The Information Content of Option Demand*

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October 28, 2012

Abstract

This paper provides direct evidence on positive and negative information in option demand imbalances for future stock returns using publicly available data. We disentangle excess option demand due to investors with information on the underlying from excess option demand driven by diverse beliefs. We obtain economically significant returns for option investment strategies that trade on the informed demand in options (e.g., 25% or 39% for out-of-the-money long calls or puts with 1-month time to maturity). Moreover, we address the impact of informed option demand on price pressure in option markets. Informed option demand is associated with an increase in option bid-ask spreads and put-call parity violations, implying that informed trading reduces liquidity in the option market and increases deviations from the arbitrage equilibrium.

JEL-code: D82, G10, G12, G14

Keywords: Asymmetric Information, Option Market Demand, Market Sidedness, Open Interest, Liquidity, Market Microstructure

*We are grateful to Yakov Amihud, Don Chance, Amit Goyal, Jens Jackwerth, Robert Korajczyk, Markus Leippold, Mahendrarajah Nimalendran (discussant FMA 2012), Per Östberg, Franziska J. Peter, Jörg Seidel, Nitish Sinha (discussant MFA 2012) and Nagpurnanand Prabhala for helpful comments and valuable suggestions. This paper has also benefited from comments of participants at the Midwest Finance Association (MFA) Annual Meeting 2012 in New Orleans, the Swiss Society for Financial Market Research Conference 2012 in Zurich, the Eastern Finance Association (EFA) Annual Meeting 2012 in Boston, the Financial Management Association (FMA) European Meeting and Doctoral Consortium 2012 in Istanbul and the NCCR Finrisk Research Day 2012. Part of this research has been conducted while Kehrle obtained financial support of the National Centre of Competence in Research "Financial Valuation and Risk Management" (NCCR FINRISK). Puhan gratefully acknowledges financial support of the Swiss National Foundation and the Zell Center for Risk Research, Kellogg School of Management. *Please note that the views expressed in this paper are those of the author(s) and do not necessarily represent those of the Swiss National Bank.*

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1 Introduction

In the absence of any frictions, option markets are redundant to the stock market and option pricing is independent of option demand. However, Black (1975) and subsequently several other studies argue that the possibility to take higher leverage, to exploit the implied volatility of the underlying, downside protection or lower initial capital, can provide an incentive for informed investors to trade in the option market. Easley, O'Hara and Srinivas (1998) show in a sequential trading model, which allows informed traders to trade in the stock and option market, that a pooling equilibrium with informed trading in the option market is possible. This implies that option markets are not at all times informationally redundant to stock markets.[1] Furthermore, Garleanu, Pedersen and Poteshman (2009) challenge the independence of option pricing and option demand by demonstrating that demand pressure effects are important to explain the gap between the empirical and the theoretical values of option prices.

This paper provides direct evidence on positive and negative information in option demand imbalances for future stock returns using publicly available data. Our results provide a new aspect of the economic value of derivatives and evidence for market inefficiencies. Moreover, we address the impact of informed option demand on price pressure in option markets, providing new insights on option market liquidity and deviations off the arbitrage equilibrium that are directly relevant for market makers and uninformed investors.

Motivated by the work of Sarkar and Schwartz (2009), who disentangle trade initiation triggered by asymmetric information and trade initiation driven by diverse beliefs in the stock market, we disentangle excess option demand due to directionally informed traders from excess option demand that is related to diverse beliefs. In case of directional informed trading, we define option markets to be one-sided, i.e. markets with an excess option demand for one particular option contract type (e.g., long call or long put) due to investors with information on the underlying. Option market one-sidedness, results in demand imbalances and price pressure due to relatively large changes in the open interest of out-of-the-money (OTM) options on one side of the option market.[2] Option markets with diverse beliefs are defined as two-sided option markets, i.e. markets where uninformed investors trade with the same probability in each possible option market trade on the call and on the put market side. We call this approach, in analogy to Sarkar and Schwartz (2009), Option Market Sidedness (OMS).

In order to make the market sidedness of the option market measurable, we derive a new open interest based measure of informed option demand and demand pressure in the option market, which we refer to as OMS measure. Sarkar and Schwartz (2009) introduce a measure of stock market sidedness as the correlation of buyer-initiated and seller-initiated trades. An increase in

[1] There are also, several well known examples of insider trades in long call options to profit from positive superior and long put options to trade on negative information like the case of the German Commerzbank's option and stock market moves in April 2011 or the evidence from the 2001 terrorist attacks in Poteshman (2006).

[2] The open interest of a call or put option refers to the total number of contracts, that have not been settled in the past for the same underlying security. Option contracts that are more liquid and subject to higher demand usually exhibit higher levels of open interest and potentially also larger changes in open interest.

their measure indicates more diverse beliefs. A decrease signals private information trading. They find that one-sided stock markets are on average associated with relatively large order imbalances. In our study of option market informed trading, the OMS measure for the call (put) market indicates demand imbalances due to informed traders who exploit positive (negative) signals by buying call (put) options. The measure that captures positive information trading in the call market is defined as the correlation between open interest changes of OTM call options with open interest changes of in-the-money (ITM) put options. Analogously, the OMS measure in the put market is the correlation between open interest changes of OTM put options with those of ITM call options and indicates informed trading activities on negative signals. A relatively higher OMS measure reflects a two-sided market, which is determined by uninformed investors with diverse beliefs. This follows the intuition that for larger values of the OMS measure, the changes in the call and put open interest tend to move in the same direction. Conversely, we hypothesize that one-sided markets are characterized by the presence of informed investors, which results in an excessive increase in the change in open interest of one option type relative to the other option type (e.g. call vs. put options). This one-sided demand pressure correlates with a relatively lower OMS measure.

Our focus on informed option trades, which create a long position in an option, enables us to use one distinct measure for the positive and negative information case respectively. The implicit assumption behind this is in accordance with for instance Garleanu, Pedersen and Poteshman (2009), Pan and Poteshman (2006), Lakonishok, Lee, Pearson and Poteshman (2007), Easley, O'Hara and Srinivas (1998), Ni, Pan and Poteshman (2008), or Choy and Wei (2012), which establish that informed investors' option market activity is mostly concentrated on the opening of new long positions. Apart from the evidence in the literature, we argue that this is a valid assumption for two major reasons.[3] First, alternative option positions such as selling put and call options provide the informed trader with a relatively worse risk and return profile. Second, the first argument becomes even stronger for the specific case of our study, in which we focus on OTM options as those contracts that are used by the informed investors. In this we draw on findings of a broad set of studies, which establish that informed traders are more likely to trade (far) OTM options (see e.g. Chakravarty, Gulen and Mayhew 2004, Chen, Lung and Tay 2010). Buying OTM options enables informed traders to take a leveraged position which makes it even less likely that they take a short position. For instance in a negative news event, if a long put option is OTM it implies that with the short call position the informed trader would have to bear theoretically unlimited risk.

Furthermore, as a control, we distinguish between directional informed trading, captured by the OMS measure, and volatility informed trading. For this purpose, we develop an option market sidedness measure of volatility informed trading, OMS^{σ}. We argue in line with e.g. Ni, Pan and Poteshman (2008) that volatility informed trading results in an excess demand in at-the-money

[3] Focusing on long call and long put trades of informed investors does imply that we cannot capture the other trades that informed investors might take such as shorting an option or the underlying. However, in order to identify informed trading as clean as possible, we restrict our focus. This is not problematic since adding more informed trading cases to our set-up, would only strengthen our results. Occasional evidence such as the example new openings in long put options on the German Commerzbank in the week before a recapitalization announcement in April 2011 or the evidence from the 2001 terrorist attacks in Poteshman (2006) also support the representativeness of our approach.

(ATM) call and put straddle pairs. Therefore, we construct OMS^{σ} as a correlation of the change in open interest of these two option types.

To test our hypotheses on option market sidedness, we use a dataset that comprises all exchange traded securities at the intersection of OptionMetrics Ivy DB, the CRSP NYSE/AMEX/NASDAQ daily return files and COMPUSTAT from January 1996 until December 2009. Our results with respect to the information content of option demand for future stock returns are: First, the option market sidedness measure for the call (put) market captures positive (negative) private signals and predicts increasing (decreasing) stock excess returns. The results emphasize the high information content of OTM option demand asymmetries. Second, our measure of volatility informed trading has predictive power for stock return volatility and our results for the directional OMS measure are robust to volatility informed trading. Third, smaller and higher return volatility firms, exhibit a higher concentration of demand asymmetries related to informed trading. These results corroborate insights from the literature on stock market informed trading and also the predictions from the model of Easley, O'Hara and Srinivas (1998) that informed traders exploit their information more likely in the option market the larger the number of informed traders, the lower the liquidity of the underlying stocks and the larger the size of the leverage of an option position. Fourth, we find economically significant returns for option investment strategies that trade on the informed demand in options (e.g., 25% or 39% in one roughly four weeks for OTM long calls or puts with 1-month time to maturity).

Regarding the impact of excess option demand due to informed trading on option price pressure we find: First, informed option demand is associated with an increase in option bid-ask spreads. This implies that informed trading reduces liquidity in the option market and that our measure of option market sidedness can be useful as a new liquidity measure for the option market. Second, the asymmetric demand pressure due to informed trading increases the violations of the put-call parity. This indicates that the demand pressure of informed investors contributes to an increased deviation of option markets off the arbitrage equilibrium.

Our study contributes to the literature that examines the relation of stock and option markets. Previous works largely use option market trading volume, bid-ask spread narrowness and volatility in order to study the relation of stock and option markets (see e.g. Easley, O'Hara and Srinivas 1998, Chakravarty, Gulen and Mayhew 2004, Cherian and Jarrow 1998, Ni, Pan and Poteshman 2008, Bollen and Whaley 2004, Pan and Poteshman 2006, Johnson and So 2012). Several studies consider the lead-lag relationship between option and stock markets (e.g. Cao, Chen and Griffin 2005, Kumar, Sarin and Shastri 1992, Chakravarty, Gulen and Mayhew 2004). Other studies like Cremers and Weinbaum (2010), Ni, Pan and Poteshman (2008), or Doran and Krieger (2010) investigate whether changes in the volatility or in option prices reflect information flows from option markets to equity markets. However, the results from public data on option market volume, volatility or bid-ask spreads are mixed regarding their informativeness for future positive and negative stock price movements and with respect to market inefficiencies that could provide a reason for an economic value of derivatives markets (e.g. Pan and Poteshman 2006, Easley, O'Hara and Srinivas 1998, Chan, Chung and Fong 2002, Stephan and Whaley 1990, Muravey, Pearson and Broussard 2012, Choy and

Wei 2012). Moreover, evidence on the impact of informed trading on liquidity levels and the arbitrage equilibrium is rare (e.g. Garleanu, Pedersen and Poteshman 2009).

The conceptual approach of market one-sidedness and option excess demand developed in our study contributes to the literature an innovative method to analyze the relation between stock and options markets. It allows for new insights on the information in option markets for future stock returns and on the implications of informed trading for the option market microstructure as opposed to trading volume, volatility or price related measures. This is largely related to the fact that the use of option demand asymmetries based on imbalances in the change in open interest focuses our attention to trades, which indicate trading activities off the long-run market equilibrium. One key aspect for this effect is that the number of outstanding option contracts, as opposed to the number of stocks outstanding, is endogenous. In this respect, the increase in open interest is an endogenous proxy of excess demand since the open interest only changes if new option contracts have to be created. A (large) one-sided increase in this measure is therefore a sharp indicator of (large) asymmetric demand shifts in the option market. Simple order volume, volatility or price based measures, that are mostly used in previous studies, could not capture this effect (Cho and Engle 1999, Cao and Wei 2010). Since we use publicly available data, our approach also lends itself to mitigate the inference problem of positive and negative private information for future asset prices, which uninformed investors face. Furthermore, an appealing feature of OMS is that it disentangles positive as well as negative information trading and reflects the dynamic evolution of option demand with highly asymmetric demand and perfectly diverse beliefs as the two ends of the market trading continuum.

Another novel contribution is that we are able to disentangle directional information trading from volatility information trading while most of the literature does not differentiate along this dimension. At the same time, our OMS measure is also informative on price pressure in the option market and can be useful as a new option market liquidity measure that allows for sharper predictions than simple order volume based measures. In contrast to many studies in this field, our study is also of a relatively general nature. Previous literature often uses a very limited arbitrary set of securities or focuses on extreme events or pre-selected time periods (e.g. Cao, Chen and Griffin 2005, Poteshman 2006, Chesney, Crameri and Mancini 2011, Chen, Lung and Tay 2010, Bollen and Whaley 2004, Kumar, Sarin and Shastri 1992, Choy and Wei 2012). In our study, we empirically validate our hypotheses using a comprehensive dataset of US securities within a time window of almost 15 years of data.

The rest of this paper is organized as follows. In Section 2, we first develop our concept of option market sidedness and explain how we differentiate directional from volatility informed investors. Second, we introduce our empirical specifications. Section 3 details the data and provides descriptive analyses. In Section 4 we present and discuss the results. Section 5 concludes the paper.

2 Empirical Specifications

In this section we first motivate and outline our option market sidedness approach. In addition, we develop our measures of directional and volatility informed trading. Thereafter, we introduce and explain the empirical specifications.

2.1 Informed Option Demand

Informed option demand, as we understand it in our paper, creates option market demand imbalance due to their off-equilibrium demand for particular option contracts. This informed excess option demand affects the dynamics of open interest, which is an effective endogenous measure of the excess demand. To understand the mechanics of the informed option demand and in order to verify the information content of excess option demand, we answer in this section two questions: (i) Why is the change in open interest an endogenous demand measure? (ii) How can we capture the information in excess option demand for future stock returns using the change in open interest?

In order to answer the first question it is important to understand the crucial difference between the change in open interest and trading volume. Only in two cases of trading activities, that is when option trading volume is not zero, the level of open interest shifts. To illustrate this, consider the following simple example of a buyer A and a seller B of one derivative contract. If buyer A wants to buy a contract to open a new position and seller B has to create a new position in order to cater the demand, the trading volume changes and the open interest increases by one unit. If buyer A enters the option market to buy a contract to close a position, and seller B sells this contract, thereby closing a previously held position, the option volume changes along with a decrease of open interest by one unit. However, if A buys the contract to open a position and B closes a position by selling a contract or if A closes a position with the newly acquired option contract while B has to open a new position, the volume will change but not the open interest. In the two latter examples of option trades between A and B, the option imbalance in demand and supply was neither increased nor decreased and the open interest has not changed. However, in the first two examples the open interest changes and indicates endogenously an excess demand in the first case and an excess supply in the second case. Overall this means that large volumes do not necessarily arise from a large excess demand because the same option could be traded several times on a trading day. This makes it more difficult to interpret the information in trading volumes.

Several studies such as Ni et al. (2008), Pan and Poteshman (2006), Lakonishok et al. (2007), Bollen and Whaley (2004), Easley et al. (1998), or Garleanu et al. (2009) argue that a decrease in the open interest is unlikely to result from informed trading and informed trading is instead likely to result in an opening of new buying positions and an increase in open interest. Along the lines of the literature, we implicitly assume, by using the change in open interest as an endogenous measure of option demand, that the impact of informed trading activities is reflected in a (large) increase in open interest on one side of the option market. It is also intuitive that in the case of a private signal it is unlikely that market makers have options readily available above the long-term average level.

Instead market markers have to step in and create new contracts to cater the excess demand in the market (Garleanu et al. 2009, Bollen and Whaley 2004). Consequently, an increased demand for particular option types increases the open interest. The change in open interest is therefore a less noisy measure of option demand than the trading volume or the volatility. The analysis of the private data used in Pan and Poteshman (2006) and Lakonishok et al. (2007) support this view. They show that the presence of informed traders is more likely for opening option volume and positive open interest changes than for closing volume and negative open interest changes.

Furthermore, if an increase in open interest is a more likely outcome of informed option demand rather than a decrease in open interest, we conjecture that the one-sided buying pressure is likely to decrease liquidity levels in the option market. Market-makers, who observe the large asymmetric demand, are not naive and want to protect themselves from the directionally informed investors. Therefore, we subsequently test also the price impact of asymmetric excess option demand. The results of this analysis lend themselves to providing further support to an increase in open interest as more likely outcome of informed excess option demand rather than a decrease in open interest.

Next, we consider (ii) and explain how we capture in the data directionally informed excess option demand by using a measure of OMS. The measure indicates times of one-sided option markets with asymmetric information and disentangles them from times of two-sided markets with diverse believes. The construction of the measure is inspired by the measure of stock market sidedness in Sarkar and Schwartz (2009). At an aggregate level, investors, who trade on private information on the underlying in the option market, induce a market imbalance in the change in open interest, compared to the no information market equilibrium, where all investors make each possible option trade with the same probability. The strengths of this demand imbalance depends on the degree of information asymmetry.[4] The measure of OMS that we develop captures both, the asymmetry of demand in the market and the change in the strengths of the asymmetry over time, that is the dynamic evolution of the information content of option demand. We define an OMS measure for the call or put market side respectively, in order to disentangle whether the market imbalance is associated with a positive or negative private signal. To compute the OMS measure, we use a 30 days backward looking correlation between daily changes in open interest for each security. More specifically, the daily call market sidedness measure OMS^C is obtained by correlating the change in open interest of OTM call options and the change in open interest of ITM put options. On the call market side our measure reflects a positive signal. This creates an excess demand for OTM call options relative to the ITM put option demand because informed traders exploit their advantageous information by seeking for a beneficial risk-return profile and a leveraged position. In order achieve this, informed traders enter call markets and increase the demand pressure for OTM call options in excess of the long-run mean supply. Therefore, we suggest that in case of positive information the change in open interest on the put market is lower than the long-run mean value as only the uninformed fraction of traders continue to trade in-the-money put options. Analogously, the put

[4] We choose daily windows for the entire empirical part. Obviously, asymmetric information can persist intradaily, for one or two days or for longer periods, depending on the nature of the information. Most often, the information asymmetry occurs at a daily or intradaily level, thus the daily windows that we use are a viable choice (see also Pan and Poteshman 2006).

side OMS^P measure is the correlation of the change in open interest of OTM put options with the change in open interest of ITM call options. A negative signal induces an increased arrival of informed traders on the put market. This increases the demand pressure for OTM put options. The high demand leads to an increase in put open interest because the demand in the option market significantly exceeds its long-run mean supply. Additionally, a negative signal results in a lower change in call ITM open interest because only the uninformed traders continue to trade ITM call options. The ability of the measure to capture this dynamic evolution of option demand asymmetries while controlling for effects of an overall increase in the trend and variation of the long-run market open interest is an appealing feature of the correlation measure that for instance a simple ratio does not provide.

Clearly, investors could also have information on the volatility of future returns instead of information on the return direction. For instance, earnings announcements on average increase the volatility of a stock's return for a certain period of time, which sophisticated investors could exploit (see e.g. Beaver 1968). Previous works of e.g. Back (1993) and Ni et al. (2008) show that the option market contains information on the future volatility of stock returns. Thus, it seems important to distinguish excess option demand from directional and from volatility traders. Since the option Vega is the greatest for ATM options and volatility traders do not know the direction of the future stock return movement, we make the common assumption that volatility informed traders take straddle positions in ATM options in order to exploit their information. Volatility informed traders either profit from an increase or a decrease in volatility. To profit from an increase in volatility, they buy call and put options pairs with the same strike price and (relatively short) maturity. To profit from a decrease in volatility, they short call and put option pairs with the same strike price and (relatively short) maturity. Again it is rather unlikely that the informed traders already hold the appropriate position before they obtain the information, implying an increase in open interest as more likely to be related to volatility trading than a decrease in open interest. This implies that for volatility informed trading, we expect a large increase in the open interest for both ATM option contracts of the straddle trade. In particular, we measure the option demand of the volatility traders by selecting all closest to maturity ATM call and put option pairs with the same strike price and the same expiration date and correlate their change in open interest for a 30 day backward looking window. This measure of volatility informed option demand, which we refer to in the following as OMS^σ, increases whenever the open interest of both sides of the ATM option pair comoves stronger, indicating an excess demand in straddle pairs.

2.2 The Information Content of Directional and Volatility Informed Option Demand

2.2.1 Predicting Stock Returns and Volatility with Informed Option Demand

In the first part of our empirical analysis, we examine whether a one-sided option demand reflects the trades of investors who possess private information. It is important to stress again that the stock return variation does not arise from the fact that option market informed traders create demand imbalances in the option market. It is an exogenous piece of information that affects returns. The link between both markets is merely that option market informed investors receive a private signal on the underlying and trade on it in advance.

In particular, we investigate whether a high level of one-sided option demand, which is reflected in a low directional OMS for the call market side (OMS^C) predicts increasing stock returns. Analogously, we expect low values for the OMS measure for the put market (OMS^P) to predict decreasing stock returns. We use Fama and MacBeth (1973) (FMB) regressions to test the relation of future individual stock returns and the directional OMS measure. The empirical specification reads as,

$$RET_t = \beta_0 + \beta_1 OMS^C_{t-1} + \beta_2 OMS^P_{t-1} + \mathbf{B}C_t + \epsilon_t, \tag{1}$$

where RET_t is the daily stock return in excess of the risk free rate at day t.[5] β_0, β_1 and β_2 denote the coefficients of the intercept, the OMS^C_{t-1} and the OMS^P_{t-1} measure at day $t-1$. Further, we control in (1) for potential effects of additional exogenous variables by including the matrix C_t. Control variables are e.g. firm size, book-to-market ratio, market returns, lagged stock returns, long-term past stock returns, long-term past stock return volatility and option volume. The corresponding coefficient vector is $\mathbf{B}$. ϵ_t is an error term.

We conjecture a negative sign for β_1, reflecting that informed traders buy call options if they receive a positive private signal. The trades of these informed investors imply an immediate increase in the demand for call options with a corresponding increase in the call open interest, which induces OMS^C_{t-1} to decrease. Furthermore, the positive signal is incorporated in the stock's future fundamental value, which leads to an increase in future stock returns. Thus, we expect a decrease in OMS^C_{t-1} to significantly predict an increase in returns. Analogously for the put option case, the sign of the coefficient for the put market sidedness measure (OMS^P_{t-1}) is reversed compared to the positive signal case. Informed traders buy put options if they receive a negative private signal. This decreases the market sidedness measure and predicts decreasing stock returns.

One could argue that the directional OMS^C and OMS^P measures pick up also open interest shifts due to information driven trading on volatility. Therefore, we control for volatility trading by including the OMS^σ measure. First, we verify that OMS^σ indeed is informative on future stock return volatility. For this purpose, we follow Ni et al. (2008) and test whether the OMS^σ measure predicts the stock individual realized volatility RV_t by estimating the following FMB-regression:

$$RV_t = \beta_0 + \beta_1 OMS^\sigma_{t-1} + \beta_2 OMS^\sigma_{t-1} \cdot EAD_t + \mathbf{B_1} D_t + \mathbf{B_2} C_t + \epsilon_t, \tag{2}$$

with

$$D_t = \left[OMS^C_{t-1} \quad OMS^C_{t-1} \cdot EAD_t \quad OMS^P_{t-1} \quad OMS^P_{t-1} \cdot EAD_t\right] \tag{3}$$

as the vector of variables that control for directional informed trading. C_t is again a set of control variables which additionally includes the lag of the RV proxying short-term autoregressive volatility

[5] We conducted the analysis also for four factor risk-adjusted returns by regressing the excess return on the Fama-French factors and momentum. The results are virtually the same.

effects. The corresponding coefficient vectors are $\mathbf{B_1}$ for D_t and $\mathbf{B_2}$ for C_t. EAD_t is one if t is an earnings announcement date (EAD) for the respective stock and is zero otherwise. ϵ_t is an error term.

Drawing on findings by for instance Beaver (1968) and Ni et al. (2008) that earnings announcements on average increase the volatility of a stock's return for a certain period of time and that volatility informed traders are more likely to trade in the option market on volatility information prior to earnings announcement dates (EAD), we expect a positive slope coefficient for $OMS^{\sigma} \cdot EAD_t$, i.e. $\beta_2 > 0$ and $(\beta_2 + \beta_1) > 0$. For the OMS^{σ} measure it is ambiguous which coefficient to expect because high and low volatility bets could result in an increase in open interest of both contract types. However, we include the variable into the regression in order to control for non-EAD times. A significant positive coefficient for the OMS^{σ} measure indicates that on average a large increase in ATM straddle trading is associated with an increasing future volatility.

Since $EADs$ are public knowledge, we expect the impact of directional informed trading before announcement dates to be negligible. Sarkar and Schwartz (2009) emphasize that before announcement dates, markets are often times largely two-sided. This is also supported by Choy and Wei (2012) who show that around earnings announcements the diversity in beliefs on the markets tends to be higher. Thus, for the directional OMS measure we conjecture an insignificant coefficient for the EAD interacted OMS measure. A decreasing OMS^C and OMS^P indicates for both market sides an increase in the future realized stock return volatility. This is intuitive since the future price discovery in the stock market is most likely associated with an increase in the return volatility no matter whether the stock returns increase or decrease.
After verifying the predictive power of the OMS^{σ} measure for stock return volatility, we use OMS^{σ} as a control in our return predictability regression. For this purpose, we re-estimate the regression model in (1) and include in addition the following vector of variables:

$$V_t = \left[OMS^C_{t-1} \cdot EAD_t \quad OMS^P_{t-1} \cdot EAD_t \quad OMS^{\sigma}_{t-1} \quad OMS^{\sigma}_{t-1} \cdot EAD_t \right]. \tag{4}$$

After controlling for volatility informed trading the main results of our predictive stock return regressions should qualitatively not be affected. Furthermore, if the EAD interacted OMS^{σ} variable exhibits insignificant results in the return regressions this would corroborate that the excess demand in the call and put option ATM straddle pairs is associated with non-directional volatility informed trading.

2.2.2 Option Market Demand and Firm Characteristics

In the literature on stock and option market informed trading, several firm characteristics such as size are associated with an increased probability of informed trading in general and for informed trading in the option market in particular (e.g. Easley et al. 1998). If these firm characteristics also have an enhancing effect on the predictive relation between option market sidedness and future stock returns, this would provide further support for our main results on the information content of excess option demand. Specifically for the case of option market informed trading, for instance Easley et al. (1998) show that informed traders more likely trade in the option market if the underlying is smaller and less liquid and Ni et al. (2008) show that this is the case for higher volatility stocks. Thus, in order to further validate the informativeness of (excess) option demand for future stock returns, we investigate whether smaller firms, higher return volatility firms and firms with lower trading volume are subject to more informed trading. For this to hold we expect that return sorts according to these firm characteristics yield a significantly stronger power of the stock return predictions of the OMS measure.

In order to study the cross-sectional implications of excess option demand, we build quartile portfolios of stocks that are sorted according to the size or volatility of a firm at the end of each year. Then, we run the regression in (1) for each quartile portfolio.[6] The expected signs of the coefficients for the OMS measures are as in the above for regression model (1), however, we expect the absolute size of the coefficient to be larger for smaller and for higher volatility firms.

2.2.3 Option Portfolio Strategies

Finally, we investigate the economic significance of the information in excess option demand of informed traders. In particular, we consider the profitability of informed trading conditional on the OMS measure. We use a very simple trading rule since our primary aim is not to find a return maximizing investment strategy but to assess the economic significance of the predictive relation between option market sidedness and stock returns.

One important argument of our study is that low call or put market OMS values arise from an excess demand in call or put options due to informed trading and predict stock returns. Therefore, we choose as trading signals low levels of the OMS measure, that is values of OMS^C or OMS^P that are at or below -0.5. We form portfolio groups with respect to the options' moneyness and remaining times to maturity at the investment date. The moneyness groups are sorted similar as in e.g. Chakravarty et al. (2004) or Lakonishok et al. (2007), that is according to the ratio of the strike price K and the stock price S. For call options we use $\frac{K}{S}$ and for put options we use $\frac{S}{K}$. This implies larger values of the respective ratios for farther OTM call and put option contracts. For very far OTM options the transaction costs become considerably higher. Therefore, we limit our trading strategy to option contracts with a moneyness of up to and including 1.3. Clearly, a higher leverage makes an options investment more attractive for an informed investor. However, the increasing transaction costs with higher levels of leverage create a trade-off between potentially higher gains and potentially higher costs. The time to maturity groups are formed according to the temporal distance between the point in time when the investor receives the trading signal and the maturity date.

In the first trading strategy we buy OTM call options in case of positive and OTM put options

[6] We also ran regressions for stock trading volume sorted quartile portfolio excess returns. However, the intuition for this sorting variable and the regression results are very similar to the size sorted portfolios. Therefore, we do not report them for reasons of brevity. They are available on request.

in case of negative information as indicated by the OMS based trading signal. This strategy implements the behavior of an informed investor that implicitly underlies the construction of our OMS measure. In the second strategy we control for the impact of the underlying's volatility on the option investment by forming delta-hedged portfolios.[7] The investor buys an option and additionally hedges the investment against the stock return volatility by short-selling delta shares of the underlying contract. Since the open interest is reported in the evening, the trader can only obtain the trading signal after the exchange closes. Whenever the trader obtains a signal in a time window that starts three weeks before maturity and ends on the Tuesday before the maturity date (the maturity date is usually a Saturday), the trader makes an investment on the subsequent day. The last possible trade could be made on the Wednesday before maturity.[8] All option investments are sold on the Thursday two days before maturity and the stock position in the delta-hedge strategy is settled simultaneously. For example, in the evening of 01/02/2006 a trader, who follows the first trading strategy, receives a positive signal, i.e. the OMS^C measure is lower than -0.5, for Apple Inc.. The next day he buys an OTM call option with expiration date 01/21/2006.[9] He sells the option on the Thursday (i.e. 01/19/2006) before the option expires.

2.3 Option Market Price Pressure and Informed Option Demand

After investigating the information content of option demand for future stock returns, a very natural extension of our study is to explore the response of option market makers to option market sidedness, or put differently the relation between informed option demand and price pressure in the option market. Furthermore, if we find a negative relation between market one-sidedness and option market liquidity levels this would provide further support to previous literature and our implicit assumption that informed investors open new positions which market makers do not have readily available and they have to step in and create new contracts.

Easley et al. (1998) find that the higher the relative amount of informed traders and the more likely the arrival of a positive or negative signal, the larger the price pressure on call or put options. Other studies like Back (1993), Cao and Wei (2010), Wei and Zheng (2010), Garleanu et al. (2009) and Ni et al. (2008) also show that asymmetric information, and thus informed trading activities coincide with a widening of option bid-ask spreads.[10] Thus, we expect that an excess option demand due to informed trading exerts pressure on the size of the option spreads. This implies that market makers, who cannot perfectly hedge their inventories, observe the demand pressure in a particular option type and increase the option bid-ask spreads for the respective contract (see e.g. Easley et al. 1998, Garleanu et al. 2009, Kyle 1982, Ni et al. 2008).

[7] More sophisticated trading strategies would be possible. However, the choice of the strategies is coherent with our characterization of informed trading, which underlies the option market sidedness approach and its measure. Furthermore, it follows the idea that if a simple trading rule does not provide profitability there is no point in creating portfolio returns with more complex trading rules.

[8] Note that for different ranges of trading windows we obtain qualitatively similar results.

[9] We use the closing price as reported in OptionMetrics.

[10] See e.g. Madhavan (2000) for a comprehensive review of theoretical models that establish asymmetric information and inventory risk costs of market making.

Therefore, we expect that a one-sided excess option demand of informed traders correlates with an increase in option bid-ask spreads on the respective option market side.[11] Intuitively, this contributes to a relative increase in pricing inefficiencies between both market sides, such as, for instance, violations of the put-call parity (PCP). Previous studies such as Cremers and Weinbaum (2010) or Easley et al. (1998) provide evidence in support of this hypotheses.

To analyze the impact of excess option demand on option prices, we investigate first the variation in liquidity levels, i.e. in option bid-ask spreads. Second, we test whether violations of the PCP are larger in the presence of informed traders.

2.3.1 Option Demand Imbalances and Liquidity Levels

If liquidity levels indeed decrease with an increase in option market sidedness, we conjecture that the variation in option market sidedness has significant explanatory power for part of the variation in option bid-ask spreads. Thus, since low OMS values signal a high level of option market sidedness, we expect that regressions of the bid-ask spread on OMS^C and OMS^P yield negative coefficients for the option market sidedness measures. The same sign of the coefficients is expected as the demand pressure increases independently of the type of the private signal. Like this our measure of informed trading also becomes a new measure of liquidity in option markets, which allows for sharper predictions than a simple order volume based measure (cf. Cho and Engle 1999, Cao and Wei 2010). This is also intuitive if one remembers that the OMS measure captures order imbalances. The more pronounced this imbalance, the lower the OMS measure and the lower the liquidity.

It is important to point out that in order to explain the variation in the spread size, we use the contemporaneous OMS measure for the spread regressions because informed trading increases contemporaneously the demand pressure.

Apart from the control variables used in the regressions, we correct the daily median bid-ask spreads for firm effects and for the potential impact of stock return momentum or reversal effects. We compute, as for instance in Chan et al. (1995), standardized bid-ask spreads by using the mean and standard deviation of spreads for a three months centered moving window.

Using again the FMB-procedure, we first regress the OTM call and put spreads on the contemporaneous OMS^C and OMS^P measure respectively and second we add to these regressions stock specific control variables such as size, past long-term stock returns and stock return volatility and option market specific controls such as option volume.

2.3.2 Demand Pressure and Violations of the Put-Call Parity

Finally, we consider relative changes in the deviations from the PCP and their relation with option market sidedness. Apart from possibly the demand pressure of informed traders, there are many other reasons in the real market that determine the empirically observed violations of the PCP.

[11] Note that obviously for the bid price, due to the absence of informed traders as sellers of call and put options, the bid price in the positive and negative information event is equivalent to the bid price in the no information case.

For American options the early exercise premium, and for all option types general frictions such as short-sale constraints or taxes, can lead to violations of the PCP. However, for our purposes the general fact that the PCP might be violated is irrelevant since we are interested in an increase in PCP violations in the presence of informed trading.

Our main motivation for investigating in this context PCP violations is related to the study of Cremers and Weinbaum (2010). They point out that deviations from the PCP are not necessarily fully and at all times violations from the PCP that arise from inefficient pricing and could easily be arbitraged away. Cremers and Weinbaum (2010) show that deviations from the PCP indicate price pressure coming from trades of informed investors. In addition, in the sequential trade model of Easley et al. (1998) informed trading can result in violations of the put-call parity. Thus, we expect that the one-sided increase in the demand pressure due to informed trading also positively correlates with absolute PCP deviations.

Kamara and Miller (1995) and Ackert and Tian (2001) show that PCP deviations reflect option liquidity risk by regressing PCP deviations on option liquidity risk proxies. In order to investigate the relation between our measure of option demand asymmetry and PCP deviations, we first compute:

$$PCP\ 1 = a^{C} - b^{P} + Ke^{-rT} - S^{bid}, \tag{5}$$

and

$$PCP\ 2 = a^{P} - b^{C} + S^{ask} - Ke^{-rT}, \tag{6}$$

where a and b denote the daily ask and bid price for the put and call options, respectively. T is the time to maturity in days, K is the strike price and r is the risk free rate. We use the absolute PCP 1 and PCP 2 in FMB-regressions that also control for several other stock individual and option market specific factors that can help to explain the variation in the PCP deviations. The controls are e.g. size, book-to-market, past returns, historical volatility or trading volume. We expect the contemporaneous OMS measures for the call and put market case to load significantly and negatively on the PCP deviations. Note that for our approach it is not relevant to account for frictions like transaction costs, taxes or the early exercise premium since we are only interested in the effects of the OMS measure on the variation in the violations.

3 Data

In this section we describe the data sources and the data selection. Furthermore, we report and discuss summary and descriptive statistics.

3.1 Stock Market Data

We obtain the stock market data from the CRSP NYSE/AMEX/NASDAQ return files for each security on a daily frequency. Only securities from the merged CRSP and COMPUSTAT database are in the sample. The sample period is January 1996 until December 2009. We exclude stocks with a return history of less than 24 consecutive months. The variables extracted include the closing price, high and low price, shares outstanding, returns (RET) and the volume as the total number of traded shares of stock. The latter serves as proxy for the stock's liquidity. We also use a proxy for the underlying's daily realized volatility which we define as in Ni et al. (2008) as 10,000 times the difference of an underlying stock's intraday high and low prices divided by the closing stock price (RV). Market equity is defined as the price of day t multiplied by the shares outstanding. The logarithm of market equity is used as proxy for firm size ($SIZE$). From the daily return data we compute a 60 days backward looking cumulative return (MOM) as a proxy for stock momentum and as a proxy for long-term stock variation the square root of the averaged cumulative squared returns (STD). We extract annual fiscal year-end book equity values from the COMPUSTAT data base. The annual book-to-market ratio at day t is given by previous year's end-of-year book equity divided by the corresponding year's market equity (BM) (see Daniel and Titman 2006). We winsorize the sample at the 99%- and 1%-level with respect to BM. Also from CRSP we obtain a value weighted NYSE/AMEX index with dividends as a proxy for monthly market returns. From all returns of the individual stocks and the market index we substract the average one month risk free rate from the Fama risk free rates file as provided by CRSP. We obtain monthly market betas as in Easley et al. (2002) and denote the individual stock market beta as $BETA$. In the daily cross-sectional regressions we include the stock's previous month's market portfolio betas to control for the single stock's market risk exposure.

Earnings announcement dates (EAD) are obtained from the I/B/E/S Database.

3.2 Option Market Data

Our option market daily data consist of all American option contracts for all available stocks at the intersection of the stock market data and option market data as provided by OptionMetrics Ivy DB, which is a comprehensive data set with information on the entire US equity options market.[12] We exclude option contracts with a maturity of more than 250 days. Furthermore, we group all option contracts in moneyness categories. Similar to e.g. Chakravarty et al. (2004) or Lakonishok et al. (2007) we define the moneyness range for options as the ratio of the strike price K and the stock price S. For call options we use $\frac{K}{S}$ and for put options we use $\frac{S}{K}$. For OTM options the respective ratio is larger than 1.05 and for ITM options it is smaller than 0.95. Accordingly, ATM options have a moneyness range of 0.95–1.05. The option contracts that are considered for computing the OMS measure are those that are OTM within the fourth week before the maturity date on at least 2 out

[12] The daily preliminary open interest is reported at the end of each trading day and the final official data is released on the following morning.

of 5 trading days.[13]

After selecting options into moneyness categories we create daily open interest, spread and volume measures for each category, i.e. ITM Call, ITM Put, ATM Call, ATM Put, OTM Call, and OTM Put. We use as an aggregated daily open interest for each stock k the median over the open interest of option contracts in a moneyness category $i \in \{1, \ldots, N_t\}$, where N_t is the number of considered options at day t. We denote the aggregated daily open interest as $OI_{t,m}^{k,j}$ with $j = \{C, P\}$ and $m = \{ITM, ATM, OTM\}$, i.e. the superscript j indicates whether the open interest is obtained for the call or the put market.[14] The change in open interest for the put and call options is then the first difference of the open interest for the call and put market side in the different moneyness categories respectively.

Analogously to the change in open interest, we use as an aggregated daily volume for OTM and ITM options for each stock the median over the volume of option contracts in a moneyness category $i \in \{1, \ldots, N_t\}$, where N_t is the number of options considered at day t. $SVOL_{t,m}^{j}$ denotes the square root of daily volume for call or put options, with $j = \{C, P\}$ and $m = \{ITM, OTM\}$.[15] Additionally, option spread variables are analogously obtained as volume and open interest. $SPREAD_{t,OTM}^{j}$ and $SPREAD_{t,ITM}^{j}$ denotes the median daily relative bid-ask spreads of call options that are OTM or ITM for call or put options.[16]

3.3 Descriptive Statistics

Table 1 provides summary statistics of our main measures and the control variables.

INSERT TABLE 1 ABOUT HERE

OMS^C and OMS^P are the option market sidedness measures for the call and put market, respectively. The directional trade measures OMS^C and OMS^P are on average positively valued (0.43 and 0.46) and the 25% quantile is also positive (0.11 and 0.16). However, this is not surprising since directional informed trading is neither permanent nor frequent and it would be counterintuitive if we would observe signs of informed trading in a particular stock several times within a year. OMS^{σ} is the measure of imbalances in option demand due to volatility informed trading. The measure is slightly positive in the mean (0.313). In contrast to the directional informed trading measure, increasing values of OMS^{σ} indicate volatility informed trading and lower values indicate more diverse

[13] Since our measure is a dynamic metric, we must allow options contracts to change the moneyness category over time when approaching maturity since we would otherwise exclude the possibility that an option contract, which an informed investor buys, ever becomes ITM. On the other hand for an informed trader to buy the option OTM, one single OTM day would theoretically already be sufficient. To test the robustness of our results with respect to our moneyness definition, we have also considered several different selection criteria, using the dates up to 5 trading days before maturity. No matter whether we consider stricter or weaker OTM day selection rules our results are qualitatively the same.

[14] In what follows, we omit for reasons of simplicity the index k. Nevertheless, all measures and variables are computed for each single underlying stock.

[15] We use the square root of the volume in order to standardize the variable.

[16] We use the median in order to mitigate the impact of potential outliers.

beliefs on the future volatility of the stock returns. Consequently, the mean of OMS^{σ} is lower and the entire distribution is slightly shifted to the left compared to the distribution of the directional informed trading measures. The spread size varies substantially with the moneyness ranges, the mean of the standardized spread is roughly 1 for the OTM options ($SPREAD^{C}_{OTM}$, $SPREAD^{P}_{OTM}$) and roughly 0.1 for the ITM options ($SPREAD^{C}_{ITM}$, $SPREAD^{P}_{ITM}$). This corresponds to the fact that it is more expensive to trade in OTM options. Nevertheless, OTM options are usually the most actively traded type of options, which is also the case in our sample. Option market trading volume is relatively higher for OTM options ($SVOL^{C}_{OTM}$, $SVOL^{P}_{OTM}$), namely 4.4 and 4.6 for call and put OTM options and 3.5 and 3.7 for call and put ITM options ($SVOL^{C}_{ITM}$, $SVOL^{P}_{ITM}$) respectively.

Table 2 reports daily mean excess returns for portfolios that are sorted by the directional OMS measure. We construct stock return groups based on the lagged OMS^{C}_{t-1} and OMS^{P}_{t-1} measures and compute the mean excess returns in t of these portfolios across our sample firms. The OMS measure is a correlation and thus it takes values on a scale from -1 to +1. To form stock portfolio groups, we set the portfolio break points on 0.2 interval steps of the OMS measure. To gauge potential cross-sectional effects, we first form quartile stock portfolios that are sorted using the firm's size or volatility. Thereafter, we group the stocks in each of the quartile portfolios according to their stock specific OMS value.

INSERT TABLE 2 ABOUT HERE

In Panel A of Table 2, we find for lower values of the OMS measure higher portfolio returns for the call market and lower returns for the put market. This pattern provides a first piece of evidence in favor of our hypothesis that the OMS measure reflects asymmetric information and the presence of directional informed investors. The results indicate that private information trading in case of a positive signal precedes return increases and in case of a negative signal return decreases.

Clearly, the relation between the OMS measure and stock returns exhibits a nonlinear pattern. The return is the highest for the lowest OMS^{C} portfolio (see column (1) in Table 2). It decreases nonlinearly with an increase in OMS^{C}. This asymmetric pattern in the return portfolios implies the presence of substantial price adjustments for extremely low OMS^{C} values. The return differences between the stock portfolios with negative OMS values are notably larger than the return difference for positive OMS values. Even though the stock returns decrease with an increasing OMS measure across groups, for the portfolio of stocks with the highest OMS^{C} (see column (10) in Table 2), we observe a reincrease in the portfolio return. We conjecture that this return pattern is associated with a higher degree of option market symmetry in case of particular events of high dispersion of beliefs such as for instance earnings announcements, which are prescheduled events that are often preceded by highly two-sided markets (see e.g. Sarkar and Schwartz 2009, Choy and Wei 2012). Analogously, these findings hold but with reversed signs for the portfolio returns of the put OMS^{P} sorted portfolios. In order to account for these potential non-linearities, we include the quadratic term of the OMS measure in our stock return predictability tests below. Given the results in Table 2, we expect the signs of the coefficients for the squared terms of OMS^{C} and OMS^{P} to be positive and negative, respectively.

Additionally, we observe in Panel A of Table 2 that the OMS groups vary substantially in their size from roughly 25,000 observations to more than 1 million. This matches also the observation from the summary statistics that on average the value of the OMS measure is clearly positive and is intuitive given that low OMS values reflect option demand imbalances induced by private information trading. Naturally, we expect that private information trading days occur significantly less often than on no information trading days. This is also in line with our previous argument on the average sample distribution of the OMS variables.

Considering Panel B in Table 2, we observe that there is a low versus high size effect which is reflected along the double sorted portfolios in higher returns on the call market and lower returns on the put market for smaller firms. Usually, smaller firms are more information opaque and their stocks are traded less frequently. These differences in firm characteristics tend to create a cross-sectional variation in the degree of the market's information asymmetry. In the literature it is broadly established that size has a negative relationship with informed trading in stock markets (e.g. Easley et al. 1998). This results in an overall higher level of stock price efficiency, a faster speed of price adjustment and a lower return variation for larger stocks. Furthermore, we find a low versus high volatility effect. The value of any option position is higher for high volatility stocks and therefore increases the likelihood that informed traders exploit their information in the option market (see Easley et al. 1998).

4 Results

4.1 The Information Content of Directional and Volatility Informed Option Demand

4.1.1 Predicting Stock Returns and Volatility with Informed Option Demand

As detailed in Section 2.2, we first investigate the information content of (excess) option demand. We test the predictive power of our OMS measure for stock returns and robustify the results by controlling for volatility informed trading.

Table 3 reports the FMB-regression results with stock returns as dependent variables in Panel A and C and realized stock return volatility as dependent variable in Panel B. To save space we omit the regression results of the controls.

INSERT TABLE 3 ABOUT HERE

Since we use in Panel A and C percentage returns in the regressions we can interpret the estimated coefficients directly as a percentage change in returns the day after e.g. the directional OMS measure drops from zero to minus one. In Panel B we express the realized volatility in basis points, therefore the coefficients indicate daily basis point changes after e.g. the OMS measure drops from zero to minus one. In Panel A regression model (I), we firstly validate the predictive power of the directional

OMS measure. The coefficient of the OMS^C measure is negative and statistically significant. This supports our hypothesis that OTM call option excess demand indicates positive information trading because we conjecture that in the case of a positive private signal, the call market sidedness measure decreases and predicts increasing returns. Our results imply that a drop of the OMS^C measure from zero to minus one implies an increase of the returns on the next day by 16 basis points. The coefficient of the OMS^P measure is as expected positive and significant. This implies that indeed in the OTM put option case a decreasing OMS^P measure, which signals an increase in option market sidedness, predicts decreasing stock returns. The decrease in the return of the next day that is implied by an OMS^P measure change from zero to minus one is 15 basis points.

The coefficients of the squared OMS measures exhibit the expected signs and are statistically significant on a 1% significance level. This confirms the non-linearity in the relation between the OMS measure and returns that we observe in the OMS sorted stock portfolio returns in Table 2. The positive and negative significant coefficients of the squared term for the call and the put market measure respectively, imply that for instance a negative change in the directional OMS that is close to minus one and thus indicates asymmetric information, produces a relatively larger return movement than a negative change in OMS close to zero. These results hold for all following regression models where the squared term of the directional OMS measures is included.[17]

In regression model (II) we additionally include the $CP-RATIO$ that is the ratio of daily aggregated open interest in call and in put option contracts of a particular stock minus one. The $CP-RATIO$ is common in practice as a buy or sell signal for technical trading analysis. A ratio that is greater than zero is supposed to indicate bullish markets while a ratio that is smaller than zero indicates bearish markets. Adding this measure does not change the significance or signs of the OMS measure. This implies that the OMS measure picks up additional information that is not contained in the $CP-RATIO$.[18]

Panel B summarizes the results for the regression of the realized volatility proxy RV on the EAD (non-)interacted lags of the OMS^σ measure. In model (III) coefficients are significant at the 1% level. The coefficient for the OMS^σ is not straight forward interpretable due to the fact that ATM straddle bets on increasing as well as decreasing volatility would both increase the open interest in the respective call and put option pairs. However, the EAD interacted OMS^σ coefficient is directly interpretable since earnings announcements are usually associated with an increase in the return volatility. The coefficient of the EAD interacted OMS^σ measure is as expected positive and $\beta_2 + \beta_1 > 0$, implying that an excess demand in call and put option ATM straddle pairs conditional on an EAD strongly indicates trading on increasing future volatilities. This corroborates our expectations and validates OMS^σ as indicator of volatility trading.

In regression model (IV) we add OMS^C and OMS^P in order to robustify the results of the OMS^σ measure. Furthermore, this specification helps to corroborate that the OMS^C and OMS^P measures

[17] We have also tested whether our results still hold if we run the above daily regressions for each year in our sample separately. We find that the results are in almost all years qualitatively the same as for the whole sample.

[18] Using alternatively for instance the change in call open interest, divided by the change in put open interest, does not affect our results.

are associated with directional information trading. In particular, we are interested in the coefficient of the OMS measures around $EADs$. The results show that indeed the EAD interacted directional OMS measures exhibit neither for the call nor for the put market side a significant coefficient. For the entire time series of the realized volatility, a lower directional OMS measure implies for both market sides increases in the future realized stock return volatility, which is in line with our expectations.

In Panel C we add to the stock return regressions from Panel A the OMS^{σ} and the EAD interacted OMS^{σ} measure in order to control for volatility informed trading. In model (V) the coefficients of the directional OMS measures and their squared terms are roughly unchanged as compared to the results in Panel A. This indicates that these results are not affected by volatility informed trading. Furthermore, the EAD interacted OMS^{σ} measure provides insignificant results in the return regressions, which further supports our hypothesis that the excess demand in the call and put option ATM straddle pairs is associated with non-directional volatility informed trading. The significant positive coefficient for the OMS^{σ} measure indicates that on average a large increase in ATM straddle trading is associated with increasing future returns.

Finally, in model (VI) we further robustify that OMS^C and OMS^P are informative about the direction of future returns by adding to model (II) additionally EAD interacted OMS^C and OMS^P variables. The coefficients are as expected insignificant and do not affect the results for the OMS^C and OMS^P variables.

In order to examine more closely the information content of option demand for stock returns, we investigate next, similar to Pan and Poteshman (2006), the predictability horizon of the OMS measure. We extend the predictability horizon of OMS^C and OMS^P respectively up to 20 trading days. Figure 1 plots the slope coefficients of OMS^C on the left-hand side and the slope coefficients of OMS^P on the right-hand side. The dashed lines are the 95% confidence-intervals.

INSERT FIGURE 1 ABOUT HERE

The plots show that the predictability is robust and relatively strong during the first three weeks on the call market side and during the first two weeks on the put market side. Subsequently, the predictability of OMS^C and OMS^P decays further and looses its economical and statistical significance.

4.1.2 Option Market Demand and Firm Characteristics

Next, we investigate the cross-sectional implications of option market sidedness. Previous literature finds that certain firm characteristics matter for stock price efficiency, information opaqueness and the likelihood of informed trading in the stock or option market. Therefore, we expect that firm characteristics exhibit different degrees of exposure towards option market sidedness.

Regression results for sorted portfolios according to a firm's size or volatility are reported in Table

4. As in previous regressions we control for several other factors.

INSERT TABLE 4 ABOUT HERE

In the left part of Table 4, the coefficients of the call and put option market sidedness measure (OMS^C_{t-1} and OMS^P_{t-1}) are as above significantly negative and positive, respectively. The quadratic OMS terms again corroborate our conjecture of a nonlinear relationship and the coefficients exhibit the expected signs. As expected from the findings in Table 2, there is a stronger relationship of private information trading and stock returns for smaller firms.

In the right part of Table 4, we consider cross-sectional regressions of the excess returns of quartile portfolios that are sorted according to the yearly return standard deviation. The coefficients of the OMS measure clearly increase in absolute terms with an increasing stock return volatility. These results confirm that informed traders are more likely to trade in higher volatility stocks.

4.1.3 Option Portfolio Strategies

The results from the regression analyzes provide strong evidence that the OMS measure has predictive power for future stock returns. In order to show the economic significance of informed option demand, we consider next the profitability of informed trading conditional on the OMS measure by implementing a trading strategy, which mimics the behavior of an informed investor that implicitly underlies the construction of our OMS measure.

In Table 5 we report mean returns of the portfolios that are obtained in each trading round from the two trading strategies in Section 2.2.3, respectively.

INSERT TABLE 5 ABOUT HERE

The results for the simple long put option strategy in the right part of Panel A show that farther OTM options provide on average for each trading round higher portfolio returns. The average portfolio returns for the different maturity and moneyness groups range between 24% and 85%.[19] The left part of Panel A shows the profitability of OMS based OTM long call option strategies. The profits across all maturity and moneyness groups range between 5% and 25%. Very far OTM call options provide lower returns, while investments for the same time to maturity groups using closer to the money options provide substantially larger portfolio returns. We interpret this as evidence for what is a well established fact in the literature, namely that negative public information induces, on average, more extreme stock return decreases compared to the stock return increases following positive public information. So in order to profitably exploit future stock return movements, investors need to consider the expected strengths of the stock return movement.

[19] Note that for untabulated farer OTM options the portfolio returns amount to almost 200%. However, due to the high transaction costs in far OTM options informed investors are unlikely to trade into such option contracts. Therefore we omit the results for higher moneyness classes and can provide them on request.

The economic significance of the option market sidedness hypothesis is corroborated in Panel B where the results for the delta-hedge strategy are reported. Due to the volatility-hedging the returns are naturally lower than in the simple long strategies. Once we hedge the call or put option portfolio against stock volatility, we find that again farer OTM options and option contract portfolios with relatively longer times to maturity provide higher portfolio returns.

4.2 Option Market Price Pressure and Informed Option Demand

After demonstrating that option demand of informed investors predicts future stock returns, we next investigate the impact of the informed trading on option prices. First, we present the results for the spread regressions that explore how market makers potentially protect themselves against option market sidedness. Thereafter, we consider the relation between the variation in the violations of the PCP and option market sidedness.

4.2.1 Option Demand Imbalances and Liquidity Levels

The regressions of OTM option bid-ask spreads of call and put options on the respective OMS measure explore the relation of one-sided excess option demand of informed traders and its price impact.

In Table 6 we report the option spread FMB-regression results.[20]

INSERT TABLE 6 ABOUT HERE

The spread regressions in model (I) the expected negative relation between the OMS measures and the stock individual bid-ask spread. In addition, the results are almost identical for both call and put option spreads which corroborates that the impact of the demand pressure is similar for the positive and negative information case. All results are robust to the controls that we include in model (II) and (IV). Overall, the findings show that the OMS measure can be useful as a new liquidity measure in the option market.[21]

4.2.2 Demand Pressure and Violations of the Put-Call Parity

If informed traders create an excess option demand on one side of the market, we expect that the one-sided increase in the demand pressure moves the market further off the arbitrage equilibrium. Therefore, we conjecture a decreasing OMS measure for the call and put market is associated with an increase in the PCP deviations.

[20] In order to test whether firm effects change the quality of our results, we have also estimated OLS regressions with and without firm level fixed effects as well as with firm level or firm level and month clustered standard errors. Our results do not qualitatively change and we find no evidence for a substantial firm effect.

[21] In untabulated results we find that option market sidedness does not affect liquidity risk. This is in line with the notion of informed option trading as exploitation of private directional information which by itself, however, remains unobserved by the uninformed investors.

We compute the PCP according to (5) and (6) and we use absolute values as dependent variables in FMB-regressions. We also control for several other factors that could explain the variation in the PCP deviations.

In Table 7 reports the PCP regression results.

INSERT TABLE 7 ABOUT HERE

The regression results confirm our expectation of a negative relation between the OMS measures and the PCP deviations. Whenever the option demand indicates asymmetric information the PCP deviations increase. This is in line with our notion that informed trading in option markets creates a one-sided demand pressure which impacts the deviations of the pricing relations in the option market. The findings imply that informed option market demand contributes to deviations from the arbitrage equilibrium which puts further into question a fundamental principle of most option pricing approaches.

5 Conclusion

The traditional view that option markets are informationally redundant to stock markets, is frequently challenged in the literature. Furthermore, breaking with the assumption that option pricing is independent of option demand, mainly addresses the large gap between empirical and theoretical option prices. However, so far there is only very mixed and limited evidence in public data for directional private information trading in the option market and the implications of informed trading for option market price pressure are rarely addressed.

This paper investigates option demand imbalances due to an imbalance in option demand related to investors with positive and negative private information on the underlying using publicly available data. The guiding idea is that informed traders create an excess demand in one particular option contract type (e.g., OTM long call or OTM long put) which we interpret as option market one-sidedness. In contrast, a two-sided market is characterized by uninformed investors with diverse beliefs and equal probabilities of taking any possible option trade. We call this approach, in analogy to Sarkar and Schwartz (2009), Option Market Sidedness (OMS). The conceptual approach of market one-sidedness and option excess demand developed in our study contributes an innovative method to analyze the relation between stock and options markets, which allows for new insights on the information in option markets for future stock returns and on the implications of informed trading for the option market microstructure as opposed to trading volume, volatility or price related measures.

In order to make the market sidedness of the option market measurable, we derive a new open interest based measure of informed option demand and demand pressure in the option market, which we refer to as OMS measure. The measure indicates positive and negative private information trading at an individual security level. Furthermore, as a control, we distinguish between directional informed trading, captured by the OMS measure, from volatility informed trading. For this purpose, we develop OMS^{σ} as option market sidedness measure of volatility informed trading. To test our hypotheses, we use a comprehensive dataset of all securities at the intersection of the OptionMetrics Ivy DB, CRSP NYSE/AMEX/NASDAQ daily return files and Compustat from January 1996 until December 2009.

First, we find direct evidence for positive and negative information in option excess demand for future stock returns, which provides a new aspect of the economic value of derivatives and evidence for market inefficiencies. Our demand based approach also lends itself to mitigate the inference problem of positive and negative private information for future asset prices, which uninformed investors face. Second, controlling for volatility informed trading does not affect our results on the directional private information trading. Third, smaller and higher return volatility firms, exhibit a higher concentration of demand asymmetries related to informed trading. This corroborates findings in the previous literature on informed trading in the option and stock market. Fourth, we find economically significant returns for option investment strategies that trade on the excess demand in options (e.g., 25% or 39% in one roughly four weeks for OTM long calls or puts with 1-month time to maturity).

Moreover, we address the impact of informed option demand on price pressure in option markets, providing new insights on option market liquidity and deviations off the arbitrage equilibrium that are directly relevant for market makers and uninformed investors. First, we find that informed trading reduces liquidity in the option market and that our measure of option market sidedness can be useful as a new liquidity measure for the option market. Second, the asymmetric demand pressure due to informed trading increases the violations of the put-call parity. This indicates that the demand pressure of informed investors contributes to an increased deviation of option markets off the arbitrage equilibrium.

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Appendix A Tables & Figures

	Mean	Std	Q25	Median	Q75
OMS_t^C	0.4225	0.3981	0.1137	0.4728	0.7512
OMS_t^P	0.461	0.3972	0.1579	0.5262	0.7945
OMS^σ	0.313	0.4641	-0.0041	0.3653	0.7031
$BETA$	1.2058	0.4176	0.8415	1.095	1.4419
$SIZE$	7.2081	1.6289	6.089	7.1154	8.2207
BM	0.7835	5.7843	0.2555	0.4463	0.7452
RV	415.0599	359.5822	198.4127	315.2174	510.3861
MOM	0.0319	0.2672	-0.0912	0.0377	0.1604
STD	0.0312	0.0193	0.0182	0.0263	0.0386
$SPREAD_{OTM}^C$	1.1076	0.7801	0.303	1.0278	2
$SPREAD_{ITM}^C$	0.0999	0.1447	0.0471	0.0748	0.1111
$SPREAD_{ITM}^P$	0.1146	0.1803	0.0494	0.0779	0.1211
$SPREAD_{OTM}^P$	1.0739	0.7394	0.3529	1	2
$SVOL_{OTM}^C$	4.4227	4.5578	1.8708	3.1623	5.2915
$SVOL_{ITM}^C$	3.5068	3.3994	1.5811	2.7386	4.1231
$SVOL_{ITM}^P$	3.7412	4.4287	1.5811	2.7386	4.4721
$SVOL_{OTM}^P$	4.5585	5.0207	2	3.1623	5.2915

Table 1: **Descriptive Statistics of Sample Variables.** The table provides summary descriptive statistics for sample variables across the full sample period from January 1996 until December 2009. The table reports the mean, the standard deviation (Std), the median, the 25 percent (Q25) and the 75 percent quantile (Q75) across all sample firms. OMS^C and OMS^P are the option market sidedness measures for the call and put market, respectively (for details see Section 2.1). OMS^σ is the option demand imbalance measure that is related to volatility informed trading (for details see Section 2.1). $BETA$ is the individual stock market beta which is obtained as described in Section 3.1, $SIZE$ is the logarithm of market equity. BM is the logarithm of the book-to-market ratio measured by book equity divided by, market equity using the fiscal year-end value preceding year. RV is in basis points and is defined as in Ni et al. (2008) as 10,000 times the difference of an underlying stock's intraday high and low prices divided by the closing stock price. MOM is obtained from the daily returns as cumulative returns over a 60 days backward looking window. STD is the average realized standard deviation obtained from the daily returns over a 60 days backward looking window. $SPREAD_{OTM}^C$ and $SPREAD_{ITM}^C$ are the median daily relative bid-ask spreads of call options that are OTM or ITM. $SPREAD_{OTM}^P$ and $SPREAD_{ITM}^P$ are the median daily relative bid-ask spreads of put options that are OTM or ITM. $SVOL_{OTM}^C$ and $SVOL_{ITM}^C$ denote the square root of the daily median call option trading volume that are OTM or ITM. $SVOL_{OTM}^P$ and $SVOL_{ITM}^P$ denote the square root of the daily median put option trading volume that are OTM or ITM. The descriptives for the OMS measure, the daily option spreads and option volume are formed using all days where the respective variable was nonzero.

Panel A: Single Sorted Portfolio Returns in Percent	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Low				OMS^{C}_{t-1}					High
mean return	0.2034	0.1595	0.0977	0.0786	0.0579	0.029	-0.0338	-0.046	-0.0292	0.0731
N_{PF}	34722	46398	73500	119622	475600	764753	679025	812852	926336	1013504
	Low				OMS^{P}_{t-1}					High
mean return	-0.1257	-0.0822	-0.0638	0.0224	0.0441	0.0747	0.1231	0.1216	0.0923	-0.013
N_{PF}	33309	43050	69471	112235	472177	737474	683548	848467	1029269	1303315

Panel B: Double Sorted Portfolio Returns in Percent	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Low				OMS^{C}_{t-1}					High
Low $SIZE$	0.2237	0.1379	0.0164	-0.0295	-0.0535	-0.1111	-0.1976	-0.2183	-0.181	-0.0105
	0.2435	0.1995	0.1238	0.102	0.0673	0.0288	-0.0501	-0.0544	-0.0477	0.0915
	0.2033	0.2186	0.1292	0.127	0.0794	0.064	0.0112	-0.0033	0.0167	0.1006
High $SIZE$	0.1493	0.0941	0.1004	0.0868	0.1063	0.0868	0.0409	0.0321	0.0409	0.1007
Low STD	0.0964	0.0767	0.0695	0.0621	0.041	0.024	-0.0128	-0.0128	-0.0017	0.0572
	0.1793	0.1302	0.0909	0.0754	0.0655	0.0276	-0.0113	-0.0179	-0.006	0.0746
	0.2804	0.2008	0.1321	0.1307	0.077	0.0508	-0.025	-0.0356	-0.0188	0.0845
High STD	0.2686	0.242	0.099	0.0421	0.0463	0.0121	-0.0821	-0.1082	-0.0813	0.075
	Low				OMS^{P}_{t-1}					High
Low $SIZE$	-0.1704	-0.1863	-0.1538	-0.0181	-0.0083	-0.0097	0.0302	0.0081	-0.0203	-0.139
	-0.1528	-0.0987	-0.0889	0.0133	0.0477	0.1009	0.1707	0.1434	0.0931	-0.0324
	-0.1198	-0.0702	-0.0404	0.0364	0.0765	0.107	0.1455	0.1582	0.1273	0.0131
High $SIZE$	-0.0618	0.0055	0.0025	0.0418	0.05	0.0764	0.1178	0.1344	0.1183	0.0508
Low STD	-0.055	-0.0082	-0.0187	0.0375	0.0505	0.0688	0.0954	0.091	0.0755	0.0159
	-0.0811	-0.024	-0.025	0.0043	0.0401	0.0843	0.1149	0.1134	0.0999	0.0114
	-0.2514	-0.1242	-0.0727	0.029	0.0447	0.0932	0.1398	0.1426	0.1058	-0.0063
High STD	-0.1613	-0.2092	-0.1568	0.0188	0.0407	0.0516	0.1414	0.1367	0.0852	-0.0747

Table 2: Single and Double Sorted Portfolio Excess Returns. The table reports daily mean excess returns for OMS_{t-1} measure grouped portfolios (Panel A). OMS^{C}_{t-1} and OMS^{P}_{t-1} are the option market sidedness measures for the call and put market, respectively (for details see Section 2.1). We construct OMS^{C}_{t-1} and OMS^{P}_{t-1} measure groups of the underlying stocks and compute the contemporaneous mean excess return of these portfolios. Portfolio returns are in percentages. The OMS measure takes values on a scale from -1 to +1, thus we form 10 portfolios where in each portfolio the stocks' OMS values span a 0.2 range. Panel B reports double sorted portfolios where first quartile return portfolios are formed according to the firm variables $SIZE$ or STD and subsequently. Within the quartile portfolios we group stocks according to the OMS_{t-1} measure as in Panel A. The sorting variable $SIZE$ is the logarithm of market equity using the year-end value and STD is the yearly return standard deviation. N_{PF} is the number of observations in each portfolio. The sample period is January 1996 to December 2009.

Panel A: Stock Return Predictive Regressions with Directional Asymmetric Option Demand

Dependent Variable	$CONSTANT$	OMS^C_{t-1}	OMS^P_{t-1}	$OMS^{2,C}_{t-1}$	$OMS^{2,P}_{t-1}$	$CP-RATIO$	$adj.\ R^2$
(I): RET	0.058**	-0.158***	0.153***	0.207***	-0.243***		0.003
	(2.21)	(-11.2)	(10.08)	(13.16)	(-15.69)		
(II): RET	-0.103*	-0.158***	0.114***	0.179***	-0.228***	0.001***	0.12
	(-1.77)	(-10.36)	(7.61)	(11.98)	(-14.32)	(3.82)	

Panel B: Realized Volatility Predictive Regressions with Volatility and Directional Asymmetric Option Demand

Dependent Variable	$CONSTANT$	OMS^C_{t-1}	OMS^P_{t-1}	$OMS^{2,C}_{t-1}$	$OMS^{2,P}_{t-1}$	OMS^σ_{t-1}	$OMS^\sigma_{t-1}\cdot EAD_t$	$OMS^C_{t-1}\cdot EAD_t$	$OMS^P_{t-1}\cdot EAD_t$	$adj.\ R^2$
(III): RV	0.191***					-0.015***	0.241***			0.099
	(11.39)					(-8.14)	(10.32)			
(IV): RV	0.214***	-0.019***	-0.01**	0	-0.021***	-0.009***	0.093*	0.617	0.063	0.114
	(12.04)	(-4.07)	(-2.33)	(-0.03)	(-4.46)	(-4.36)	(1.78)	(1.46)	(0.36)	

Panel C: Stock Return Predictive Regressions with Directional Asymmetric Option Demand and Volatility Trading Control

Dependent Variable	$CONSTANT$	OMS^C_{t-1}	OMS^P_{t-1}	$OMS^{2,C}_{t-1}$	$OMS^{2,P}_{t-1}$	OMS^σ_{t-1}	$OMS^\sigma_{t-1}\cdot EAD_t$	$OMS^C_{t-1}\cdot EAD_t$	$OMS^P_{t-1}\cdot EAD_t$	$adj.\ R^2$
(V): RET	-0.051	-0.158***	0.136***	0.174***	-0.233***	0.01**	2.227			0.128
	(-0.85)	(-12.11)	(9.09)	(12.55)	(-14.42)	(1.99)	(0.95)			
(VI): RET	-0.05	-0.155***	0.136***	0.171***	-0.231***	0.009*	0.025	2.898	-1.156	0.132
	(-0.84)	(-11.86)	(9.13)	(12.33)	(-14.43)	(1.86)	(0.16)	(1)	(-1)	

Table 3: FMB-Regression Results for Daily Individual Stock Excess Returns and Realized Return Volatilities on the Directional OMS and OMS^σ Measures and Controls. The table provides daily FMB-regression results of individual stocks' excess returns (RET) and of the daily individual stocks' realized volatility (RV) on the directional OMS measure and on OMS^σ as well as on control variables. The results for the control variables are omitted. Returns are in percentages. RV is in basis points and is defined as in Ni et al. (2008) as 10,000 times the difference of an underlying stock's intraday high and low prices divided by the closing stock price. OMS^C_{t-1} and OMS^P_{t-1} are the lagged option market sidedness measures for the call and put market, respectively (for details see Section 2.1). $OMS^{2,C}_{t-1}$ and $OMS^{2,P}_{t-1}$ are the corresponding quadratic terms. OMS^σ is the option demand imbalance measure that is related to volatility informed trading (for details see Section 2.1). $CP-RATIO$ is a daily ratio of the open interest in the call option market divided by the open interest in the put option market minus one. The controls include: $BETA$ as the individual stock market beta which is obtained as described in Section 3. $SIZE$ as the logarithm of market equity. BM as the logarithm of the book-to-market ratio measured by book equity divided by market equity using the fiscal year-end value preceding year. $LAG\ RET$ as the previous day's excess stock return. $LAG\ RV$ as the lag of the realized volatility. MOM as obtained from the daily returns as cumulative returns over a 60 days backward looking window. STD as the average realized standard deviation obtained from the daily returns over a 60 days backward looking window. $SVOL^C_{OTM}$ and $SVOL^C_{ITM}$ as the square root of the daily median call option trading volume that are OTM or ITM. $SVOL^P_{OTM}$ and $SVOL^P_{ITM}$ as the square root of the daily median put option trading volume that are OTM or ITM. Newey-West robust t-statistics are in parentheses (20 lags). *** indicate a 1% level of significance, ** a 5% level of significance and * a 10% level of significance. The R^2 is the average cross-sectional adjusted R^2.The overall number of stocks in the regression is 4157. The sample period is January 1996 to December 2009.

	Size Sorted Quartiles				Volatility Sorted Quartiles			
	Low	$SIZE$		High	Low	STD		High
CONSTANT	-0.036	-0.041	-0.028	-0.016	-0.036	-0.027	-0.056	-0.203***
	(-0.97)	(-1.36)	(-1.02)	(-0.58)	(-1.26)	(-0.8)	(-1.41)	(-3.01)
OMS^{C}_{t-1}	-0.255***	-0.202***	-0.153***	-0.119***	-0.068***	-0.133***	-0.203***	-0.316***
	(-5.66)	(-7.76)	(-8.8)	(-9.07)	(-5.48)	(-6.52)	(-9.33)	(-8.75)
OMS^{P}_{t-1}	0.107***	0.116***	0.128***	0.116***	0.065***	0.12***	0.13***	0.156***
	(2.74)	(4.05)	(6.16)	(7.25)	(4.81)	(7)	(4.81)	(3.96)
$OMS^{2,C}_{t-1}$	0.348***	0.235***	0.192***	0.141***	0.096***	0.166***	0.228***	0.379***
	(7.43)	(7.74)	(10.23)	(9.06)	(7.9)	(7.95)	(9.28)	(9.04)
$OMS^{2,P}_{t-1}$	-0.234***	-0.231***	-0.222***	-0.17***	-0.113***	-0.192***	-0.248***	-0.303***
	(-5.77)	(-8.36)	(-10.24)	(-9.19)	(-9.02)	(-11.28)	(-9.91)	(-6.95)
$BETA$	-0.035**	-0.023	-0.04***	-0.054***	-0.004	-0.009	-0.008	-0.013
	(-2.12)	(-1.63)	(-2.65)	(-3.49)	(-0.27)	(-0.72)	(-0.58)	(-0.74)
$SIZE$					0.004*	0.005*	0.013***	0.04***
					(1.86)	(1.76)	(3.08)	(5.9)
BM	0.01	0.006	0.009**	0.011**	0.004*	0.004	0.008	0.026*
	(1.09)	(1.15)	(2.47)	(2.33)	(1.82)	(1.02)	(1.55)	(1.76)
$LAG\ RET$	-2.911***	-3.034***	-3.781***	-4.039***	-4.086***	-3.833***	-3.68***	-2.954***
	(-10.64)	(-13.03)	(-17.17)	(-19.61)	(-18.07)	(-18.05)	(-19.1)	(-12.73)
MOM	1.84***	1.755***	1.799***	1.915***	1.758***	1.804***	1.758***	1.743***
	(40.85)	(41.84)	(44.59)	(41.74)	(42.88)	(48.08)	(48.85)	(40.88)
STD	1.217	2.13**	2.327**	2.298**				
	(1.1)	(2.06)	(2.22)	(2.14)				
adj. R^2	0.057	0.072	0.097	0.129	0.058	0.053	0.055	0.054

Table 4: FMB-Regression Results for Size and Standard Deviation Sorted Quartile Portfolio Excess Returns on the OMS Measure and Controls. The table provides daily FMB-regression results of excess returns of size ($SIZE$) and standard deviation (STD) sorted quartile portfolios on several control variables. The sorting variable $SIZE$ is the logarithm of market equity using the year-end value and STD is the yearly return standard deviation. Returns are in percentages. OMS^{C}_{t-1} and OMS^{P}_{t-1} are the option market sidedness measures for the call and put market, respectively (for details see Section 2.1). $OMS^{2,C}_{t-1}$ and $OMS^{2,P}_{t-1}$ are the corresponding quadratic terms. $BETA$ is the individual stock market beta which is obtained as described in Section 3. $BETA$ is the individual stock market beta which is obtained as described in Section 2.1. $SIZE$ is the logarithm of market equity. BM is the logarithm of the book-to-market ratio measured by book equity divided by market equity using the fiscal year-end value preceding year. $LAG\ RET$ is the previous day's excess stock return. MOM is obtained from the daily returns as cumulative returns over a 60 days backward looking window. STD is the average realized standard deviation obtained from the daily returns over a 60 days backward looking window. Newey-West robust t-statistics are in parentheses (20 lags). *** indicate a 1% level of significance, ** a 5% level of significance and * a 10% level of significance. The R^2 is the average cross-sectional adjusted R^2. The overall number of stocks in the regression is 4157. The sample period is January 1996 to December 2009.

Panel A: Long Option Only Strategy

		Call Option Portfolio Returns			Time to Maturity		Put Option Portfolio Returns		
		3-7 days	8-14 days	15-21 days			3-7 days	8-14 days	15-21 days
$\frac{K}{S} \in$	$]1.0; 1.1[$	23.71	17.57	24.57	$\frac{S}{K} \in$	$]1.0; 1.1[$	27.01	26.89	38.69
	$[1.1; 1.2[$	11.44	8.5	23.64		$[1.1; 1.2[$	25.47	29.56	50.7
	$[1.2; 1.3[$	4.57	5.46	15.49		$[1.2; 1.3[$	84.08	85.37	47.54

Panel B: Delta-Hedged Option Strategy

		Call Option Portfolio Returns			Time to Maturity		Put Option Portfolio Returns		
		3-7 days	8-14 days	15-21 days			3-7 days	8-14 days	15-21 days
$\frac{K}{S} \in$	$]1.0; 1.1[$	0.17	0.66	0.88	$\frac{S}{K} \in$	$]1.0; 1.1[$	0.44	1.12	2.35
	$[1.1; 1.2[$	0.52	1.11	1.18		$[1.1; 1.2[$	0.45	1.23	2.25
	$[1.2; 1.3[$	0.34	1.96	2.47		$[1.2; 1.3[$	-1.51	1.53	2.74

Table 5: Mean Portfolio Returns for OMS **Based Option Trading Strategies Across Maturities and Moneyness.** The table provides mean portfolio returns for option portfolio trading strategies using values ≤ -0.5 of the OMS measure as trading signal. Returns are in percentages. The option market sidedness measure (OMS) is computed for the call and put market, respectively (for details see Section 2.1). The first strategy (Panel A) corresponds either long OTM call or long OTM put. The second strategy (Panel B) neutralizes the effects of the underlying's volatility in the option investment by forming delta-hedged portfolios. For details on the trading strategies see Section **??**. We form portfolio groups with respect to the options' moneyness at the investment date and the beginning time of the investment in relation to the maturity date. The moneyness groups are sorted according to the ratio of the strike price K and the stock price S. For call options we use $\frac{K}{S}$ and for put options we use $\frac{S}{K}$. This implies larger values of the respective ratios for farer OTM put and call option contracts. The days to maturity groups are formed according to the temporal distance between the point in time when the investor receives the trading signal and the maturity date. We report separately the results for call (left part) and put (right part) option portfolios. The sample period is January 1996 to December 2009.

	(I)	(II)	(III)	(IV)
CONSTANT	0.004	-0.047**	0.014	-0.101***
	(0.23)	(-2.19)	(0.71)	(-5.25)
OMS_t^C	-0.017***	-0.009***		
	(-4.41)	(-2.71)		
OMS_t^P			-0.038***	-0.031***
			(-8.75)	(-8.07)
$SIZE$		0.01***		0.01***
		(5.27)		(4.52)
$LAG\ RET$		-2.332***		2.506***
		(-37)		(41.29)
MOM		-0.566***		0.535***
		(-29.29)		(28.35)
STD		-0.041***		
		(2.96)		(3.3)
$SVOL_{OTM}^C$		-0.041***		
		(-28.56)		
$SVOL_{ITM}^C$		0.008***		
		(7.04)		
$SVOL_{ITM}^P$				-0.002***
				(-3.77)
$SVOL_{OTM}^P$				-0.037***
				(-29.54)
adj. R^2	0.001	0.079	0.002	0.068
N	4157	4157	4157	4157

Table 6: FMB-Regression Results for Individual Firm Option Bid-Ask Spreads on the OMS Measure and Controls. The table provides daily FMB-regression results using as dependent variables daily median individual firm bid-ask spreads for OTM call (model (I) and (II)) and put (model (III) and (IV)) options, respectively. OMS^C and OMS^P are the option market sidedness measures for the call and put market, respectively (for details see Section 2.1). For the ITM and OTM option classification see Section 2.1. $SIZE$ is the logarithm of market equity. $LAG\ RET$ is the previous day's excess stock return. MOM is obtained from the daily returns as cumulative returns over a 60 days backward looking window. STD is the average realized standard deviation obtained from the daily returns over a 60 days backward looking window. $SVOL_{OTM}^C$ and $SVOL_{ITM}^C$ denote the square root of the daily median call option trading volume that are OTM or ITM. $SVOL_{OTM}^P$ and $SVOL_{ITM}^P$ denote the square root of the daily median put option trading volume that are OTM or ITM. Newey-West robust t-statistics are in parentheses (20 lags). *** indicate a 1% level of significance, ** a 5% level of significance and * a 10% level of significance. The R^2 is the average cross-sectional adjusted R^2.The overall number of stocks in the regression is 4157. The sample period is January 1996 to December 2009.

	PCP 1	PCP 2	PCP 1	PCP 2	PCP 1	PCP 2
CONSTANT	0.393***	0.391***	-0.076	0.343***	-0.077	0.342***
	(40.87)	(53)	(-1.32)	(13.61)	(-1.35)	(13.72)
OMS^{C}_{t-1}	0.008	-0.021***	0.002	-0.023***	-0.117***	-0.014*
	(0.73)	(-6.54)	(0.15)	(-7.62)	(-3.64)	(-1.94)
OMS^{P}_{t-1}	0.012	-0.017***	-0.014*	-0.024***	-0.03**	-0.03***
	(1.14)	(-3.48)	(-1.69)	(-6)	(-2.17)	(-3.29)
$OMS^{2,C}_{t-1}$					0.154***	-0.013
					(4.29)	(-1.52)
$OMS^{2,P}_{t-1}$					0.02	0.009
					(1.01)	(0.94)
$BETA$			0.04***	-0.009**	0.041***	-0.009**
			(4.31)	(-2.4)	(4.32)	(-2.44)
$SIZE$			0.054***	0.012***	0.055***	0.012***
			(8.43)	(3.55)	(8.53)	(3.6)
BM			0.048***	0.006**	0.048***	0.006**
			(6.43)	(2.2)	(6.44)	(2.25)
$LAG\ RET$			-0.005	0.046***	-0.011	0.047***
			(-0.22)	(4.2)	(-0.52)	(4.31)
MOM			0.062***	0.112***	0.063***	0.111***
			(4.97)	(18.46)	(4.97)	(18.33)
STD			-0.325	-1.4***	-0.293	-1.394***
			(-1.29)	(-7.96)	(-1.17)	(-7.92)
$SVOL^{C}_{OTM}$			-0.02***	-0.005***	-0.02***	-0.005***
			(-9.17)	(-6.2)	(-9.13)	(-6.18)
$SVOL^{P}_{OTM}$			0.01**	-0.006***	0.009*	-0.006***
			(1.96)	(-9.71)	(1.92)	(-9.68)
adj. R^2	0.002	0.003	0.042	0.031	0.042	0.032

Table 7: FMB-Regression Results for Individual Firm Put-Call Parity Violations on the OMS Measure and Controls. The table provides daily FMB-regression results for daily median individual firm Put-Call Parity violations. Put-Call Parity violations are defined as described in Section .
OMS^{C}_{t-1} and OMS^{P}_{t-1} are the option market sidedness measures for the call and put market, respectively (for details see Section 2.1). $OMS^{2,C}_{t-1}$ and $OMS^{2,P}_{t-1}$ are the corresponding quadratic terms. C_t is the vector of control variables that are specified below. $BETA$ is the individual stock market beta which is obtained as described in Section 3. $SIZE$ is the logarithm of market equity. BM is the logarithm of the book-to-market ratio measured by market equity divided by book equity using the fiscal year-end value preceding year. $LAG\ RET$ is the previous day's excess stock return. MOM is obtained from the daily returns as cumulative returns over a 60 days backward looking window. STD is the average realized standard deviation obtained from the daily returns over a 60 days backward looking window. $SVOL^{C}_{OTM}$ denotes the square root of the daily median OTM call option trading volume. $SVOL^{P}_{OTM}$ denotes the square root of the daily median OTM put option trading volume. Newey-West robust t-statistics are in parentheses (20 lags). *** indicate a 1% level of significance, ** a 5% level of significance and * a 10% level of significance. The R^2 is the average cross-sectional adjusted R^2.The overall number of stocks in the regression is 4157. The sample period is January 1996 to December 2009.

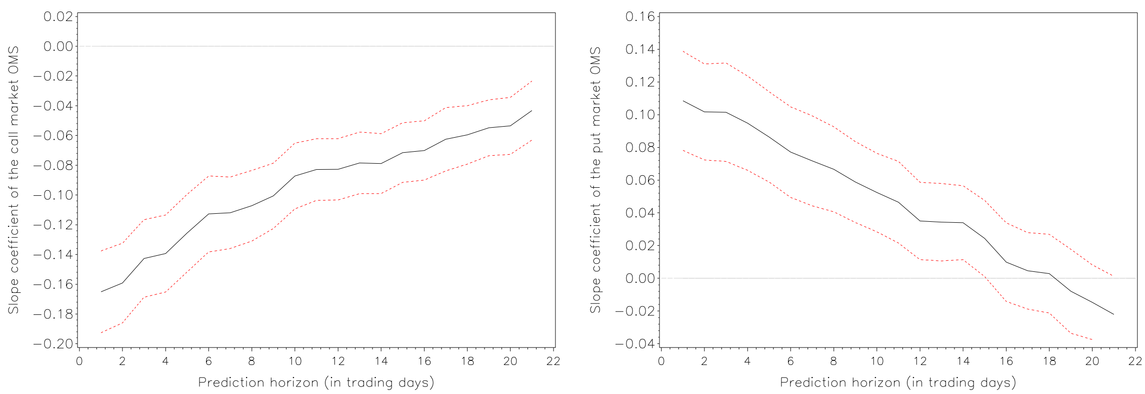

Figure 1: Predictability Horizon of the OMS **Measure for Future Stock Returns.** In order to obtain the plotted time series, we run daily FMB-regressions of the following form

$$RET_t = \beta_0 + \beta_1 OMS^C_{t-i} + \beta_2 OMS^{2,C}_{t-i} + \beta_3 OMS^P_{t-i} + \beta_4 OMS^{2,P}_{t-i} + \mathbf{B}C_t + \epsilon_t,$$

whereas $i = \{1, 2, \dots 20\}$. That is, we regress excess stock returns in percent at time t on the $t-i$ lag of the call and put market OMS measure and of the respective quadratic term ($OMS^{2,j}_{t-i}$ with $j = \{C, P\}$). The vector of control variables (C_t) is as in the main regression in (1). The left figure plots the slope coefficient of the call market OMS measure (OMS^C_{t-i}). The right figure plots the slope coefficient of the put market OMS measure (OMS^P_{t-i}). The dashed lines are the 95% confidence intervals. The sample period is January 1996 to December 2009.