sigma_c^2 \square \P_t = \sigma^2 \square \P_t \left[\frac{P(\P_t)}{C(P(\P_t), \tau; P(\P_t))}\right] N(h_c)^9$$

$$\sigma_p^2 \square \P_t = \sigma^2 \square \P_t \left[\frac{P(\P_t)}{PT(P(\P_t), \tau; P(\P_t))}\right] N(h_p)$$

and $\emptyset^*$ is a fixed parameter given by (9), and N(.) is the standardized normal density. △

The immediate rates of return, R, for liquidity traders, are,

$$R = \frac{CC(.) - (P(\P_t^*) - P(\P_t)) + (1 - e^{-r\tau})\, P(\P_t)}{P(\P_t)e^{-r\tau} + c(.)} = \frac{CC(.) - P(\P_t^*) - e^{-r\tau}\; P(\P_t)}{P(\P_t)e^{-r\tau} + c(.)}$$

for (**p1**) above.

and $R = \frac{CC(\;) - (P(\P_t^*) - P(\P_t)) + (1 - e^{-r\tau})\, P(\P_t)}{P(\P_t)e^{-r\tau} + c(.)}$ for (**p2**), where both represent abnormal return.

The proof follows directly from Margabe (1978) and Stultz(1982). The underlying logic is straightforward: Both (10a) and (10b) imply that a liquidity trader, who could take a position (p1) or (p2) holds an option on the maximum of two assets (maximum of two calls in (p1) and maximum of two puts in (p2)), while shifting from one option to another is costless. The values of these options are (10), while, (i) based on the belief that export the options held by insiders and liquidity traders coincide in their values, as the superior information, if any, possessed by an insider is disclosed, or, the value of information embedded in the disclosure of insiders' trades diminishes to zero for lack of new disclosed confirming information. ii) The liquidity traders bet on the difference between the observed volatility and the Bayesian inferred volatility, and (iii), the volatilities of the options are extracted using the standard RNVA continuous-time framework.

There is a clear trade-off between the particularity of the assumptions that we make and the applicability of the above derivation.

Thus, we will compare the results to those of a parameterized test, in which we will regress the market reaction on variables such as type of insiders, the volume of the transactions, previous transactions, time of disclosure before or after closing, the multitude of insiders' trading, etc. Additionally, we test if other firms' characteristics, such as earning per share, sale, market cap, and power indices may explain the magnitude of the market reactions to disclosures of insider trading.

3. Data

During 2020, the TSE[10] has disclosed 13,459 trades that have been executed by insiders, where the latter are broadly defined by the TSE. About 20% of the firms are dual-listed on both TSE and the NASDQ. Rather than using all observations indiscriminately, we wish to isolate those arm's length trades that may contain new information, and yet avoid the use of a subjective judgment. Thus, we selected 2123 trades using the following rules that are likely to be used by the market participants as well,

a. We excluded repeated trades within one-week period, made by the same insider, and used only the first trade as we wish to detect a market reaction to an unexpected disclosure.

b. We eliminated trades by institutional investors who owned less than 5% of the shares during the entire period, as well as any block trading between two such institutional investors as one sells and the other buys.[11]We excluded end-of-quarter summary disclosures as specific trades have previously been disclosed.

c. We excluded grants of shares/options awarded to managers periodically, or

d. options that are exercised at the expiration date.

Insiders in our sample include the following categories of traders:

a. Control owners (with Shapley or Owen's power index of more than 0.9 (a combined score for all related control owners, if any).

b. Management (CFO, CEO, directors, and other major functions).

c. Institutional investors who own more than 5% of the shares (see below the definition of "purchase" or "sale").

We included trades of institutional investors labeled as "interested parties", adhering to the rules of the TSE that limit institutional participation in firms' decision process, but in fact, does not prevent them from being exposed to privileged information. Some institutions hold significant portions of the firms' outstanding shares and provide the major source of funding for the firms. Moreover, the data implies that when some particular money managers make a trade, the market believes that they possess superior information and therefore follow through.

3.1 The variables

- Raw prices

[8] See next section for definition of "purchase" and "sale".

[9] Following RNVA continuous time framework, $N(h_c)$ is the normal, zero mean density function of the term $\left[(r\tau + .5\sigma^2 \square \P_t))/\sigma^2 \square \P_t \sqrt{\tau}\right]$ where $\sigma^2 \square \P_t$ is the variance of the rates of return of the underlying shares.

[10] Tel Aviv Stock exchange. Regulations of the local SEC regarding insiders' disclosure have **not** changed during the sample period. As of the last day of the sample, all firms must report any size trades by insiders as broadly defined by the exchange..

[11] Institutional investors in the TSE do possess superior information, but there is no reason to believe that one possesses more information than the other.

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i) If the disclosure is made between the opening and closing hours of TSE:
The share/market price at the beginning of the day in which the disclosure was made
The share/market price at the end of the said date (The immediate effect).
The share/market prices 30 and 90 days afterward (The ex-pose effect).
ii) If the disclosure is made after closing hours of TSE:
The closing share/market price just before the disclosure.
The closing share/market price in the following day.
The share/market prices are 30 and 90 days afterward.
iii) If the firm is dual-listed on TSE and NASDQ:

If the disclosure is made during trading hours of the TSA-same as (i)

If the disclosure is made after the closing of TSE but before 4 pm EST, the opening and closing share price on the NASDQ.

The share/market price is 30 and 90 days afterward.

Reported "out-of-the exchange" transactions of major blocks of shares, were considered as follows:
A "sale" if the reported buyer did not have prior holdings as the selling entity was likely to have superior information relative to the buyer.
A "purchase" if the reported buyer did not have prior holdings if at the same time active managers added shares to their position.
A "purchase" if the buyer had prior holdings.
A "sale" if the reported seller had prior holdings.

- Control shifts require further considerations. The TSE is characterized by a highly concentrated holding pattern where most of the firms are controlled by a few shareholders. Hence, when an insider who is also a controlling owner discloses a transaction, or when a controlling owner transfers a bulk of shares to a new control owner there may be two conflicting effects (see Bebchuk 1994). First, the effects of these shifts are uncertain, as the "efficiency" of these shifts, using Bebchuk's terms is unpredictable. More importantly, when a controlling owner, for example, buys additional shares he/she sends a positive signal but on the other hand, he/she strengthens his/her control power, which may reduce the portion of the firm's value that "belongs" to the public. Using Shapley or Owen's power indices, in most cases, the indices are between 0.9 and 1, even before the control owner trades. This observation will require specific tests of our hypotheses on trades made by control owners.
- Dividend adjustments. Market Index prices are dividend-adjusted. If the firm had an x-dividend date within 90 days of the disclosure, prices were adjusted upward by the rate of dividend discounted by 25% statutory tax.
- The volume of insiders' transactions and the price, if any, at which the transactions were executed. The multitude of arm's length trades at the same day by various insiders, but not among themselves, were recorded as a net amount.
- Type of insiders as described above.
- Time of disclosure, within trading hours or after closing, as specified above.
- The most recent annualized 90-days standard deviation of the firm's daily rates of return, and the single-factor time-series "beta" of the firm's equity. Additionally, we calculated the mean and the standard deviation of the 30-days moving raw standard deviations over the most recent 90-days period (the last two parameters are needed the "priors" for our theoretical derivation, described in the previous chapter). We checked the accuracy of our computations of the raw standards deviations and their two distributional moments. The difference between 30, 90, 120-days annualized standard deviations was not significant. The share of all firms in the sample was traded at least once each day.
- The annual long-term rate of interest on nominal government debt, adjusted to one day, 30 days, and 90 days rates.
- Firm's characteristics: earnings per share, market capitalization held by the public (excluding control owners), and control power indices.
- CAR is calculated based on a single-factor model, where the time series "beta" of the firm's equity return is calculated for the broad market index, TSE90. However, since the sample includes all listed firms, the "beta" was calibrated such that the average "beta" is one for the entire sample.

3.2 Summary description of the data

The number of purchases by insiders is significantly higher than the number of sales during the sample period, 2020. Furthermore, the trade is unevenly spread over the year, where 20% of trades occur from November 15th to the end of December, and very few trades take place from the end of March to mid-May. The sample was collected during the Covid19-year, 2020, where January to February 20th and November 15th to the end of the year were bullish periods.

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Sample period	January 1st .2020 to March 31st, 2021*
First Half	January 1st 2020 to September 30th*
Second half	July 1st 2020 to March 31st 2021*
	*(90 more days for share prices)

Trades by type of insiders	Cntrol 40%	Management 33.33%	Institutional 26.67%
Buy/sell trades	Buy	sell	
	64.90%	35.10%	
Avergae time-series "beta"		0.836	
Average standard deviation		56.89%	

TABLE 1 - Summary of data

3.3 Hypotheses

We conjecture that overall,

H1-Disclosures of insider trading are significant informative signals, the immediate value of which should rationally be equal to the theoretical derivation described in Section 2.

H2-There is a positive correlation between the immediate market reactions to the disclosures of insider trading and the ex-post realization depicted by the 30 or 90-days CAR.

H3-A parameterized test that attempts to predict immediate market reactions based on known factors at the time of disclosure will have less predictive power than the theoretical value derived in Section 2.

3.4 Results

Initially, we will report the empirical finding, presenting the average abnormal returns and the percentage of observations that significantly deviate from the mean.

Type of sample	One-day average access return	dev*	Average 30-days CAR	dev*	Average 90-days CAR	dev*
Entire sample	**0.967%**	5.6%	**2.508%**	4.4%	**5.547%**	3.3%
First half of 2020	**0.991%**	7.1%	**2.201%**	4.9%	**2.459%**	4.4%
Second Half of 2020	**0.946%**	3.8%	**2.796%**	4.2%	**9.359%**	2.9%
By firm's average CAR	**1.076%**	2.7%	**2.095%**	4.3%	**7.507%**	1.6%
Volume weigted	**1.331%**	1.6%	**3.010%**	0.2%	**9.023%**	0.3%
Trades by control owners	**1.251%**	1.6%	**3.668%**	3.6%	**9.772%**	4.6%
Trades by management	**0.702%**	5.6%	**1.916%**	5.7%	**4.875%**	1.8%
Trades by institutional inv.	**1.028%**	1.0%	**1.989%**	5.2%	**1.470%**	4.4%
Trades - sale	**0.756%**	6.7%	**-1.398%**	3.7%	**-9.858%**	4.0%
Trades - purchase	**1.082%**	5.6%	**4.617%**	5.6%	**12.833%**	2.9%

* Percentage of observations exceeding two standard-deviations from fhe mean

TABLE 2 - Empirical finding

The one-day excess return, AR1, represents the immediate market reaction to the disclosures of insider trading, given that liquidity traders are unable to assess whether or not these trades are motivated by privileged information regarding the true value of the firm's shares. The ex-post realization, CAR30, and CAR90 represent the market ex-post assessments whether or not the initial insider trading was followed by confirming pieces of significant new information.

The observed immediate market reaction is slightly less than **one percent** of excess return. As we mentioned above, we excluded all disclosures that could not convey any new information. Had we used stricter, somewhat subjective selection rules, the excess return would be higher? The significantly higher CAR30 and CAR90 support our conjecture about the ambiguity of the information content of the initial disclosures.

We may proceed to analyze the main thrust of this study.

First, we question whether the theoretical derivation is a predictor of the immediate market reaction to the disclosures, that is, how the actual market reaction corresponds to our theoretical premium?

The average raw theoretical derivation, GAMMA1 (see Table 4 below) for the entire sample was 1.328% as opposed to 0.9674% for the actual data. We tested the predictive power of the theoretical value to the actual one-day excess return, AR1, as follows:

$$AR1_t = \alpha + \beta . GAMMA1_t + \varepsilon_t$$

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The results are statistically very significant.

We also tested the same on the adjusted derivation, GAMMA4 that represents a longer horizon until the market can assess the motivation underlying an insider's trade (see discussion below) and found similar results.

$$AR1_t = \alpha + \beta . GAMMA4 + \varepsilon_t$$

The relationship between 30-dyays CAR and GAMMA1 is significant as well.

$$CAR30_t = \alpha + \beta . GAMMA1 + \varepsilon_t$$

All sample for AR1 by Gamma1

Predictor	Coefficient	Standard Error	t	p-value	F
					10.41
Constant	-0.0034	0.0046	-0.744	0.45717	
GAMMA1	0.7006	0.2304	3.041	0.00243	

All sample for AR1 by Gamma4

Predictor	Coefficient	Standard Error	t	p-value	F
					9.27
Constant	-0.00339	0.00456	-0.743	0.4576	
GAMMA4	1.39109	0.45738	3.041	0.0024	

All sample for CAR30 by Gamma1

Predictor	Coefficient	Standard Error	t	p-value	F
					10.41
Constant	-0.0430	0.02241	-1.919	0.05536	
GAMMA1	3.6499	1.13122	3.227	0.00130	

TABLE 3 - The realtionship between the theoretical value and the actual market reaction

We need to elaborate further on the issue of the "market horizon", i.e., the time-span that liquidity traders may "patiently" wait until additional confirming information, following an insider's trade, is or is not disclosed. We need to elaborate further on this critical point.

The time horizon, mentioned above, is so-called the expiration date of the option underlying our theoretical derivation when the value of the option is nullified in absence of a disclosure of confirming information. In other words, the date at which liquidity traders realize, for example, that no positive news is likely to follow a purchase by an insider. A liquidity trader who acts on the news of an insider's trade may anticipate the release of significant information that motivated the insider to trade. If no new information is subsequently released, the liquidity trader may eventually realize that insiders' trades were not triggered by new information and the value of their option is nullified.

The choice of such a time horizon is critical in calculating the theoretical rational value of the information embedded in the disclosure of insider trading. We wish to analyze the difference if the horizon is say, *n* or *m* days, *n*<*m*, after a disclosure.

It is wrong to assume that the liquidity trader's option is a more valuable form, (i.e. longer horizon) as the likelihood of an insider trade being informative is **not** time-dependent, unlike the case of a standard option. It is easy to demonstrate that the longer the market assessment of the horizon, the lower the value of the option. A simple example will illustrate this conjecture:

Consider two potential horizons, *n and m*, *n*<*m*. Assume that there is a risk-adjusted probability p* that a new supporting information will follow an insider trade, i.e. the market believes that each day until the *n'th* or *m'th* day, the probability for disclosure is $p^* \left(\frac{1}{n}\right) or\ p^* \left(\frac{1}{m}\right)$ respectively. The value of information, if released, is *K*. It is straightforward to demonstrate that for any positive risk-free rate (or, correspondingly, non-risk-adjusted probability and any positive cost of capital) then,

$$Pv(K, n) > PV(K, m).^{12} \qquad (11)$$

Thus, we adjusted[13] the calculated theoretical value by implementing horizons of τ=1, 2, 3, 4, 7, 30-days. The results are reported in Table 4.

[12] Alternatively, we can illustrate the same conclusion utilizing the assumption that liquidity traders have heterogeneous beliefs regarding the horizon with a mean distribution of n. The market reaction to insider trading, i.e., the value of the option, should imbed the likelihood that each day after the disclosure some market participants will liquidate their positing being disappointed that no information follows the disclosure of insider trading. The longer the horizon, n, the lower will be the value of the option.

[13] The time factor was adjusted linearly but the value is concave with respect to time.

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Horizon	1	2	3	4	5	7	30
Value	1.865%	1.328%	1.084%	0.939%	0.840%	0.710%	0.343%

Table 4 - theoretical value as a function of horizon

The conclusion we can draw from Table 4 is that if we assume that the immediate market reaction to disclosures of insider trading is **rational**, then the horizon, until the value of the option is nullified, is between 3 to 4 days. Alternatively, one may conclude that the market underreacts to the information as the actual market reaction is lower than the raw theoretical derivation.

Finally, we wish to compare the predictive power of our theoretical derivation with that of other variables that are commonly utilized in the literature (See, for example, Lakonishok and Lee, 2001). We tested whether the magnitude of the abnormal returns if any, may be explained by other known variables such as the firms' EPS, the market cap excluding the portion held by control owners, and the Power Indices

Predictor	Coefficient	Standard Error	t	p-value	F
					1.9189
Constant	0.012652	0.0027864	4.5646	0.00001	
CAP	-0.000001	0.000001	-1.4004	0.1631	
EPS	-0.001519	0.0022148	-0.686	0.4671	
CONT	0.000053	0.0004968	0.107	0.9148	

Table 5.1 - All sample

Predictor	Coefficient	Standard Error	t	p-value	F
					3.1423
Constant	0.0207796	0.0028662	7.250	0.00000	
CAP	-0.0000022	0.0000013	-1.773	0.0787166	
EPS	-0.0032252	0.0081988	-0.393	0.6947062	
CONT	-0.0000554	0.0001009	-0.549	0.5842424	

Table 5.2 - Positive CAR

Predictor	Coefficient	Standard Error	t	p-value	F
					1.2053
Constant	-0.0136111	0.0026436	-5.149	0.000004	
CAP	0.0000007	0.0000006	1.098	0.277424	
EPS	0.0000613	0.0013413	0.046	0.963701	
CONT	-0.0001384	0.0000956	-1.447	0.153890	

Table 5.3 - Negative CAR

Predictor	Coefficient	Standard Error	t	p-value
Constant	0.0211000	0.0025	8.5916	0
CAP	-0.0000021	0.0000013	-1.9682	0.0506

Table 5.4 - All sample absolute values

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We find **no** support for this hypothesis, while in other studies, for example, the smaller the market cap the stronger is the market reaction (in terms of abnormal returns), but in our study, this result is not confirmed.

4. Conclusion

This study, utilizing Bayesian inference, derives the value of an ambiguous piece of the information associated with the disclosures of insider trading. It is demonstrated that upon a disclosure, liquidity traders may possess a non-trivial option so that the non-negative value of this information is ensured.

This study finds a strong relationship between the theoretical derivation and actual immediate market reaction to the disclosure of insider trading. If the market reaction is rational, then one may conclude that it takes 3-4 days until the market realizes that in some cases, an insider trade is not motivated by new private information regarding the value of the underlying shares.

The results substantiate the notion of ambiguity of the information content of the disclosures regarding insider trading. Thus, it is believed that this methodology can be applied to any case of ambiguous information.

References

Alles, M., and R. **Lundholm**, 1993, On the optimality of public signals in the presence of private information, Accounting Review 88(1), pp 93-112.

Armstrong, V.S., "A Theoretical and Empirical Analysis of Insider Trading Sanctions", PH.D. Dissertation, (1995), Arizona State University.

Asparouhov, T., and **Muthen**, B. 2010. Bayesian analysis using MPLUS, Technical implementation. Retrieved from http://www.statmodel.com/download/Bayes3.pdf.

Baesel, J.B. and G.R. **Stein**, 1979, The value of information: Inferences from Profitability if Insider Trading, Journal of Financial Quantitative Analysis, 14, p 553-571.

Ben-David, I., U. **Bhattacharya**, and S. **Jacobsen**, 2021, Do Announcement Returns Reflect Value Creation? (Not Really), WP January 13th.

Bebchuk, L.A, 1994, "Efficient and inefficient sale of corporate control", The Quarterly Journal of Economics.

Bettis, J. C., **Coles**, J. L., and **Lemmon**, M. L., 2001, Managerial ownership, incentive contracting and the use of zero-cost collars and equity swaps by corporate insiders. Journal of Financial and Quantitative and Analysis, 36 (3): 345-370.

Betzer, A., and **Theissen**, E., 2007. Insider trading and corporate governance: the case of Germany. European Financial Management (December): 1-28.

Black, F., 1986, Noise, Journal of Finance, 41, 529-543.

M. **Bolandnazar**, M., R. J. **Jackson** JR., W. **Jiang**, and J. **Mitts**, 2020, Trading Against the Random Expiration of Private Information: A Natural Experiment Journal of Finance VOL. LXXV, NO. 1.

Peter **Bossaerts**, P., P. **Ghirardato**, S. **Guarnaschelli** and W. R. **Zame**, 2010, Ambiguity in Asset Markets: Theory and Experiment, The Review of Financial Studies, Vol. 23, No. 4 pp. 1325-1359

Caldentey, R., and E. **Stacchetti**, 2010, Econometrica , , Vol. 78, No. 1 , pp. 245-283.

Carlton, D.W., and D.R. **Fischel**, 1983, The Regulation of Insider Trading, Standford Law Review, 893, pp 857-895.

Chau, M., and **Vayanos**, D. 2008. Strong-form efficiency with monopolistic insiders. The Review of Financial Studies 21 (5), 2275-2306.

Cheng, S., **Nagar**, V., and **Rajan**, M. V. , 2007. Insider trades and private information: the special case of delayed-disclosure trades. The Review of Financial Studies 20 (5): 1833-1864.

Cheunk, M. Y., **Fan**, D. K., and R.W. **So**, , 2006, Insider trading in Hong Kong: some stylized facts. Pacific-Basin Finance Journal 14: 73-90.

Chiang, C.H.. , S. G. **Chung** and L. **Henock** , 2017, Insider Trading, Stock Return Volatility, and the Option Market's Pricing of the Information Content of Insider Trading, Journal of Banking and Finance Vol. 76, (March 2017): 65-73.

Chowdhury, M., J.S, **Howe** and **J.C. Lin**, , 1993. The Relation Between Aggregate Insider Transactions and Stock Market Returns. Journal of Financial and Quantitative Analysis 28: 431-437.

Clacher, I., D.J**. Hillier**, and S. **Lhaopadchan**, 2009, Corporate Insider Trading: A Literature Review, 38(143) Spanish Journal of Finance and Accounting, p. 373, 379-398.

Cornell, B., and E. **Sirri**, 1992, The Reaction of Investors and Stock Prices to Insider Trading. Journal of Finance (September): 1031-1059.

International Journal of Business and Applied Social Science

E-ISSN: 2469-6501
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February/2022
DOI: http://dx.doi.org/10.33642/ijbass.v8n2p3

Damodaran, A. and C. H. **Liu**, 1993, "Insider Trading as a Signal of Private Information, Review of Financial Studies 6, 79-119.

Degryse, H., F.d. **Jong** and J. **Lefebvre**, 2013, An Empirical Analysis of Legal Insider Trading in The Netherlands, De Economist v 162, pp. 71–103.

Del Brio, E. B.; **Miguel**, A. DE., and **Perote**, J., 2002, An investigation of insider trading profits in the Spanish stock market. The Quarterly Review of Economics and Finance 42 (1), 73-94.

DeLong, J. **Brad**, A. **Shleifer,** L. H. **Summers,** and R.J. **Waldmann**, 1990, Noise trader risk in financial markets, Journal of Political Economy, 98, pp. 703-738.

Finnerty, J. E., 1976, Insiders' activity and inside information: A multivariate analysis. Journal of Financial and Quantitative Analysis 11, pp. 205-216.

Friedrich, S., A. **Gregory**, J.,**Matako** and I.**Tonks**. , 2002, Short-run returns around the trades of corporate insiders on the London Stock Exchange. European Financial Management 8 (1), pp. 7-30.

Hakansson, N.H., J.G. **Kunkel**, and d J.A. **Olson**., 1982, Sufficient and Necessary conditions for information to have social value in pure exchange, Journal of Finance, 37, pp. 1169-1181.

Hauser, S, **Kraizberg**, E., and **Dahan**, R., 2003. Price behavior and insider trading around seasoned equity offerings: the case of majority-owned fi rms. Journal of Corporate Finance 9 (2), pp. 183-199.

Hillier, D., and A.P. **Marshall.,** 2002, The market evaluation of information in director's trades. Journal of Business Finance & Accounting 29, pp. 77-110.

Hirshleifer, J., 1971, The private and social value of information and the reward to inventive activity, American Economic Review 61, pp. 561–574.

Heston, S.L., 1993, A closed-form solution for options with stochastic volatility with applications to bond and currency options. Review of Financial Studies 6(2), pp. 327–343.

Huddart, S., J.S. **Hughes** and C. **Levine**, (2001), Public disclosure and dissimulation of insider trades, Econometrica V69, 3 665-681/

Hull, J.C., and W.A. **White**, 1987, The pricing of options on assets with stochastic volatilities, Journal of Finance, 42, pp. 281-300.

Jaffe, J. F., 1975, On the use of public information in financial markets, Journal of Finance 30, 831–839.

—-- 1974b. Special information and insider trading. Journal of Business 47: 410-428.

Jagolinzer, A., D. **Larcker** and D.**Taylo**r. , 2011. Corporate governance and the information content of insider trades. J. Account. Res. 49, 1249–1274 .

John, K., and L. **Lang**., 1991, Insider trading around dividend announcements: Theory and evidence. Journal of Finance 46: 1361-1390.

John, K., and **Mishra**, B. ,1990, Information content of insider trading around corporate announcements: The case of capital expenditures. Journal of Finance 45 (3): 835-854.

Kyle, A.S.,1985, Continuous auctions and insider trading, Econometrica, Vol. 53 No. 6, pp. 1315-1335.

Lakonishok, J. and I. **Lee**., 2001, Are insider trades informative? The Review of Financial Studies 14 (1): 79-111.

Lin, J., and **Howe**, J. S. 1990. Insider trading in the OTC market. Journal of Finance 45: 1273 1284.

Lodere, C., and **Sheehan**, D. P., 1989, Corporate Bankruptcy and Managers Self-Serving Behavior. The Journal of Finance 44: 1059-1075.

Margrabe, W., 1978, The Value of an Option to Exchange One Asset for Another, The Journal of Finance, Vol. 33, No. 1 (Mar., 1978), pp. 177-186

Maurer, T. A., and N.K. **Tran**, 2016, Public information and risk sharing in a pure exchange economy, Working paper, Washington University in St. Louis.

_____, 2018, The Hirshleifer effect in a dynamic setting, Working paper, Washington University in St. Louis.

Manne, H., 1966, Insider trading and the stock market, New York: Free Press.

Muthen, B., 2010. Bayesian analysis in Mplus: A brief introduction. Retrieved from http://www.statmodel.com/download/IntroBayesVersion%203.pdf,

Milgrom, P., and N. **Stokey**, 1982, Information, trade and common knowledge, Journal of Economic Theory 26, 17–27.

Ng, D., 1975, Information accuracy and social welfare under homogeneous beliefs, Journal of Financial Economics, 2 pp 53-70.

International Journal of Business and Applied Social Science

E-ISSN: 2469-6501
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DOI: http://dx.doi.org/10.33642/ijbass.v8n2p3

Owen, G., 1972, Multilinear Extensions of Games, Management Science, 18, 1972: 64-79.

Ozkan, A., and A. **Trzeciakiewicz**, 2014, Informative content of insider purchases: evidence from the financial crisis, Review of behavioral science, Vol. 6, (I), pp 26-45.

Pascutti, M. J., 1996, Inside Trading, Market Regimes, and Information, working paper, Harvard University.

Pratt, S. P., and **Devere**, C. W., 1970. Relationship between insider trading and rates of return for NYSE common stocks, 1960-66, in LORIE, J., and BREALEY, R. Eds.: Modern Developments in Investment Management, Praeger, New York.

Seyhun, H. N., 1986a, Insiders profits, costs of trading, and market effi ciency. Journal of Financial Economics 16: 189-212.
— 1986b. The information content of aggregate insider trading. Journal of Business 59, 1-24.

Shapley, L.S. and M. **Shubik**., 1954, A Method for Evaluating the Distribution of Power in a Committee System" American Political Science Review, 48, 787-792.

Stulz, R., 1982, Options on the minimum or the maximum of two risky assets, Journal of Financial Economics 10, pp 161-185.

Teall, J. L., 1996, A Binomial Model for the Valuation of Corporate Voting Rights, Journal of Business Finance and Accounting, June.

Zhang, G., 2001, Regulated managerial insider trading as a mechanism to facilitate shareholder control, Journal of Business Finance & Accounting 28 (1-2): 35-62.