Disagreement in the equity options market and stock returns*

Benjamin Golez†
University of Notre Dame

Ruslan Goyenko‡
McGill University

First version: March 2019 / this version: November 2020

Abstract

We estimate investor disagreement from synthetic long and short stock trades in the equity options market. We show that high disagreement predicts low stock returns after positive earnings surprises and high stock returns after negative earnings surprises. The negative effect is stronger for high-beta stocks and stocks that are more difficult to sell short. In the cross-section of all stocks and the subset of the 500 largest companies, high disagreement robustly predicts low monthly and weekly stock returns.

Key words: Disagreement, dispersion of beliefs, equity options, stock returns, earnings surprises

JEL classification: G12, G13, G14

*For comments and suggestions, we thank Adem Atmaz, Robert Battalio, Paul Gao, Jens Jackwerth, Dmitriy Muravyev, and Neil Pearson and seminar participants at the University of Notre Dame and Indiana University.

†256 Mendoza College of Business, University of Notre Dame, Notre Dame, IN 46556, USA, Tel.: +1-574-631-1458, bgolez@nd.edu

‡1001 rue Sherbrooke Quest, Desautels Faculty of Management, McGill University, Montreal, PQ, Quebec, Canada H3A 1G5, Tel.: +1 514-398-5692, ruslan.goyenko@mcgill.ca

1. Introduction

What is the effect of investor disagreement on stock returns? In rational expectations models, disagreement is associated with information uncertainty and should lead to higher future stock returns (Wang, 1994; He and Wang, 1995). However, if short-sale constraints sideline pessimists, an increase in disagreement leads to temporary overvaluations by optimists and lower future stock returns (Miller, 1977; Scheinkman and Xiong, 2003).[1] To date, the empirical literature is inconclusive about which effect dominates. Several studies find a negative relation between disagreement and future stock returns (Diether, Malloy, and Scherbina, 2002; Goetzmann and Massa, 2005; Yu, 2011). Others argue that these effects are driven by small, illiquid, and low credit-rated stocks (Sadka and Scherbina, 2007; Avramov et al., 2009) or that the effect is positive (Doukas, Kim, and Pantzalis, 2006).

Existing studies mostly rely on disagreement measures that proxy for differences in investor information sets, such as analysts' forecast dispersion (Diether, Malloy, and Scherbina, 2002).[2] Several papers point out that this measure is a noisy proxy for disagreement, because it is agnostic about whether investors differ in their prior beliefs and how investors process information (e.g., Cookson and Niessner, 2020).[3] The literature also suggests that disagreement should be best studied using differences in investors' actual demand for stocks (Goetzmann and Massa, 2005;

[1] The negative relation between disagreement and futures returns can also arise if investors trust their own valuations only and dismiss the information contained in asset prices (Banerjee, 2011).
[2] See also Nagel (2005), Doukas, Kim, and Pantzalis (2006), Sadka and Scherbina (2007), Avramov et al. (2009), Yu (2011), and Hong and Sraer (2016), among others.
[3] The use of analysts' forecasts also has been criticized on the grounds that individual investors rarely pay attention to analysts; that analysts' forecasts are stale, biased, and subject to agency issues; and/or it is subject to the compounding effects of uncertainty that analysts face when making their forecasts (Goetzmann and Massa, 2005; Doukas, Kim, and Pantzalis, 2006; Binsbergen, Han, and Lopez-Lira, 2020).

Jian and Sun, 2014; Koijen and Yogo, 2019). In this paper, we estimate investor disagreement from synthetic stock trades in the equity options market.

Equity options are uniquely suited for the study of investor disagreement. First, high-embedded leverage and short expirations make options attractive to investors with strong beliefs. Second, unlike in the stock market, in the equity options market, there are no asymmetries in the cost of establishing either a long or a short synthetic stock position. This makes options convenient to speculate on either positive or negative directional moves of the underlying stocks (Lakonishok et al., 2007). The high growth in options trading volume highlights the increasing popularity of options contracts among retail and institutional investors.[4]

We measure stock-level disagreement in the options market as the extent to which synthetic long and short stock trades are offset among options investors. Our primary data are the daily signed options volume from the Chicago Board of Options Exchange (CBOE) and the International Securities Exchange (ISE) from January 2005 to December 2018. These two exchanges account for 58% of the total trading in the U.S. equity options markets over the period analyzed. We focus on trades of retailers and institutions. On average, we can estimate disagreement for 61% of U.S. equity stocks that account for 93% of stocks' market capitalization.

We find that disagreement varies substantially across time and stocks. It is positively correlated with stock turnover and the stock-level dispersion in mutual funds holdings, which we use as a proxy for holdings-based disagreement in the stock market (Jiang and Sun, 2014). We also find that disagreement is positively correlated with company size. Since large companies are less

[4] In August 2020, the options volume reached a historical high. Equity options volume, as measured in notional shares traded, exceeded the U.S. stock volume by 20% (Zuckerman and Banerji, 2020). This makes the U.S. options market the most active (synthetic) stock market in the world, more active than the U.S. stock market itself.

informationally opaque, our evidence suggests that more information can increase differences in beliefs (Harris and Raviv, 1993; Kandel and Pearson, 1995). In comparison, analysts' forecast dispersion is negatively related to company size and mutual fund holdings dispersion, and it exhibits a low correlation with our measure of disagreement.

We first document that investor disagreement is negatively and significantly related to future monthly and weekly stock returns. The results hold in portfolio sorts and Fama-MacBeth regressions. Our results are robust to controlling for other variables related to disagreement and many other stock- and option-based control variables. Results are also robust to accounting for options combination strategies (e.g., covered calls and volatility bets) and excluding the global financial crisis. Importantly, our results hold for the subsample of the 500 largest stocks. In comparison, analysts' dispersion does not produce a significant spread between the high and low value-weighted portfolios, and it is not significant in the Fama-MacBeth regressions in the subsample of the largest stocks.

To provide further insights into the economic mechanisms of disagreement, we analyze stock price reactions around earnings announcements. Atmaz and Basak (2018) develop a dynamic model in which disagreement amplifies wealth transfers between optimists and pessimists and generates an overreaction to cash flow news. As predicted by Atmaz and Basak's (2018) model, we show that, for positive earnings surprises, high pre-announcement disagreement predicts low stock returns; for negative earnings surprises, high pre-announcement disagreement predicts high stock returns. The negative effect is stronger among stocks, which are more likely to be short-sale constrained, such as high-beta stocks (Hong and Sraer, 2016), especially if they have low institutional ownership (Nagel, 2005). Meanwhile, the positive effect is stronger among stocks, for which short-sale constraints are less likely to be binding.

We make two main contributions to the literature on the effects of investor disagreement on asset prices (Chen, Hong, and Stein, 2002; Diether, Malloy, and Scherbina, 2002; Goetzmann and Massa, 2005; Nagel, 2005; Doukas, Kim, and Pantzalis, 2006; Sadka and Sherbina, 2007; Banerjee and Kremer, 2010; Yu, 2011; Jian and Sun, 2014). First, we introduce a new measure of disagreement based on investors' observable trades and show that investor disagreement affects the prices of all stocks, including the largest and most liquid stocks. Second, we show that investor disagreement can be either negatively or positively related to future returns. The sign of the relationship depends on the direction of the cash flow news (Atmaz and Basak, 2018) and the likelihood that short-sale constraints are binding (Hong and Sraer, 2016).

Our work is also related to the study of disagreement in the options market. Buraschi and Jiltsov (2006) link options trading activity to disagreement in a general equilibrium model and show that dispersion of beliefs affects the implied volatility smile. Ge, Lin, and Pearson (2016) argue that the options-to-stock-volume ratio captures the demand for leverage rather than disagreement. Our results are robust to controlling for the options volume as well as the options-to-stock-volume ratio. Andreou et al. (2018) use the dispersion of trading volume across moneyness levels to proxy for differences in investors' expectations. Our measure accounts for trades' direction and is not directly affected by options liquidity and stock volatility. Our results are robust to controlling for their measure.

The rest of the paper is organized as follows. In Section 2, we provide the motivation for our disagreement measure. In Section 3, we present the data and empirical estimation. In Section 4, we report the summary statistics. In Section 5, we report the main results for the relation between investor disagreement and stock returns. In Section 6, we report tests motivated by recent theoretical models. In Section 7, we provide robustness checks. Section 8 concludes.

2. Measuring disagreement

In this section, we provide the theoretical motivation for our measure of disagreement in the equity options market.

2.1 Disagreement in the stock market

In the theoretical models of disagreement, investors differ in their beliefs about the value of a stock. The source of disagreement is either a difference in information sets or a difference in investors' priors and the way investors update their information (Hong and Stein, 2007). Appendix A presents different modeling choices in a select set of theoretical models. The general implication of these models is that agents with different beliefs form different portfolios. This implies that investor disagreement can be inferred from investors' trades.

Differences in investor trading positions reflect the level of disagreement, whereas trading volume mostly reflects innovations in disagreement (Banerjee and Kremer, 2010). Since disagreement is non-negative, high stock volume can occur if disagreement has recently increased or if disagreement has been previously high. As a result, stock volume tends to cluster around high disagreement (Banerjee and Kremer, 2010). This motivates the use of differences in trading positions and stock volume as proxies for disagreement (Massa and Goetzmann, 2005; Banerjee, 2011; Jiang and Sun, 2014; Koijen and Yogo, 2019).

2.2 Disagreement in the options market

Buraschi and Jiltsov (2006) derive similar implications for the options markets. They consider a general equilibrium economy with rational agents who have incomplete and heterogeneous information. Agents can trade in the stock market and the options market. The stock market has a positive net supply, and the options market has zero net supply. In this setting, differences in beliefs create a natural demand for options. Without disagreement, investors only hold stocks. As investors start disagreeing, they take on options positions. Optimists demand call options from pessimists, and pessimists demand put options from optimists.

The model links options trading activity to differences in beliefs and thereby provides the main intuition for measuring disagreement in the options market. However, an implicit assumption in the model is that all options trades are cleared among option investors. Since options are in zero net supply, the model thus implies that all options trading is due to disagreement.

On the listed options markets, liquidity is supplied by professional market makers, and most investor orders are executed against market-maker quotations (CBOE, 2018).[5] This means that options trading does not hinge on optimists matching with pessimists. Even if all investors are optimistic, options trading still occurs because market makers absorb the excess demand. This creates a disparity between the options volume and disagreement.

As an illustration, suppose we have two investors. Each investor can be either an optimist or a pessimist. An optimist buys an at-the-money call option, and a pessimist sells an at-the-money call option. Both investors trade with the market maker. There are three possible scenarios: (a) both investors are optimistic, (b) both investors are pessimistic, or (c) one investor is optimistic and the other investor is pessimistic.

Only case (c) features disagreement (in cases (a) and (b), beliefs are perfectly aligned). However, according to the standard measurement of options trading, options volume is always equal to two. In the first case, each investor buys one call option from the market maker; in the

[5] According to the Chicago Board of Options Exchange (2018), the majority of transactions are intermediated by option market makers. Muravyev and Ni (2020) refer to statistics from the Options Clearing Corporation (OCC). The authors cite that market makers clear 85% of all trades.

second case, each investor sells one call option; and in the last case, one investor buys a call option, and the other investor sells a call option.

Thus, to infer disagreement from trades in the options market, we need to account for the direction of investor trades and isolate options volume due to disagreement from options volume due to investors' directional trading as a group.

Formally, let POS denote the synthetic positive exposure to the underlying stock that options traders create in the options market. Similarly, let NEG denote the synthetic negative stock exposure. If options were exclusively traded among option investors, the market-clearing condition would imply that $POS = NEG$. Since market makers absorb excess demand, POS can be larger than NEG or NEG can be larger than POS. We can split the maximum between the positive and the negative exposures as

$$Max(POS, NEG) = Min(POS, NEG) + [Max(POS, NEG) - Min(POS, NEG)]. \quad (1)$$

The first term on the right-hand side of Eq. (1) measures the exposure offset among option investors. The second term measures the excess demand absorbed by the market maker.

We denote the first term as disagreement:

$$Disagreement = Min(POS, NEG). \quad (2)$$

For a given level of options trading, disagreement is smallest when all investors take one-sided positions (when $POS = 0$ or $NEG = 0$). Disagreement is at its maximum when $POS = NEG$.

We denote the second term on the right-hand side of Eq. (1) as the directional trading of options investors. To determine the sign of directional trading, we multiply it by negative one when NEG is larger than POS:

$$Directional = \begin{cases} [Max(POS, NEG) - Min(POS, NEG)] & if \;\; POS \geq NEG \\ [Max(POS, NEG) - Min(POS, NEG)] \times -(1) & if \;\; POS < NEG \end{cases}. \tag{3}$$

We can now relate disagreement and directional trading to the above example. For at-the-money calls, the options delta is approximately one half. A long position in an at-the-money option is thus equivalent to a 0.5 synthetic stock exposure.

In case (a), when both investors are optimistic, $POS \simeq 1$ and $NEG = 0$, and, hence, $Disagreement = 0$ and $Directional \simeq 1$. In case (b), when both investors are pessimistic, $POS = 0$ and $NEG \simeq 1$, and, hence, $Disagreement = 0$ and $Directional = -1$. In case (c), when one investor is optimistic and the other investor is pessimistic, $POS \simeq 0.5$ and $NEG \simeq 0.5$, and, hence, $Disagreement \simeq 0.5$ and $Directional = 0$. Thus, the proposed measure of disagreement in Eq. (2) correctly reflects dispersion of investor beliefs in the above example.

Appendix B generalizes the above example. We derive a simple model with investors who have heterogeneous beliefs. We assume that investors trade on their views in the options market. A competitive risk-neutral market maker sets the option prices and absorbs the excess demand. Using reasonable parameters, we show that, unlike options volume, our measure of options disagreement strongly correlates with the assumed dispersion in beliefs.

3. Data and empirical measurements

In this section, we present the data and empirical measurement of disagreement in the equity options market. We also specify all control variables.

3.1 Main data

Our primary data are the daily Open/Close signed Buy/Sell volume for U.S. equity options from January 2005 to December 2018. U.S. equity options trade on several exchanges. We obtain data from the two largest exchanges, the Chicago Board of Options Exchange (CBOE) and the International Securities Exchange (ISE).[6] These two exchanges account for 58% of the total trading activity in the U.S. equity options markets over the period analyzed.

For each equity option, the data report eight different categories for daily trading volume. In particular, the data distinguish between trades based on "buy" and "sell" orders and between trades based on orders to "open" new positions and orders to "close" existing positions. In total, we have four different types of volume for each call and put contract: "Open Buy (*OB*)," "Close Buy (*CB*)," "Open Sell (*OS*)," and "Close Sell (*CS*)."[7]

These option volumes are reported separately for two groups of end-users: "customers" and "firms." The "customer" classification includes retail investors and institutional investors (such as hedge funds). The "firm" classification identifies proprietary trading desks that trade from their accounts. Since options are in zero net supply, the market maker's signed options volume can be calculated using the market-clearing condition (as the negative of the aggregate trades for customers and firms).

We merge our signed Open/Close data with the OptionMetrics data. From OptionMetrics, we obtain implied volatilities, option deltas, and other option characteristics. We eliminate options with fewer than 10 days to maturity. We discard options with missing implied volatilities and an absolute value of the option delta greater than 0.98 or smaller than 0.02.

---

[6] CBOE and ISE are the only exchanges that provide detailed options volume data.

[7] Formally, we can define the corresponding options orders as "Open Buy," an order to buy an option to open a new long position in the option; "Close Buy," an order to buy an option to close an existing short position in the option; "Open Sell," an order to sell an option to open a new short position in the option; and "Close Sell," an order to sell an option to close an existing long position in the option.

3.2 Empirical measurements of disagreement

In Section 2, we provide the motivation for our measure of disagreement. We show that, if investors use options to establish directional bets, the extent to which synthetic stock exposures are offset among investors reflects disagreement in the options markets. We now discuss the empirical estimation of our measure of disagreement.

We first need to determine which options trades to include in the calculation of options disagreement. As described above, our data distinguish between customers and firms. The customers classification includes retail and institutional investors, who typically use options to trade on their views (Lakonishok et al., 2009). The firms classification includes proprietary desks, which often act as liquidity providers. For example, Garleanu, Pedersen, and Poteshman (2009) find that firms act more like market makers than like traditional options investors.[8] We calculate stock-level options net order imbalances for customers and firms. Consistent with the notion that firms provide liquidity to customers, we find that order imbalances for customers and firms are highly negatively correlated at –0.402. Therefore, when estimating investor disagreement, we focus on customers' trades, and we treat firms as market makers.[9]

Next, we need to determine which options trades to include in the estimation of synthetic stock positions. Synthetic positive stock exposure can be obtained with a long position in a call option and a short position in a put option. Synthetic negative stock exposure can be obtained with a long

[8] The authors write that "We actually believe that proprietary traders are more similar to market-makers, and, indeed, their positions are more correlated with market-maker positions (the time-series correlation is 0.44). Consistent with this fact, our results are indeed stronger when we reclassify proprietary traders as market-makers (i.e., assume that end-users are the public customers)" (Garleanu, Pedersen, and Poteshman, 2009, p. 4276).

[9] Customer trading accounts for 74% of the total signed volume in our sample, whereas firms represent 26% of the total signed volume. If we recalculate disagreement using "customer" and "firm" trades, our main results weaken, but remain qualitatively similar. See the discussion in Section 7.

position in a put option and a short position in a call option. The contribution of a given option to the synthetic stock exposure merely depends on the options delta.

Therefore, for our first measure of disagreement, we calculate synthetic stock exposures by aggregating across the whole range of options trades. Specifically, we estimate daily stock-level positive exposure by summing the delta-adjusted total buy volume for call options and the delta-adjusted total sell volume for put options across all maturities and moneyness levels:

$$POS = \sum \left|\Delta^{Call}\right|\left(OB^{Call} + CB^{Call}\right) + \left|\Delta^{Put}\right|\left(OS^{Put} + CS^{Put}\right), \tag{4}$$

where Δ denotes options delta for a given call or put option. Similarly, we calculate daily synthetic negative exposure by summing the delta-adjusted buy volume for put options and the delta-adjusted sell volume for call options:

$$NEG = \sum \left|\Delta^{Put}\right|\left(OB^{Put} + CB^{Put}\right) + \left|\Delta^{Call}\right|\left(OS^{Call} + CS^{Call}\right). \tag{5}$$

In Eq. (2), we define disagreement as the minimum between the positive and the negative synthetic stock exposures. In the cross-section of stocks, options trading is highest for the largest and most liquid companies. Options volume also has been steadily increasing over time. To account for the cross-sectional and time-series effects, we standardize disagreement by the maximum between the positive and the negative synthetic stock exposure:

$$Disagreement = \frac{Min(POS, NEG)}{Max(POS, NEG)}. \tag{6}$$

On any given day, stock-level disagreement varies between zero and one. It equals zero when all customers take one-sided bets, and it equals one when the positive exposure of some customers entirely offsets the negative exposure of other customers.[10]

When disagreement is close to zero, investors as a group are taking directional bets. This is captured by our measure of directional trading (Eq. (3)). For consistency, we standardize our measure of directional trading by the maximum between the positive and the negative synthetic stock exposures. The standardized signed directional is bounded between −1 and +1, and it is similar in spirit to the measures used in studies that examine whether signed options trading volume predicts returns (Pan and Poteshman, 2006; Hu, 2014). We focus on the effects of investor disagreement, and we use directional trading as a control variable.

Alternative measures of options disagreement

We motivate our measure of disagreement under the assumption that investors use options to trade on their directional views. According to Lakonishok et al. (2007), this is the predominant use of equity options by retail investors and institutions.[11] However, investors may also use options as an overlay to their existing stock positions. Lakonishok et al. (2007) show that customers rarely use such combinations at the individual stock level. An important exception is covered calls. A covered call involves a long position in the underlying stock and a short position in a call option. To account for the use of covered calls, we estimate the second version of the disagreement measure, where we exclude sold calls:

[10] Standardizing disagreement by *Max(POS,NEG)* is intuitive, as doing so bounds our measure between 0 and 1. In Section 7, we show that our main results are similar when we use the unscaled version of disagreement.
[11] Recent anecdotal evidence suggests that directional trading remains the most popular strategy in the equity options market (Zuckerman and Banerji, 2020).

$$DisagreementSC = \frac{Min(POS, NEG^{SC})}{Max(POS, NEG^{SC})}. \tag{7}$$

Positive synthetic exposure, POS, is the same as before. Negative synthetic exposure excludes trades to open sell calls, that is, $NEG^{SC} = \sum \left|\Delta^{Put}\right|\left(OB^{Put} + CB^{Put}\right) + \left|\Delta^{Call}\right|\left(CS^{Call}\right)$.

Equity options also may be used to create volatility bets. A typical volatility bet, a straddle, involves a simultaneous long (or short) position in at-the-money calls and puts. Such a strategy is not as popular as writing covered calls, and it is mostly used ahead of scheduled corporate announcements. In Section 7, we show that our results are robust to excluding at-the-many options in the estimation of disagreement, as well as to many other variations in the construction of our disagreement measure.

As is standard in the literature, we conduct our main analysis at the monthly frequency. We first calculate the total customer options daily volume. Then, we take the volume-weighted average of daily disagreements across the previous 10 days for each company. We apply the same procedure to all versions of disagreement and our measure of directional trading.[12]

3.3 Control variables

We employ three sets of control variables. The first set comprises variables related to investor disagreement:

- *Analysts' forecast dispersion (AnalystDis)*. Defined as in Nagel (2005): standard deviation of the raw Institutional Brokers' Estimates System (I/B/E/S) analysts' current

[12] In Section 7, we show that taking the volume-weighted average across the whole month leads to similar results.

fiscal year earnings per share forecasts (as in Diether, Malloy, and Scherbina, 2002), scaled by firms' total assets (see also Johnson, 2004)

- *Stock turnover (StockTurn).* Monthly stock volume divided by the total number of shares outstanding
- *Dispersion in mutual fund holdings (MFDis).* Defined as in Jiang and Sun (2014): standard deviation of the active holdings in a given stock across all mutual funds whose investment universe includes the stock. Active holdings are measured on a quarterly basis as actual holdings minus benchmark holdings.[13] We obtain monthly observations by assuming that the dispersion of active holdings does not change within the quarter

The second set of control variables includes other stock-related variables: *Market capitalization (log(Size)), Book-to-market (log(BM)), Return (Ret), Idiosyncratic volatility (IdiosyncVol), Momentum (Mom), Operating profit (OP), Investment (INV), Effective stock spread (ESS), Stock order imbalance (SOI), Probability of informed trading (PIN),* and *Institutional ownership (InstOwner).* Finally, the third set of control variables includes other options-related variables: *Options open interest (OpenInterest), Options volume (OptVolume), Options order imbalances (OOI), Put-call volume ratio (PP), Options-to-stock volume (OS), Effective options spread (EOS), Implied volatility (ImVol), Call-put volatility spread (CP-vol-spread), Monthly change in call* and *put implied volatility (CVol* and *PVol),* and *Implied skew (ISkew).* See Appendix C for definitions of all stock- and options-based control variables.

[13] We use domestic actively managed funds from the CRSP MF database (excluding sector, index, and exchange-traded funds) and MF holdings from the Thomson Reuters Mutual Fund Holdings database. Funds' self-declared benchmarks come from Morningstar. We focus on the most popular benchmarks from Russell and Standard & Poor's. From each of these two sources, we obtain small-, mid-, and large-cap benchmarks plus their value and growth components. We obtain official benchmark constituent weights from Russell and Compustat.

4. Summary statistics

Table 1 reports monthly summary statistics, and Table 2 reports pairwise correlations for the main variables. Panel A in each table is based on observations for all stocks, and Panel B reports the same statistics for the subset of the 500 largest companies. The largest companies in a given year are based on the 500 highest market capitalization companies at the end of the previous year. Since options trading is most active among large and liquid stocks, the sample of all stocks for which we can calculate disagreement is tilted toward larger stocks. We capture around 61% of the U.S. equity market in terms of the number of stocks and approximately 93% in terms of market capitalization.[14]

In the sample of all stocks, the average for options disagreement is 0.33. This suggests that, typically, one-third of options investors' positions is due to disagreement, and two-thirds of positions is due to the directional views of options investors as a group. The standard deviation for disagreement is 0.24. This indicates substantial time-series and cross-sectional variability in investor disagreement. Disagreement is relatively persistent, with an average autocorrelation coefficient of 0.47.

Our measure of directional trading is, on average, slightly negative. This is consistent with the notion that investors are on average net sellers in equity options and use options to make bearish bets more often than to make bullish bets (Garleanu, Pedersen, and Poteshman, 2009).[15] The pairwise correlation between disagreement and directional trading is low at 0.01. As confirmation that disagreement is different from directional trading, note that disagreement is negatively related

[14] In our sample period, the monthly cross-sectional average of companies in the CRSP universe is 3,150. The monthly cross-sectional average for stocks for which we can calculate options disagreement is 1,924.

[15] As expected, the directional measure is positively correlated with options order imbalances (*OOI*) and negatively correlated with the put-call volume ratio (*PP*) of Pan and Poteshman (2006).

to the probability of informed trading (correlation with *PIN* is -0.15). In contrast, directional trading is positively correlated to *PIN* at 0.06. Both measures are positively related to the options open interest and options volume, with disagreement more so (correlations of 0.30 and 0.21, respectively) than directional trading (correlations of 0.01 and 0.02, respectively). Disagreement is also negatively related to the effective options spread (correlation with *EOS* of -0.38). This outcome is expected as higher disagreement is associated with lower net order imbalances that liquidity providers need to absorb and hence lower inventory costs.

In line with the general prediction of theoretical models featuring dispersion of beliefs (e.g., Banerjee and Kremer, 2010; Banerjee, 2011; Atmaz and Basak, 2018), disagreement is positively correlated with stock turnover (correlation of 0.14). Options disagreement is also positively correlated with the dispersion of mutual fund holdings (correlation of 0.17). These findings are reassuring, as both measures are based on investors' demand for stock exposure. Still, the correlation coefficient is low, suggesting that options disagreement contains information not captured in mutual-fund-holdings-based disagreement.

Options disagreement is also positively correlated with company size at 0.37. Since there is more information available about large companies, our evidence suggests that disagreement increases with the amount of public information. This is consistent with the notion of *agree to disagree* models, whereby investors have different economic models that lead them to interpret news differently, and hence an influx of public information increases differences in investor beliefs (Harris and Raviv, 1993; Kandel and Pearson, 1995). The higher mean for disagreement for the 500 largest companies (0.48), compared to the mean for disagreement for all stocks (0.33), further supports this interpretation.

In contrast to our measure of disagreement, analysts' forecast dispersion exhibits a much lower correlation with stock turnover (correlation of 0.02), and it is negatively correlated with mutual funds' holdings-based measure of disagreement (correlation of -0.04). Analysts' dispersion is also negatively (rather than positively) correlated with company size (correlation of -0.09). Thus, disagreement based on investors' trades differs substantially from the disagreement measures based on the dispersion of information that investors use to form their beliefs.

5. Stock return predictability

In this section, we examine how disagreement relates to future stock returns. We first consider portfolio sorts. Then we turn to Fama and MacBeth (1973) regressions, where we control for the existing proxies for disagreement and other stock and option characteristics. We always present results separately for the sample of all stocks and the subset of the 500 largest companies.

5.1 Portfolio sorts

At the end of each month, we assign stocks to five portfolios. Then we calculate the value-weighted return for each portfolio in the following month. We regress the resulting time series of each portfolio on the four Fama-French-Carhart factors and evaluate statistical significance using Newey and West (1987) *t*-statistics with three lags.[16] We sort stocks into portfolios using either the disagreement measure that includes all options trades (*Disagreement*) or the disagreement measure that excludes transactions to open sell calls (*DisagreementSC*). For comparison, we also report results for analysts' forecast dispersion (*AnalystDis*).

[16] Table OA.4 in the Online Appendix shows that the results are robust to using a five-factor Fama-French model augmented with the Carhart momentum factor.

Table 3 reports results separately for all stocks (left panels) and the 500 largest stocks (right panels). We find that options disagreement is an important sorting measure for the cross-section of stock returns. When we move from low disagreement to high disagreement portfolios, raw returns and alphas decrease. The high minus low portfolio alpha is always statistically significant. Results are strongest for the disagreement measure that accounts for covered calls trading (*DisagreementSC*). As reported in Panel B, in the sample of all stocks, the high minus low portfolio alpha is −3.89% (*t*-statistics of −3.70). In the 500 largest stocks sample, the high minus low portfolio alpha is −5.86% (*t*-statistic of −4.19). Results are robust to excluding the global financial crisis. When we exclude 2008–2009 in Panel C, the portfolio alphas decrease more monotonically from the low to high *DisagreementSC* portfolios.

In comparison, when we sort stocks based on analysts' forecast dispersion in Panel D, results are insignificant. The high minus low portfolio exhibits a small, negative alpha for the sample of all stocks and a small, positive alpha in the subsample of the 500 largest stocks.

Table OA.1 in the Online Appendix shows that portfolio sorts based on options disagreement measures are robust and stronger in the case of equal-weighted portfolios. Alphas are monotonically decreasing from the low to high portfolios, and *t*-statistics for the high minus low differences are always larger than three (in absolute value). In comparison, portfolio results with analysts' forecast dispersion remain insignificant for the 500 largest stocks and become significant in the sample of all stocks. This is consistent with Hou, Xue, and Zhang (2020), who argue that the effect of analysts' forecast dispersion on expected stock returns is mostly driven by small and micro-cap stocks.

The Online Appendix also reports portfolio results for our measure of directional trading (Table OA.2). Consistent with Pan and Poteshman (2006) and Hu (2014), we find that directional trading is positively related to future returns.

5.2 Fama-MacBeth regressions

Next, we apply the standard two-step Fama-MacBeth approach, with the next month's excess returns as the dependent variable and *t*-statistics based on Newey and West (1987) with three lags. Table 4 reports the results. Columns 1–4 are based on the sample of all stocks. In columns 5–7, we report the results for the subsample of the 500 largest stocks.

The results are in line with portfolio sorts. In the sample of all stocks, the estimated coefficient for *Disagreement* in the univariate regression is negative and significant with a *t*-statistic of −3.46. The estimated coefficient suggests that a one-standard-deviation shock to disagreement results in a 25-basis-points lower stock return in the following month.

The effect of disagreement hardly changes with the addition of stock- and options-based control variables and other frequently used measures for investor disagreement. In column 2, the *t*-statistic on *Disagreement* is −2.88. Alternative measures of disagreement are negatively related to future stock returns. However, in the sample of all stocks, only analysts' forecast dispersion is statistically significant, with a *t*-statistic of −2.57. The estimated coefficient for our directional measure is positive, with a *t*-statistic of 5.78. This is interesting because we control for previously employed measures of directional trading, such as options order imbalances (Hu, 2014) and put-call volume ratios (Pan and Poteshman, 2006). When we use our second measure of disagreement, *DisagreementSC*, the *t*-statistic is negative 3.04. Results are robust to excluding the global financial crisis of 2008–2009.

In the subsample of the 500 largest stocks, the estimated coefficients for our disagreement measures are almost identical to the sample of all stocks. In the full period, the *t*-statistic associated with *DisagreementSC* is −3.15. None of the alternative measures of disagreement is significant. The estimated coefficient for analysts' forecast dispersion changes sign from negative and significant in the sample of all stocks to positive and insignificant in the subsample of the largest stocks.

5.3 Weekly returns

One of the advantages of our measure is that we can calculate the level of disagreement at higher frequencies. In this section, we focus on the weekly frequency. We recalculate *DisagreementSC* as the volume-weighted average of daily disagreements over the past week.

Table 5 reports results for weekly portfolio sorts with value-weighted portfolio returns. Like in the case of monthly portfolio sorts, disagreement is negatively related to future returns. Results hold across all stocks as well as in the subsample of 500 largest stocks. The difference in annualized alphas between the low and high disagreement portfolios is similar to that for monthly portfolio sorts. Results with equal-weighted portfolio sorts are even stronger (Table OA.9 in the Online Appendix).

6. What drives the disagreement effect?

In this section, we provide tests tailored to identify the economic mechanisms behind our results.

6.1 Theoretical predictions

So far, we have documented a strong negative relation between disagreement and future stock returns. Such a negative relation is consistent with a general class of models featuring short-sale constraints; an increase in belief dispersion leads to temporary stock price overvaluation by optimists and lower future stock returns (Miller, 1977; Scheinkman and Xiong, 2003).

Since large stocks are much easier to borrow and cheaper to sell short than small stocks, we would expect results to be stronger in the case of all stocks than in the case of the largest stocks. However, we find the opposite; the results appear stronger in the sample of the largest stocks. All our results are also robust to controlling for institutional ownership as a proxy for how difficult it is to borrow shares when short-selling (Nagel, 2005). This suggests that physical short-sale constraints are not the only mechanism through which disagreement affects stock prices.

Atmaz and Basak (2018) develop a dynamic model in which disagreement amplifies wealth transfers between optimists and pessimists. After positive cash flow news, wealth is transferred from pessimists to optimists. As a result, optimists have a larger price impact, which generates temporary stock price overvaluations and lower future returns. Thus, the model predicts that disagreement can be negatively related to future returns even without short-sale constraints. In contrast, after negative cash flow news, wealth is transferred from optimists to pessimists. This exchange of wealth leads to lower current stock prices and higher future stock returns. Overall, the model predicts that the relationship between disagreement and future stock returns can be either positive or negative, depending on the sign of cash flow surprises.[17]

[17] Banerjee (2011) shows that the negative relation between disagreement and future returns can also arise if investors believe that only their private signal is informative. As investors dismiss the information of other investors, they perceive an increase in disagreement as risk reducing. An increase in disagreement then commands lower expected returns.

Hong and Sraer (2016) argue that short-sale constraints are not always explicit and often arise from self-imposed restrictions or limits imposed by regulations. They show that, in a general equilibrium model with short-sale constraints and shocks to aggregate disagreement, high-beta stocks experience greater disagreement about their payoffs and are more likely to be overpriced due to implicit short-sale constraints. As firm-specific disagreement co-moves with aggregate disagreement, we expect an increase in firm-specific disagreement to lead to higher overvaluation and lower future returns of high-beta stocks.[18] In the next section, we test the empirical predictions of these models.

6.2 Earnings surprises

The main insight from the theoretical model of Atmaz and Basak (2018) that we test is whether the relation between investor disagreement and future returns differs for positive and negative cash flow news. Following Hong and Sraer (206), we also explore whether the negative effect is stronger for speculative high-beta stocks.

Earnings announcements are the most natural setting in which to test the joint predictions of these models. Using the standard approach of defining earnings surprises, we test how abnormal returns following earnings announcements relate to pre-announcement disagreement.

For the earnings announcement to be included in the analysis, we require data on earnings per share, data on earnings per share lagged four quarters, data on the earnings announcement date, non-missing stock price data, and at least one earnings forecast. We only retain earnings forecasts made within 90 days of the earnings announcement.

[18] In the model, aggregate disagreement equals beta-weighted firm-specific disagreement (Hong and Sraer, 2016).

We estimate the cumulative abnormal return (CAR) following an earnings announcement day as the difference between a stock's realized cumulative return and its expected cumulative return. Expected return is estimated using the capital asset pricing model (CAPM) and the value-weighted CRSP market index as a proxy for the market portfolio. We estimate CAPM betas similar to Hong and Sraer (2016). Each month, we use the past 12 months of daily returns to estimate the market beta of each stock by regressing a stock's excess return on the contemporaneous excess market return as well as five lags of the market return to account for the illiquidity of small stocks (Dimson, 1979). The market beta is then the sum of the six ordinary least squares (OLS) regression coefficients. For each stock, we use the pre-estimated market beta for the month preceding the earnings announcement month to compute the expected return around the event window.

We define positive and negative cash flow news by imposing double criteria on earnings surprises. Specifically, following Battalio and Mendenhall (2005), we first construct two measures for earnings surprises: (1) forecast errors based on seasonal random walk (SRW) and (2) analysts' forecast errors. Actual earnings and analysts' forecasted earnings come from the IBES detail file.

We define earnings surprises based on seasonal random walk (SRW) as

$$SUE_{i,q}^{SRW} = \frac{E_{i,q} - E_{i,q-4}}{P_{i,q}}, \tag{8}$$

where $E_{i,q}$ is actual quarterly earnings per share for firm *i* for quarter *q*, $E_{i,q-4}$ is the actual earnings per share for the same quarter of the prior year, and $P_{i,q}$ is the share price 20 days prior to the earnings announcement.

We define earnings surprises based on analysts' forecasts as actual earnings per share minus the average of analysts' forecasts, also divided by share price 20 days prior to the earnings announcement:

$$SUE_{i,q}^{Analyst} = \frac{E_{i,q} - E_{i,q}^{Analyst}}{P_{i,q}}. \tag{9}$$

Based on the two measures of earnings surprises, we then assign three dummy variables, *High*, *Medium*, and *Low*. The dummy variable *High* equals one if a given earnings announcement is ranked among the top 20% of earnings surprises in that quarter based on both the SRW earnings surprise measure and the analysts' earnings surprise measure. The dummy variable *Low* equals one if a given earnings announcement is ranked among the bottom 20% of earnings surprises in that quarter based on both SRW earnings surprise and analysts' earnings surprise. The dummy variable *Medium* equals one if a given earnings announcement is ranked among the medium 40% of earnings surprises in that quarter based on both earnings surprise measures. If the rankings do not overlap between the SWR earnings surprise and the analysts' earnings surprise, we exclude those stock announcements from the sample.

We test the predictions of Atmaz and Basak (2018) by running the following panel regression:

$$\begin{aligned} CAR[1,5]_{i,t} &= \alpha^{High} High_{i,t} + \alpha^{Medium} Medium_{i,t} + \alpha^{Low} Low_{i,t} \\ &+ \beta^{Dis\times High} Disagreement_{i,t-1} \times High_{i,t} + \beta^{Dis\times Medium} Disagreement_{i,t-1} \times Medium_{i,t} \\ &+ \beta^{Dis\times Low} Disagreement_{i,t-1} \times Low_{i,t} + Controls_{i,t} + \varepsilon_{i,t}. \end{aligned} \tag{10}$$

$CAR[1,5]$ is the cumulative abnormal return for days 1 to 5 after the earnings announcement day; $Disagreement_{i,t-1}$ is the disagreement measured over the 10 days preceding the earnings announcement; and $High$, $Medium$, and Low are dummy variables for earnings surprises. Since trading on volatility is common around earnings announcements, we exclude at-the-money options when estimating pre-announcement disagreement.[19] All panel regressions include quarter fixed effects. Standard errors are clustered by firm and time.

Table 6 reports the results. Panel A reports results with quarterly fixed effects. In panel B, we add stock and options control variables from Table 4 that are available for the vast majority of earnings announcements. We start by discussing results in column (1), where we report results for all earnings announcements. In line with the literature on the post-earnings announcement drift (e.g., Bernard and Thomas, 1989), we find that the estimated coefficient for the dummy variable *High* is positive, and the estimated coefficient for the dummy variable *Low* is negative. Next, we focus on our main variables of interest, namely, the interactions between pre-announcement disagreement and the dummy variables capturing earnings surprises. As predicted by Atmaz and Basak (2018), we find that the estimated coefficient for the term *Disagreement x High* is negative, and the estimated coefficient for the term *Disagreement x Low* is positive. Both coefficients are significant in the baseline specification in Panel A and when we control for the common stock and options characteristics in Panel B.

In columns 2–4, we repeat results separately for the sample of *Low*, *Medium*, and *High* beta stocks. The model of Atmaz and Basak (2018) does not feature short-sale constraints. When short-sale constraints are binding and pessimists are sidelined, we expect the negative effect of disagreement on future stock returns to be amplified. According to Hong and Sraer (2016), short-sale constraints are most likely to be binding for higher beta stocks. In line with this prediction, we find that the negative coefficient for *Disagreement x High* is strongest for high- and medium-

---

[19] As in Bollen and Whaley (2004), we define at-the-money options as those with absolute values for deltas between 0.375 and 0.625. Results with the original measure of disagreement are qualitatively similar.

beta stocks (columns 4 and 3, respectively). In comparison, for low-beta stocks in column 2, for which short-sale constraints are less likely to be binding, only the positive coefficient for *Disagreement x Low* is significant.

To explore the effect of short-sale constraints further, we additionally condition on institutional ownership. Nagel (2005) shows that, when institutional ownership is low, fewer shares are available for borrowing, which tightens physical short-sale constraints. Therefore, we expect the negative coefficient for the interaction term *Disagreement x High* to be strongest in the subsample of high-beta stocks and low institutional ownership. In comparison, the positive coefficient for the interaction term *Disagreement x Low* should be strongest for low-beta stocks and high institutional ownership.

Table 7 reports the results for high- and low-beta stocks. In line with the above conjectures, for high-beta stocks, the estimated coefficient for *Disagreement x High* in Panel A is most negative and significant among stocks with low institutional ownership. For low-beta stocks, the estimated coefficient for *Disagreement x Low* in Panel B is most positive and significant among stocks with high institutional ownership.

To summarize, as predicted by Atmaz and Basak (2018), we provide empirical evidence on both positive and negative effects of disagreement on future stock returns, once we condition on the sign of the cash flow surprises. The negative effect prevails among stocks that are more likely to be overvalued due to short-sale constraints, such as high-beta and low institutional ownership stocks (Hong and Sraer, 2016; Nagel, 2005). The positive effect dominates for low-beta and high institutional ownership stocks.

7. Robustness and additional tests

In Table 3, we show that portfolios of high disagreement stocks earn lower returns than portfolios of low disagreement stocks. The Online Appendix shows that these results are robust and much stronger when using equal-weighted portfolio returns rather than value-weighted portfolio returns (see Table OA.1 for monthly portfolio sorts and Table OA.9 for weekly portfolio sorts). Results are also robust to sorting stocks on an unscaled version of disagreement (Table OA.3) and evaluating portfolio performance with a five-factor Fama-French model augmented with the Carhart momentum factor (Table OA.4). Moreover, we find similar results if we calculate disagreement based on customer and firm trades (Table OA.5), if we exclude open sold calls and at-the-money options (Table OA.6), or if we take the volume-weighted average of daily disagreements over the whole month (Table OA.7).

Our options data also distinguish between the opening and closing options volumes. The decision to close an existing position may depend on past returns or funding illiquidity. Moreover, in our data, we only know if investors sell their existing positions, but we do not know if investors exercise their positions. In Table OA.8, we show that results are similar if we estimate disagreement using only the options' opening volumes.

If high disagreement predicts low future returns, we expect disagreement to be positively correlated with contemporaneous returns. This prediction comes from the models featuring short-sale constraints, whereby differences in beliefs lead optimists to temporarily overvalue stock prices (Miller, 1977; Scheinkman and Xiong, 2003). The same prediction obtains in the model of Banerjee (2011) in the case when investors trust only their own valuations, and hence an increase in disagreement reduces perceived riskiness. The pairwise correlations in Table 2 already indicate that disagreement is positively correlated with returns. In Table OA.10 in the Online Appendix, we use Fama-MacBeth regressions and confirm that disagreement is significantly, positively correlated with current returns after controlling for stock and options characteristics.

In Section 6, we show that high disagreement predicts low returns after positive earnings surprises and high returns after negative earnings surprises. We obtain this result with our novel measure of disagreement in the options markets. In Table 4, we already noted that the relation between analysts' forecast dispersion and future returns is not robust to excluding small companies. Similarly, we find that analysts' forecast dispersion does not produce different signs around earnings surprises.

Andreou et al. (2018) postulate that the dispersion of trading volume across options moneyness levels can be viewed as a proxy for differences in investors' expectations. While differences in beliefs may incentivize investors to trade options further away from the at-the-money strike price, the decision to trade at a given strike price is endogenous to options liquidity, bid-ask spreads, and the volatility of the underlying stock. Our measure of differences in beliefs is fundamentally different. It considers the direction of trades, aggregates all options trades into synthetic long or short stock positions, and measures the degree to which customers' synthetic stock positions offset each other. As such, it does not hinge on the choice of maturity or the strike price. Our measure is also not endogenous to the volatility of the underlying stock. In Table 8, we repeat the main results from Table 4 while controlling for the dispersion of trading volume across options moneyness levels (*DisML*). We find that our results remain strong and significant in the sample of all stocks and the subset of the 500 largest companies.

8. Conclusions

We propose a novel measure for investor disagreement estimated from synthetic long and short stock trades in the equity options market and show that investor disagreement profoundly affects equity prices.

In the cross-section of stocks, high disagreement leads to low stock returns for both small and large stocks. By focusing on earnings announcements, we show that an increase in disagreement can lead to either higher or lower future stock returns. The relationship's sign depends on whether cash flow news is negative or positive. The negative effect after positive news is the strongest among stocks that are most susceptible to speculative overpricing, that is, high-beta stocks with low institutional ownership. The positive effect after negative news is the strongest among low-beta stocks with high institutional ownership.

Overall, our results suggest that disagreement plays an important role for asset pricing and that the effects of disagreement are consistent with the new channels proposed by recent theoretical models featuring wealth transfers between optimists and pessimists (Atmaz and Basak, 2018) and individual stock exposure to aggregate disagreement (Hong and Sraer, 2016).

Appendix A: Disagreement and (speculative) stock trading

In this appendix, we review a select set of theoretical models that link disagreement to speculative stock trading. Disagreement is captured by the dispersion in investors' equilibrium expectations about an asset's payoffs or expected returns. Depending on the source of disagreement, we can distinguish between the models in which differences in beliefs arise because of asymmetric information (Wang, 1994; He and Wang, 1995) and models in which differences in beliefs occur because of differences of opinion (Kandel and Pearson, 1995; Banerjee and Kremer, 2010). They all link differences in beliefs to the expected demand for stocks and trading volume.

Most papers feature disagreement about a single stock in a static setup. Recent studies incorporate a dynamic setup, distinguish between disagreement about the individual asset and that about the aggregate market, and incorporate options markets.

Asymmetric information models

In standard rational models with asymmetric information (private information), investors have common priors and try to infer the information of others from the market prices (Wang, 1994). As investors learn from the behavior of others, noise traders are typically needed to break the no-trade paradigm. The trading volume then depends on the flow of information and the dynamics of exogenous supply shocks. He and Wang (1995) provide a detailed account of the trade dynamics in such a noisy rational expectations model. They show that asymmetric information leads to speculative trading. Since prices are noisy and do not fully reveal all the investors' information, investors trade many rounds after receiving their private signal. As such, private information causes trading in the current period and future periods. Public information leads to convergence of beliefs, and hence to an increase in speculative trading ahead-of-scheduled public announcements.

The difference of opinion models

In contrast to the rational expectations models, in the difference of opinion models, investors have access to the same information. Differences in beliefs arise because of different priors or differences in the way investors interpret information (Miller, 1977; Harris and Raviv, 1993; Kandel and Pearson, 1995). Each trader believes in the validity of his/her prior or interpretation of the news. As a result, investors agree to disagree and hold different positions, even when all investors have precisely the same information. The trade dynamics depend on the evolution of beliefs.

The main intuition for the difference of opinion models is laid out in the static model of Miller (1977) and the dynamic versions of Scheinkman and Xiong (2003) and Banerjee and Kremer (2010). Scheinkman and Xiong (2003) develop a continuous-time framework with investors who have identical information but differ in how they interpret the signals that determine an asset's fundamental value. The source of disagreement is overconfidence in the precision of agents' own information. An optimist buys an asset because short-sale constraints give an asset buyer an option to resell the asset to an investor with even more optimistic beliefs at a later date. As time passes and information flows, agents who are relatively more optimistic at one point in time become relatively less optimistic at another point in time. This leads to trading and links disagreement to stock volume.

In the dynamic model of Banerjee and Kremer (2010), investors disagree about the interpretation of public information. There is no learning from prices. Investors agree to disagree and merely trust their own interpretation of the signal. Expected stock holdings are driven by investor beliefs. Differences in investor trading positions reflect the extent to which investors disagree, and trading volume largely reflects revisions to the level of disagreement. Since disagreement is non-negative, high trading volume can occur if beliefs recently diverged or if disagreement has been previously high. This implies that disagreement and stock volume are positively correlated (Banerjee and Kremer 2010).

Buraschi and Jiltsov (2006) extend the difference of opinion model to a general equilibrium setting with the stock market and the options market. Agents have different priors about the dividend growth process, but they update their beliefs rationally based on all available information. Differences in beliefs make options non-redundant. In the case of perfect agreement, investors hold stocks. As differences in beliefs emerge, investors adjust their stock positions and start trading options. Optimists create synthetic positive directional bets, whereas pessimists create synthetic negative directional bets. The model links disagreement to options open interest and options volume.

Atmaz and Basak (2018) extend the difference of opinion models by incorporating wealth transfers. They also show that disagreement leads to more trading. Koijen and Yogo (2018) develop a demand-based asset pricing model for investors with heterogeneous beliefs who face short-sale constraints. The model is designed to match institutional and household holdings. The model implies characteristics-based demand. The average latent demand for an asset reflects the sentiment, and dispersion in latent demand captures disagreement.

Finally, Banerjee (2011) develops a dynamic model for investors with heterogeneous beliefs about the informativeness of other investors' signals. The model incorporates the rational equilibrium model and the difference of opinion model as special cases. In both cases, disagreement leads to higher expected trading volume.

Appendix B: Investor beliefs, options volume, and disagreement

This appendix provides a simple model and simulations to analyze the relationship between the differences in investor beliefs, options volume, and our measure of disagreement.

Model setup

We consider a standard equity options market in which end-users trade with a market maker. We assume that options investors have identical endowments and preferences but different expectations about the return on the underlying asset, and they use options to trade on their views.

Each investor receives a signal about the expected stock return. The signal comprises of two parts:

$$z_i = \mu + \eta_i.$$

The first part, μ, is the common prior (public news) about the expected return shared among all investors, $\mu \sim N\left(\bar{\mu}, \frac{1}{u}\right)$. The second part, η_i, is each investor's private signal, $\eta_i \sim N\left(0, \frac{1}{q}\right)$. The private signal can originate from differences in investors' information sets. Alternatively, we can interpret the private signal as arising from differences in investors' interpretation of public news. We do not take a stance on whether or not the investor signal is correct. In this way, we capture both sophisticated and unsophisticated investors. Given the signal, the investor's conditional moments are

$$E\left[\mu \middle| z_i\right] = \frac{u\bar{\mu} + qz_i}{u+q},$$

$$Std\left[\mu \middle| z_i\right] = \sqrt{\frac{1}{u+q}}.$$

We allow investors to invest in the risk-free asset and options.[20] That is, at $t = 0$, investors allocate their initial wealth, W_0, between the risk-free asset and options such that they maximize their expected utility:

$$\max_n E\left[U\left(W_T\right)\right],$$

where $t = T$ is the options expiration date, and n is the number of options bought or sold. We consider a standard mean-variance utility function: $E(U) = E[R] - \frac{1}{2}\gamma\sigma^2$. We allow investors to trade call options only. Since there are no frictions and the put-call parity holds, the problem can be equivalently expressed in terms of put options. To ease exposition, we consider at-the-money options, $K = S_0$, with a maturity of one year, $T = 1$. Investor final wealth is

$$W_T = \left(W_0 - nC_0\right)R_{f,T} + n\max(0, S_T - K).$$

$R_{f,T} = (1 + rf) \times T$ is the risk-free rate of return; C_0 is the Black-Scholes option price; and S_T is the investor's expected stock price. Depending on their private signal, investors choose whether to trade options and how many options they want to buy or sell. The market maker absorbs excess demand.

[20] Buraschi and Jiltsov (2006) show in a general equilibrium Lucas economy that differences in beliefs make options non-redundant and lead to trading in the options market. To keep the model simple and tractable, we assume a Black-Scholes economy and allow investors to trade stocks synthetically via options. Recent anecdotal evidence supports this assumption, as synthetic trading in options exceeds the actual trading in the underlying stocks (Zuckerman and Banerji, 2020).

Simulations

We simulate the model to analyze how dispersion in investor beliefs relates to options volume and our disagreement measure.

In the model, differences in investor beliefs are captured by the standard deviation of the private signal, $\sigma(\eta)=\sqrt{\frac{1}{q}}$. We repeat the simulations 10,000 times, each time drawing $\sigma(\eta)$ from a normal distribution. We consider $N=1,000$ investors. For each draw and for each investor, we calculate investors' expected utility on a wide grid of a possible number of options bought or sold. We determine the optimal number of options bought or sold as the point at which investors' utility is maximized.

We set the mean and standard deviation of the private signal $\sigma(\eta)$ to 0 and 0.15, respectively.[21] We set the risk-aversion coefficient, γ, to either 2 or 3. The rest of the parameters are $\bar{\mu}=0.05$, $\sqrt{\frac{1}{u}}=0.1$, $W_0=1,000$, and $rf=0.02$. We use the Black-Scholes model to calculate options prices. We calculate the volatility of expected options returns as the volatility of the return on the underlying stock times the option's leverage.

Next, we determine our quantities of interest. We define POS as the delta-adjusted sum of options purchased across the investors. NEG is the delta-adjusted sum of options sold. Since the market maker clears all trades, the delta-adjusted option volume is the sum of POS and NEG:[22]

[21] We truncate the draws at 0.01 to ensure non-negativity of the standard deviation of the signal.
[22] Since investors start with zero options holdings and all trades are cleared through market makers, we can think of options volume and options open interest to be the same in our simulations.

$$OptVolume = POS + NEG.$$

Our measure of investor disagreement is defined as

$$Disagreement = Min(POS, NEG).$$

For each simulation, we retain the standard deviation of the private signal (actual differences in investor beliefs), options volume, and our disagreement measure.

Table B.1 reports the summary statistics (panel A) and pairwise correlations (panel B). Panel C reports the results for regressing options volume and our disagreement measure on the assumed differences in beliefs (the standard deviation of the private signal). We set the risk-aversion coefficient equal to 2 (left panel) or 3 (right panel).

Both options volume and our measure of disagreement are positively correlated with differences in beliefs. However, our measure of disagreement exhibits a much stronger correlation with differences in beliefs. Depending on the assumed risk-aversion coefficient, the correlation between the options volume and the standard deviation of the private signal ranges between 0.39 and 0.44. In comparison, the correlation between our measure of disagreement and the differences in beliefs is always 0.81. Put differently, the differences in beliefs explain between 16% and 20% of the variation in the options volume. In comparison, differences in beliefs explain 65% to 66% of the variation in our measure of disagreement.

Table B.1: Simulation results

This table presents summary statistics and the correlation structure for differences in beliefs (the standard deviation of a private signal η), options volume, and our measure of disagreement. We also report regressions for options volume and disagreement on the differences in beliefs. For each set of parameters, we repeat the simulations 10,000 times. The private signals are drawn from a normal distribution with a mean of zero and a standard deviation equal to 0.15. We set the risk-aversion coefficient to either 2 (left panels) or 3 (right panels). Three asterisks denote significance at the 1% level.

	Risk aversion γ=2			Risk aversion γ=3		
	SD(η)	OptVolume	Disagreement	SD(η)	OptVolume	Disagreement
Panel A: Summary statistics						
Mean	0.16	51,853	9,209	0.16	37,951	6,214
SD	0.13	19,906	8,673	0.13	17,393	5,990
Panel B: Correlations						
SD(η)	1.00	0.39	0.81	1.00	0.44	0.81
OptVolume		1.00	0.13		1.00	0.14
Disagreement			1.00			1.00
Panel C: Explanatory regressions						
SD(η)		59,785***	53,573***		59,276***	37,172***
R-squared		0.16	0.66		0.20	0.65

Appendix C: Definitions of control variables

In this appendix, we specify stock- and options-based control variables. We start by defining stock-based control variables. Whenever applicable, end-of-month observations are defined as the average across the last 10 trading days in a given month.

- *Market capitalization (log(Size)):* Individual stock market capitalization
- *Book-to-market (log(BM)):* Total Common Equity (CEQ) plus Deferred Taxes & Invest Tax Credit (TXDITC) (if available) minus Preferred Stock – Redemption (PSTKRV), Liquidating (PSTKL) or Carrying Value (UPSTK), used in that order, divided by the market value of equity at the end of the fiscal year (PRCC F ×CSHO)
- *Return (Ret):* Monthly stock return
- *Idiosyncratic volatility (IdiosyncVol):* Standard deviation of a residual in a regression of stock returns on a four-factor Fama-French-Carhart model, using 60-day rolling windows
- *Momentum (Mom):* Cumulative 12-month stock return over the risk-free rate
- *Operating profit (OP):* Defined as in Fama and French (2015): annual revenues minus cost of goods sold, interest expense, and selling, general, and administrative expenses measured with accounting data for the fiscal year ending in $t-1$, all divided by book equity at the end of fiscal year $t-1$
- *Investment (INV):* Defined as in Fama and French (2015): change in total assets from the fiscal year ending in the year $t-2$ to the fiscal year ending in $t-1$, divided by $t-2$ total assets
- *Effective stock spread (ESS):* Effective stock spread obtained from TAQ intra-day trading data. For a given trade k, the spread is defined as

$$ESS_k = \frac{2\left|S_k^P - S_k^M\right|}{S_k^M},$$

where S_k^P is the stock price at which the trade transacted and S_k^M is the midpoint price at the time of the trade. The daily effective stock spread ESS is a dollar volume-weighted average across all trades in a given day

- *Stock Order Imbalance (SOI):* Buy volume minus sell volume, scaled by total trading volume, where TAQ trades are signed using the Lee and Ready (1991) algorithm.
- *Probability of informed trading (PIN):* Calculated as in Easley, Kiefer, O'Hara, and Paperman (1996) and based on the Lee and Ready (1991) algorithm signed stock trades
- *Institutional ownership (InstOwner):* Fraction of shares outstanding owned by institutions. The data on institutional ownership come from the Thomson Financial Institutional Holdings (13F) database

Next, we define options-related variables. Unless otherwise specified, these variables are calculated using the same data we employ in the construction of disagreement measures. Implied volatilities come from OptionMetrics' volatility surface data for 30-day maturity options. End-of-month observations are obtained by aggregating over the last 10 trading days within a given month.

- *Options open interest (OpenInterest):* Delta-adjusted daily open interest from OptionMetrics, summed over all options and scaled by the number of shares outstanding
- *Options volume (OptVolume):* Delta-adjusted daily options volume from OptionMetrics, summed over all options and scaled by the number of shares outstanding

- *Options order imbalances (OOI):* Defined similarly to Hu (2014) as the difference between the delta-adjusted buy orders for puts and calls and the delta-adjusted sell orders for puts and calls, standardized by shares outstanding:

$$OOI = \frac{\sum\left(\Delta OB^{Call} + \Delta CB^{Call} + \Delta OB^{Put} + \Delta CB^{Put}\right) - \left(\Delta OS^{Call} + \Delta CS^{Call} + \Delta OS^{Put} + \Delta CS^{Put}\right)}{Shares\ Outstanding}$$

- *Put-call-volume ratio (PP):* Defined as in Pan and Poteshman (2006): the opening buy volume for puts over the sum of the opening buy volume for puts and calls (using customers' orders only):

$$PP = \frac{\sum OB^{Put}}{\sum OB^{Put} + \sum OB^{Call}}$$

- *Options-to-stock volume (OS):* Defined as in Johnson and So (2012): the total daily log option volume divided by the stock volume
- *Effective Options Spread (EOS):* Effective option spread based on intra-day LiveVol/CBOE data. It is computed similarly to the stock effective spread (*ESS*), except that we first calculate effective spreads for each option series and then we take the average across all option series for a given stock on a given day
- *Implied volatility (ImVol):* The average of at-the-money call and put implied volatilities
- *Call-put volatility spread (CP-vol-spread):* Defined as in Cremers and Weinbaum (2010): the difference between at-the-money implied volatility for a call and a put, weighted by options open interest:

$$CP - Vol - Spread = \sum w_i \left(ImVol_i^{Call} - ImVol_i^{Put}\right)$$

- *Monthly change in call* and *put implied volatility (CVol* and *PVol):* Defined as in An et al. (2014): implied volatility for a call (put) on the last day of a month minus the implied volatility for a call (put) from the previous month.
- *Implied skew (ISkew):* Defined as in An, Ang, Bali, and Cakici (2014): the difference between implied volatility for puts with an absolute delta closest to 0.2 and the average of implied volatilities for a call and a put with absolute deltas of 0.5.

References

An, B.-J., A. Ang, T. Bali, and N. Cakici. 2014. The joint cross section of stocks and options. *Journal of Finance* 59: 2279–2337.

Andreou, P., A., Kagkadis, D., Philip, and R. Tuneshev. 2018. Differences in options investors' expectations and the cross-section of stock returns. *Journal of Banking and Finance* 94: 315–336.

Atmaz, A., and S. Basak. 2018. Belief dispersion in the stock market. *Journal of Finance* 74: 1225–1279.

Avramov, D., T. Chordia, G. Jostova, and A. Philipov. 2009. Dispersion in analysts' earnings forecasts and credit rating, *Journal of Financial Economics* 91: 83–101.

Banerjee, S. 2011. Learning from prices and the dispersion in beliefs. *Review of Financial Studies* 24: 3025–3068.

Banerjee, S., and I. Kremer. 2010. Disagreement and learning: Dynamic patterns of trade. *Journal of Finance* 65: 1269–1302.

Battalio, R. H., and R. R. Mendenhall. 2005. Earnings expectations, investor trade size, and anomalous returns around earnings announcements. *Journal of Financial Economics* 77: 289–319.

Bernard, V. L., and J. K. Thomas. 1989. Post-earnings-announcement drift: Delayed price response or risk premium? *Journal of Accounting Research* 27: 1–36.

Binsbergen, J. H, van, X. Han, and Alejandro Lopez-Lira. 2020. Man vs. machine learning: The term structure of earnings expectations and conditional biases. *Working paper. The University of Pennsylvania, University of Edinburgh, and BI Norwegian Business School.*

Bollen, N. P. B., and R. E. Whaley. 2004. Does net buying pressure affect the shape of implied volatility functions? *Journal of Finance* 59: 711–753.

Buraschi, A., and A. Jiltsov. 2006. Model uncertainty and option markets with heterogeneous beliefs. *Journal of Finance* 61: 2841–2897.

Chen, J., H. Hong, and J. C. Stein. 2002. Breadth of ownership and stock returns. *Journal of Financial Economics* 66: 171–205.

Chicago Board of Options Exchange (CBOE). 2018. Bank capital regulations are adversely impacting the listed options market. Report, Chicago. http://www.cboe.com/aboutcboe/government-relations/pdf/bank-capital-february-2018.pdf.

Cookson, A. J., and M. Niessner. 2020. Why don't we agree? Evidence from a social network of investors. *Journal of Finance,* 75: 173–228.

Cremers, M., and D. Weinbaum. 2010. Deviations from put-call parity and stock return predictability. *Journal of Financial and Quantitative Analysis*, 45: 335–367.

Diether, K. B., C. J. Malloy, and A. Scherbina. 2002. Differences of opinion and the cross-section of stock returns. *Journal of Finance* 57: 2113–2141.

Dimson, E. 1979. Risk measurement when shares are subject to infrequent trading. *Journal of Financial Economics* 7: 197–226.

Doukas, J. A., C. Kim, and C. Pantzalis. 2006. Divergence of opinion and equity returns. *Journal of Financial and Quantitative Analysis* 41: 573–606.

Easley, D., N. M. Kiefer, M., O'Hara, and J. B. Paperman. 1996. Liquidity, information, and infrequently traded stock. *Journal of Finance* 51: 1405–1436.

Fama, E. F., and K. R. French. 2015. A five-factor asset pricing model. *Journal of Financial Economics* 116: 1–22.

Fama, E. F., and J. D. MacBeth. 1973. Risk, return and equilibrium: Empirical tests. *Journal of Political Economy* 81: 607–636.

Garleanu, N., L. H. Pedersen, and A. M. Poteshman. 2009. Demand-based option pricing. *Review of Financial Studies* 22: 4259–4299.

Ge, L., T-C Lin, and N. D. Pearson. 2016. Why does the option to stock volume ratio predict stock returns? *Journal of Financial Economics* 120: 601–622.

Goetzmann, W. N., and M. Massa. 2005. Dispersion of Opinion and Stock Returns. *Journal of Financial Markets* 8: 324–49.

Harris, M., and A. Raviv. 1993. Differences of opinion make a horse race. *Review of Financial Studies* 6: 473–506.

He, H., and J. Wang. 1995. Differential information and dynamic behavior of stock trading volume. *Review of Financial Studies* 6: 919–72.

Hong, H., and D. A. Sraer. 2016. Speculative betas. *Journal of Finance* 71: 2095–2144.

Hong, H., and J. C. Stein. 2007. Disagreement and the stock market. *Journal of Economic Perspectives* 21: 109–128.

Hou, K., C. Xue, and L. Zhang. 2020. Replicating anomalies. *Review of Financial Studies* 33: 2019–2133.

Hu, J. 2014. Does option trading convey stock price information? *Journal of Financial Economics* 111: 625–645.

Jiang, H., and Z. Sun. 2014. Dispersion in beliefs among active mutual funds and the cross-section of stock returns. *Journal of Financial Economics* 114: 341–365.

Johnson, T. C. 2004. Forecast dispersion and the cross section of expected returns. *Journal of Finance* 59: 1957–1978.

Johnson, T. L., and E. C. So. 2012. The option to stock volume ratio and future returns. *Journal of Financial Economics* 106: 262–286.

Kandel, E., and N. D. Pearson. 1995. Differential interpretation of public signals and trade in speculative markets. *Journal of Political Economy* 103: 831–872.

Koijen, R., and M. Yogo. 2019. A demand system approach to asset pricing. *Journal of Political Economy* 127: 1475–1515.

Lakonishok, J., I. Lee, N. Pearson, and A. Poteshman. 2007. Option market activity. *Review of Financial Studies* 20: 813–857.

Lee, C. M. C., and M. J. Ready. 1991. Inferring trade direction from intraday data. *Journal of Finance* 46: 733–746.

Miller, E.M. 1977. Risk, uncertainty and divergence of opinion. *Journal of Finance* 32: 1151–1168.

Muravyev, D., and X. C. Ni. 2020. Why do option returns change sign from day to night? *Journal of Financial Economics* 136: 219-238.

Nagel, S. 2005. Short sales, institutional investors and the cross-section of stock returns. *Journal of Financial Economics* 78: 277–309.

Newey, W. K., and K. D. West. 1987. A simple, positive semi-definite, heteroscedasticity and autocorrelation consistent covariance matrix. *Econometrica* 55: 703–708.

Pan, J., and A. M. Poteshman. 2006. The information in option volume for future stock prices. *Review of Financial Studies* 19: 871–908.

Sadka, R., and A. Scherbina. 2007. Analyst disagreement, mispricing, and liquidity. *Journal of Finance* 62: 2367–2403.

Scheinkman, J. A., and W. Xiong. 2003. Overconfidence and speculative bubbles. *Journal of Political Economy* 111: 1183–1219.

Yu, J. 2011. Disagreement and return predictability of stock portfolios. *Journal of Financial Economics* 99: 162–183.

Wang, J. 1994. A model of competitive stock trading volume. *Journal of Political Economy* 102: 127–68.

Zuckerman, G., and G. Banerji. 2020. The wildly popular trades behind the market's swoon and surge. *Wall Street Journal*, September 13.

Table 1: Summary statistics

This table reports monthly summary statistics for all the variables used in the main empirical analysis, separately for all stocks (Panel A) and for the subset of the 500 largest stocks (Panel B). Section 3 defines all variables. The sample period is from January 2005 to December 2018.

Panel A: All stocks

	Mean	Median	Min	Max	SD	N
Disagreement	0.33	0.32	0.00	1.00	0.24	326,099
Directional	-0.03	-0.03	-1.00	1.00	0.49	326,099
AnalystDis	0.02	0.00	0.00	37.82	0.25	283,460
StockTurn	0.26	0.19	0.00	230.75	0.50	326,097
MFDis	0.01	0.01	0.00	0.13	0.00	314,767
log(Size)	14.39	14.31	7.41	20.82	1.72	324,930
log(BM)	0.57	0.43	0.00	23.90	0.63	301,990
Ret	0.01	0.01	-0.99	13.50	0.15	324,648
IdiosyncVol	0.11	0.10	0.02	2.12	0.07	302,861
Mom	0.17	0.09	-1.00	3946.33	7.23	315,926
OP	0.21	0.21	-860.35	1417.33	10.84	301,961
INV	0.53	0.07	-1.00	5569.68	36.72	314,113
ESS	0.00	0.00	0.00	1.31	0.01	325,160
SOI	0.00	0.00	-0.78	1.00	0.06	325,195
PIN	0.11	0.11	0.00	0.89	0.05	318,328
InstOwner	0.78	0.82	0.00	4.99	0.24	278,546
OpenInterest	0.15	0.06	0.00	42.46	0.30	325,048
OptVolume	0.15	0.06	0.00	13.51	0.29	321,765
OOI	0.00	0.00	-0.01	0.02	0.00	321,281
PP	0.61	0.58	0.00	1.00	0.27	251,003
OS	1.09	1.29	-6.69	5.83	1.53	315,407
EOS	0.13	0.11	0.00	1.56	0.07	312,738
ImVol	0.45	0.39	0.02	2.80	0.24	316,979
CP-vol-spread	-0.01	0.00	-2.00	2.10	0.08	321,368
Cvol	0.00	0.00	-1.43	1.39	0.01	310,388
Pvol	0.00	0.00	-1.75	1.39	0.01	310,388
ISkew	0.07	0.05	-1.47	2.22	0.08	310,420

Panel B: 500 largest stocks

	Mean	Median	Min	Max	SD	N
Disagreement	0.48	0.50	0.00	1.00	0.21	79,174
Directional	-0.07	-0.07	-1.00	1.00	0.34	79,174
AnalystDis	0.00	0.00	0.00	0.60	0.01	77,346
StockTurn	0.22	0.17	0.01	8.76	0.19	79,174
MFDis	0.01	0.01	0.00	0.07	0.00	78,135
log(Size)	16.62	16.45	12.62	20.82	0.99	78,987
log(BM)	0.47	0.37	0.00	7.48	0.38	76,243
Ret	0.01	0.01	-0.87	2.60	0.09	78,987
IdiosyncVol	0.07	0.06	0.02	0.53	0.03	77,514
Mom	0.16	0.13	-0.99	35.39	0.40	78,553
OP	0.66	0.29	-13.33	1417.33	17.92	76,245
INV	0.14	0.06	-0.73	15.29	0.44	78,003
ESS	0.00	0.00	0.00	0.97	0.01	78,864
SOI	0.01	0.00	-0.59	1.00	0.05	78,868
PIN	0.09	0.08	0.00	0.68	0.04	78,111
InstOwner	0.79	0.81	0.00	1.94	0.16	70,396
OpenInterest	0.16	0.09	0.00	3.73	0.23	79,173
OptVolume	10.27	10.33	1.14	16.25	1.64	79,173
OOI	0.00	0.00	0.00	0.00	0.00	79,111
PP	0.52	0.49	0.00	1.00	0.21	77,401
OS	1.91	2.05	-4.96	5.37	1.18	79,115
EOS	0.08	0.07	0.00	1.12	0.04	78,218
ImVol	0.30	0.27	0.03	2.34	0.15	78,477
CP-vol-spread	-0.01	0.00	-1.54	0.64	0.03	79,166
Cvol	0.00	0.00	-0.56	0.12	0.00	77,419
Pvol	0.00	0.00	-0.24	0.12	0.00	77,419
ISkew	0.05	0.04	-0.45	0.96	0.04	77,423

Table 2: Correlations

This table reports monthly pairwise correlations for options disagreement and directional trading, analysts' forecast dispersion, stock turnover, and mutual fund holdings dispersion with all the variables used in the main analysis, separately for all stocks (Panel A) and for the subset of the 500 largest stocks (Panel B). Section 3 defines all variables. The sample period is from January 2005 to December 2018.

Panel A: All stocks					
	Disagreement	Directional	AnalystDis	StockTurn	MFDis
Disagreement	1.00	0.01	-0.01	0.14	0.17
Directional	0.01	1.00	0.02	0.01	-0.05
AnalystDis	-0.01	0.02	1.00	0.02	-0.04
StockTurn	0.14	0.01	0.02	1.00	-0.05
MFDis	0.17	-0.05	-0.04	-0.05	1.00
log(Size)	0.37	-0.10	-0.09	-0.05	0.49
log(BM)	-0.09	0.01	-0.03	0.03	-0.09
Ret	0.04	-0.11	0.00	0.01	0.01
IdiosyncVol	0.00	0.08	0.09	0.13	-0.30
Mom	0.01	0.00	0.00	0.00	0.01
OP	0.00	0.00	-0.01	-0.01	0.01
INV	0.00	0.01	0.00	0.00	-0.01
ESS	-0.04	0.03	0.02	-0.01	-0.07
SOI	0.06	-0.08	-0.03	0.00	0.08
PIN	-0.15	0.06	0.05	-0.01	-0.19
InstOwner	0.04	-0.06	-0.08	0.14	0.18
OpenInterest	0.30	0.01	0.02	0.49	0.02
OptVolume	0.21	0.02	0.04	0.26	-0.01
OOI	-0.02	0.22	0.01	-0.05	-0.01
PP	-0.42	-0.19	0.00	-0.13	-0.08
OS	0.48	0.00	0.00	0.12	0.16
EOS	-0.38	0.04	0.06	-0.12	-0.28
ImVol	-0.04	0.08	0.10	0.29	-0.33
CP-vol-spread	-0.05	0.04	-0.02	-0.09	0.04
Cvol	-0.01	0.02	0.00	-0.03	0.00
Pvol	0.00	0.01	0.01	-0.02	0.00
ISkew	-0.18	-0.05	0.00	-0.04	-0.03
Panel B: 500 largest stocks					
Disagreement	1.00	0.15	0.05	0.22	0.19
Directional	0.15	1.00	0.02	0.06	0.02
AnalystDis	0.05	0.02	1.00	0.17	-0.04
StockTurn	0.22	0.06	0.17	1.00	-0.11
MFDis	0.19	0.02	-0.04	-0.11	1.00
log(Size)	0.37	0.01	-0.13	-0.30	0.44
log(BM)	-0.06	-0.02	-0.09	0.04	-0.10
Ret	0.02	-0.14	0.00	-0.06	0.02
IdiosyncVol	0.18	0.08	0.23	0.42	-0.06
Mom	0.07	0.04	0.13	-0.03	0.10
OP	0.00	0.00	0.00	-0.01	0.00
INV	0.06	0.02	0.06	0.10	0.04
ESS	-0.01	0.00	-0.01	0.00	0.00
SOI	-0.02	-0.03	0.00	-0.04	-0.04
PIN	-0.10	-0.01	0.05	0.07	-0.07
InstOwner	-0.09	0.03	0.08	0.17	-0.02
OpenInterest	0.37	0.08	0.18	0.66	0.08
OptVolume	0.25	0.07	0.12	0.52	0.05
OOI	0.00	0.25	-0.01	-0.04	0.00
PP	-0.42	-0.20	-0.02	-0.18	-0.10
OS	0.56	0.11	0.08	0.21	0.24
EOS	-0.46	-0.06	0.01	-0.11	-0.21
ImVol	0.14	0.03	0.15	0.59	-0.11
CP-vol-spread	0.00	0.03	-0.02	-0.13	0.04
Cvol	0.00	0.04	-0.02	0.03	0.00
Pvol	0.00	0.04	-0.02	0.03	0.00
ISkew	-0.16	-0.07	0.02	0.13	-0.07

Table 3: Monthly portfolio sorts (value-weighted portfolios)

This table reports results for monthly portfolio sorts based on options disagreement (Disagreement), options disagreement that excludes written calls (DisagreementSC), and analysts' forecast dispersion (AnalystDis). Results are reported separately for all stocks (left panels) and for the subsample of the 500 largest stocks (right panels). Portfolio returns are value-weighted and annualized. Portfolio alphas are evaluated using a four-factor Fama-French-Carhart model and Newey-West *t*-statistics with three lags. The sample period is from January 2005 to December 2018.

	All stocks				500 largest stocks		
Panel A: Disagreement							
	Raw ret	Alpha	*t*-stat		Raw ret	Alpha	*t*-stat
Low	9.20	1.51	1.83	Low	9.33	2.36	2.52
2	9.55	1.84	2.23	2	8.62	1.37	1.53
3	9.15	1.60	2.16	3	8.71	1.71	1.83
4	8.24	0.67	0.91	4	6.69	-0.30	-0.39
High	6.68	-1.12	-2.55	High	6.95	-1.29	-1.52
High-Low	-2.52	-2.62	-2.44	High-Low	-2.39	-3.65	-2.53
Panel B: DisagreementSC							
	Raw ret	Alpha	*t*-stat		Raw ret	Alpha	*t*-stat
Low	9.96	2.41	3.29	Low	10.77	4.03	4.88
2	8.60	0.99	1.20	2	8.87	1.80	1.88
3	10.01	2.52	3.06	3	8.37	1.09	1.35
4	8.14	0.55	0.78	4	6.38	-0.96	-1.33
High	6.42	-1.48	-2.78	High	6.33	-1.83	-2.05
High-Low	-3.54	-3.89	-3.70	High-Low	-4.43	-5.86	-4.19
Panel C: DisagreementSC (w/o 2008–2009)							
	Raw ret	Alpha	*t*-stat		Raw ret	Alpha	*t*-stat
Low	11.72	2.66	3.76	Low	12.65	4.10	4.75
2	10.63	1.31	1.50	2	10.33	1.34	1.38
3	10.77	1.42	1.76	3	10.81	1.13	1.54
4	10.67	0.83	1.22	4	9.15	-0.78	-1.10
High	9.25	-1.55	-2.67	High	9.65	-1.57	-1.54
High-Low	-2.48	-4.21	-3.98	High-Low	-3.00	-5.67	-3.52
Panel D: AnalystDis							
	Raw ret	Alpha	*t*-stat		Raw ret	Alpha	*t*-stat
Low	7.46	0.43	0.95	Low	6.05	-0.60	-0.66
2	9.40	0.46	0.40	2	8.62	1.52	1.70
3	8.35	-0.79	-0.46	3	9.92	1.96	1.77
4	8.74	-0.92	-0.55	4	8.70	-0.20	-0.14
High	7.54	-0.91	-0.43	High	9.44	0.20	0.09
High-Low	0.08	-1.34	-0.60	High-Low	3.39	0.80	0.26

Table 4: Fama-MacBeth monthly return predictive regressions

This table reports two-step Fama-MacBeth monthly return regressions, with the next month's stock excess returns as the dependent variable, and *t*-statistics based on Newey-West correction with three lags. Section 3 defines all variables. DisagrementSC stands for a disagreement measure that excludes written calls. No. cross-section is the average number of stocks per month. The sample period is from January 2005 to December 2018.

	All stocks				500 largest stocks		
				w/o 2008–2009			w/o 2008–2009
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Disagreement	-0.0059***	-0.0048***			-0.0054***		
	(-3.46)	(-2.88)			(-2.88)		
DisagreementSC			-0.0053***	-0.0042**		-0.0066***	-0.0042**
			(-3.04)	(-2.49)		(-3.15)	(-2.09)
Directional		0.0047***	0.0035***	0.0034***	0.0045***	0.0028**	0.0029***
		(5.78)	(4.48)	(4.29)	(3.87)	(2.58)	(2.68)
AnalystDis		-0.0402**	-0.0412***	-0.0399***	0.2026	0.1986	0.2738
		(-2.57)	(-2.62)	(-2.64)	(0.84)	(0.82)	(1.08)
StockTurn		-0.0020	-0.0016	-0.0016	0.0072	0.0082	0.0085
		(-0.55)	(-0.44)	(-0.40)	(1.12)	(1.28)	(1.18)
MFDis		-0.1112	-0.1029	-0.0888	-0.0568	-0.0456	0.0467
		(-0.98)	(-0.91)	(-0.84)	(-0.42)	(-0.33)	(0.37)
log(Size)		-0.0002	-0.0003	-0.0001	0.0002	0.0001	-0.0004
		(-0.38)	(-0.51)	(-0.18)	(0.17)	(0.14)	(-0.47)
log(BM)		-0.0009	-0.0009	-0.0007	-0.0009	-0.0009	0.0001
		(-0.99)	(-1.04)	(-0.77)	(-0.88)	(-0.99)	(0.16)
Ret(t)		-0.0063	-0.0064	-0.0047	-0.0031	-0.0024	0.0034
		(-0.96)	(-0.96)	(-0.70)	(-0.33)	(-0.26)	(0.36)
Ret(t-1)		0.0087	0.0084	0.0130*	0.0006	0.0004	0.0088
		(1.35)	(1.31)	(1.92)	(0.06)	(0.05)	(0.87)
IdiosyncVol		0.0025	0.0016	0.0039	-0.0340	-0.0326	-0.0162
		(0.16)	(0.10)	(0.25)	(-1.11)	(-1.08)	(-0.65)
Mom		-0.0023	-0.0022	0.0014	-0.0010	-0.0010	0.0015
		(-0.67)	(-0.65)	(0.71)	(-0.30)	(-0.29)	(0.52)
OP		0.0004	0.0004	0.0004	0.0003	0.0004	0.0001
		(1.10)	(1.11)	(1.18)	(0.54)	(0.59)	(0.22)
INV		-0.0016*	-0.0017*	-0.0018*	0.0008	0.0007	0.0003
		(-1.83)	(-1.85)	(-1.91)	(0.65)	(0.56)	(0.26)
ESS		0.3289	0.3770	-0.0626	5.2352**	5.2974**	2.2505
		(0.45)	(0.51)	(-0.09)	(2.29)	(2.28)	(1.19)
SOI		0.0103	0.0101	0.0107	0.0249*	0.0231*	0.0103
		(1.25)	(1.22)	(1.27)	(1.91)	(1.79)	(0.98)
PIN		-0.0011	0.0002	0.0099	-0.0001	-0.0012	-0.0060
		(-0.10)	(0.02)	(1.00)	(-0.01)	(-0.08)	(-0.44)
InstOwner		0.0012	0.0016	-0.0009	-0.0012	-0.0010	-0.0041
		(0.46)	(0.61)	(-0.37)	(-0.33)	(-0.27)	(-1.29)
OpenInterest		-0.0020	-0.0021	-0.0035	-0.0024	-0.0031	-0.0048
		(-0.71)	(-0.75)	(-1.17)	(-0.56)	(-0.72)	(-1.10)
OptVolume		0.0142	0.0166	0.0277	-0.0376	-0.0348	-0.0398
		(0.56)	(0.66)	(1.00)	(-0.82)	(-0.75)	(-0.81)
OOI		5.9555	7.5398	7.8578	-22.9502	-20.1279	-29.0811
		(0.88)	(1.16)	(1.06)	(-1.30)	(-1.14)	(-1.55)
PP		-0.0035**	-0.0034*	-0.0020	-0.0012	-0.0008	0.0010
		(-2.02)	(-1.91)	(-1.25)	(-0.45)	(-0.31)	(0.44)
OS		-0.0007*	-0.0006	-0.0006	-0.0007	-0.0004	-0.0004
		(-1.67)	(-1.50)	(-1.42)	(-1.02)	(-0.68)	(-0.73)
EOS		-0.0120	-0.0117	-0.0207	-0.0443**	-0.0451**	-0.0494**
		(-0.72)	(-0.70)	(-1.31)	(-2.04)	(-2.08)	(-2.23)
ImVol		0.0015	0.0011	-0.0008	-0.0097	-0.0089	-0.0042
		(0.15)	(0.11)	(-0.08)	(-0.66)	(-0.60)	(-0.28)
CP-vol-spread		0.0419***	0.0420***	0.0499***	0.0272	0.0290	0.0544*
		(2.66)	(2.67)	(2.98)	(0.95)	(1.01)	(1.89)
Cvol		0.0732	0.0815	-0.0019	-0.1709	-0.1378	-0.2358
		(0.50)	(0.56)	(-0.01)	(-0.62)	(-0.50)	(-0.92)
Pvol		-0.2368*	-0.2345*	-0.1365	0.0267	0.0270	0.0507
		(-1.92)	(-1.90)	(-1.08)	(0.10)	(0.10)	(0.19)
Iskew		-0.0210	-0.0211	-0.0161	-0.0173	-0.0153	-0.0205
		(-1.54)	(-1.55)	(-1.31)	(-0.95)	(-0.85)	(-1.13)
Adj. *R*-squared	0.00	0.10	0.10	0.09	0.16	0.16	0.14
No. cross-section	1,924	956	956	956	372	372	372

Table 5: Weekly portfolio sorts (value-weighted portfolios)

This table reports results for weekly portfolio sorts based on the disagreement measure (DisagreementSC). Results are reported separately for all stocks (left panel) and for the subsample of the 500 largest stocks (right panel). Portfolio returns are value-weighted and annualized. Portfolio alphas are evaluated using a four-factor Fama-French-Carhart model and Newey-West *t*-statistics with three lags. The sample period is from January 2005 to December 2018.

	All stocks				**500 largest stocks**		
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	9.49	1.51	1.82	Low	10.43	2.92	2.84
2	11.39	3.42	3.37	2	11.28	3.51	3.31
3	10.27	2.24	2.68	3	7.97	0.18	0.19
4	8.24	0.44	0.59	4	6.97	-1.01	-1.17
High	6.00	-2.39	-3.81	High	6.52	-2.09	-2.20
High-low	-3.48	-3.90	-3.17	High-low	-3.91	-5.01	-3.01

Table 6: Earnings surprises: Main panel regressions

This table reports panel regression results for cumulative abnormal returns over the five days after the earnings announcement on dummy variables for high, medium, and low earnings surprise, and the interaction terms between the dummy variables and pre-announcement disagreement. Pre-announcement disagreement is calculated over 10 days before each announcement and excludes volatility trades and trades to open sell calls. Panel A reports baseline results with quarter fixed effects. Panel B includes an additional set of control variables. Standard errors are clustered by time and firm; *t*-statistics are reported in parentheses below the estimated coefficients. The sample period is from January 2005 to December 2018.

Panel A: Baseline results

	Cumulative abnormal returns [1,5]			
	All stocks	**Low-beta stocks**	**Medium-beta stocks**	**High-beta stocks**
	(1)	(2)	(3)	(4)
High	0.010***	0.010***	0.009***	0.011***
	(4.94)	(2.79)	(3.28)	(3.98)
Medium	0.000	0.001	0.000	-0.003
	(-0.18)	(0.86)	(0.08)	(-1.55)
Low	-0.009***	-0.012***	-0.007**	-0.008***
	(-5.10)	(-4.74)	(-2.23)	(-3.74)
Disagreement x High	-0.017***	-0.013	-0.013*	-0.020**
	(-2.68)	(-1.19)	(-1.90)	(-1.98)
Disagreement x Medium	0.001	-0.002	0.003	0.003
	(0.30)	(-0.85)	(0.75)	(0.58)
Disagreement x Low	0.019***	0.024***	0.011	0.019**
	(3.44)	(3.18)	(1.19)	(2.30)
Fixed effects	Quarter	Quarter	Quarter	Quarter
Clustered errors	Firm/time	Firm/time	Firm/time	Firm/time
Adj. *R*-squared	0.010	0.014	0.012	0.015
N	80,330	26,665	26,765	26,900

Panel B: Additional control variables				
	Cumulative abnormal returns [1,5]			
	All stocks	**Low-beta stocks**	**Medium-beta stocks**	**High-beta stocks**
	(1)	(2)	(3)	(4)
High	0.0095***	0.0105***	0.0095***	0.0089***
	(5.92)	(3.03)	(3.77)	(3.79)
Medium	-0.0002	0.0005	-0.0007	-0.0013
	(-0.25)	(0.60)	(-0.64)	(-0.75)
Low	-0.0076***	-0.0098***	-0.0076**	-0.0065**
	(-4.17)	(-3.56)	(-2.32)	(-2.35)
Disagreement x High	-0.0175***	-0.0153	-0.0145**	-0.0181*
	(-3.20)	(-1.39)	(-2.21)	(-1.91)
Disagreement x Medium	0.003	-0.0013	0.0062**	0.0049
	(1.45)	(-0.48)	(2.34)	(0.86)
Disagreement x Low	0.0127**	0.0187**	0.0124	0.0086
	(2.16)	(2.15)	(1.24)	(0.94)
Directional	-0.0001	-0.001	0.0001	0.001
	(-0.13)	(-1.14)	(0.15)	(0.85)
ESS	-0.019	-0.0001	-0.0409	-0.0167
	(-1.35)	(-0.01)	(-1.56)	(-0.44)
ESO	0.0026	-0.0011	0.0022	0.0056
	(0.50)	(-0.16)	(0.33)	(0.56)
log(Size)	-0.0001	0.0001	-0.0004	-0.0004
	(-0.37)	(0.18)	(-0.96)	(-0.82)
log(BM)	0.0018*	0.0017	0.0022*	0.0015
	(1.75)	(1.11)	(1.65)	(1.28)
IdiosyncVol	0.0333	0.0082	-0.0186	0.073***
	(1.62)	(0.36)	(-0.59)	(3.33)
SOI	0.0013	-0.0005	-0.0052	0.0087
	(0.27)	(-0.07)	(-0.80)	(0.87)
StockTurn	0.0381	0.0089	0.0744	0.0597
	(0.83)	(0.10)	(1.27)	(1.03)
PIN	-0.0102**	0.0034	-0.0234***	-0.0047
	(-2.07)	(0.51)	(-3.81)	(-0.43)
Fixed effects	Quarter	Quarter	Quarter	Quarter
Clustered errors	Firm/time	Firm/time	Firm/time	Firm/time
Adj. *R*-squared	0.010	0.014	0.016	0.014
N	73,493	24,431	24,743	24,319

Table 7: Earnings surprises: Additional results

This table reports panel regression results for cumulative abnormal returns over the five days after the earnings announcement on dummy variables for high, medium, and low earnings surprise, and the interaction terms between the dummy variables and pre-announcement disagreement. Pre-announcement disagreement is calculated over 10 days before each announcement and excludes volatility trades and trades to open sell calls. Panel A reports results for the subsample of high-beta stocks. Panel B reports results for the subsample of low-beta stocks. All regressions include quarter fixed effects and a set of additional control variables: Directional, ESS, ESO, log(Size), BM, IdiosyncVol, SOI, StockTurn, and PIN. Standard errors are clustered by time and firm; *t*-statistics are reported in parentheses below the estimated coefficients. The sample period is from January 2005 to December 2018.

Panel A: High-beta stocks			
	Cumulative abnormal returns [1,5]		
	Low InstOwner	**Medium InstOwner**	**High InstOwner**
	(1)	(2)	(3)
High	0.017***	0.006*	0.005
	(3.86)	(1.80)	(1.11)
Medium	-0.002	-0.004	0.001
	(-0.51)	(-1.60)	(0.25)
Low	-0.003	-0.006	-0.012**
	(-0.86)	(-1.28)	(-2.00)
Disagreement x High	-0.031***	-0.011	-0.011
	(-2.57)	(-0.67)	(-0.79)
Disagreement x Medium	0.013	0.003	0.003
	(1.28)	(0.34)	(0.31)
Disagreement x Low	0.016	0.012	0.008
	(0.95)	(0.89)	(0.45)
Additional controls	Yes	Yes	Yes
Fixed effects	Quarter	Quarter	Quarter
Clustered errors	Firm/time	Firm/time	Firm/time
Adj. R-squared	0.023	0.032	0.021
N	7,699	7,446	7,985

Panel B: Low-beta stocks			
	Cumulative abnormal returns [1,5]		
	Low InstOwner	**Medium InstOwner**	**High InstOwner**
	(1)	(2)	(3)
High	0.015***	0.008	0.004
	(2.79)	(1.60)	(0.90)
Medium	-0.003*	0.001	0.004*
	(-1.78)	(0.67)	(1.67)
Low	-0.010**	-0.003	-0.013**
	(-2.39)	(-0.54)	(-2.24)
Disagreement x High	-0.032*	-0.005	0.006
	(-1.70)	(-0.29)	(0.41)
Disagreement x Medium	0.007	0.001	-0.015**
	(1.23)	(0.19)	(-1.97)
Disagreement x Low	0.030*	-0.027*	0.041***
	(1.74)	(-1.85)	(2.29)
Additional controls	Yes	Yes	Yes
Fixed effects	Quarter	Quarter	Quarter
Clustered errors	Firm/time	Firm/time	Firm/time
Adj. R-squared	0.023	0.019	0.030
N	8,225	7,990	7,377

Table 8: Fama-MacBeth monthly return predictive regressions: Additional tests

This table reports two-step Fama-MacBeth monthly return regressions, with the next month's stock excess returns as the dependent variable, and *t*-statistics based on Newey-West correction with three lags. DisML is the dispersion of trading volume across options moneyness levels. Section 3 defines the rest of the variables. No. cross-section is the average number of stocks per month. The sample period is from January 2005 to December 2018.

	All stocks		500 largest stocks	
	(1)	(2)	(3)	(4)
DisagreementSC	-0.0053***	-0.0039**	-0.0066***	-0.0046***
	(-3.04)	(-2.56)	(-3.15)	(-2.65)
Directional	0.0035***	0.0048***	0.0028**	0.0048***
	(4.48)	(5.64)	(2.58)	(3.97)
AnalystDis	-0.0412***	-0.0281	0.1986	0.3970
	(-2.62)	(-1.48)	(0.82)	(1.54)
StockTurn	-0.0016	0.0025	0.0082	0.0078
	(-0.44)	(0.63)	(1.28)	(1.15)
MFDis	-0.1029	-0.0557	-0.0456	-0.0687
	(-0.91)	(-0.45)	(-0.33)	(-0.47)
log(Size)	-0.0003	-0.0001	0.0001	0.0004
	(-0.51)	(-0.10)	(0.14)	(0.42)
BM	-0.0009	-0.0010	-0.0009	-0.0009
	(-1.04)	(-1.08)	(-0.99)	(-0.88)
Ret(t)	-0.0064	-0.0071	-0.0024	-0.0027
	(-0.96)	(-1.07)	(-0.26)	(-0.30)
Ret(t-1)	0.0084	0.0076	0.0004	-0.0005
	(1.31)	(1.11)	(0.05)	(-0.05)
IdiosyncVol	0.0016	-0.0142	-0.0326	-0.0524
	(0.10)	(-0.78)	(-1.08)	(-1.47)
Mom	-0.0022	-0.0026	-0.0010	0.0005
	(-0.65)	(-0.75)	(-0.29)	(0.15)
OP	0.0004	0.0002	0.0004	-0.0001
	(1.11)	(0.53)	(0.59)	(-0.09)
INV	-0.0017*	-0.0018*	0.0007	0.0011
	(-1.85)	(-1.66)	(0.56)	(0.84)
ESS	0.3770	0.9101	5.2974**	5.3125**
	(0.51)	(1.20)	(2.28)	(2.40)
SOI	0.0101	0.0146*	0.0231*	0.0189
	(1.22)	(1.74)	(1.79)	(1.37)
PIN	0.0002	-0.0048	-0.0012	0.0039
	(0.02)	(-0.44)	(-0.08)	(0.26)
InstOwner	0.0016	-0.0018	-0.0010	-0.0015
	(0.61)	(-0.64)	(-0.27)	(-0.43)
Open interest	-0.0021	-0.0001	-0.0031	-0.0010
	(-0.75)	(-0.04)	(-0.72)	(-0.26)
Opt volume	0.0166	-0.0008	-0.0348	-0.0779*
	(0.66)	(-0.03)	(-0.75)	(-1.66)
OOI	7.5398	7.5841	-20.1279	-10.7169
	(1.16)	(1.05)	(-1.14)	(-0.58)
PP	-0.0034*	-0.0041**	-0.0008	0.0001
	(-1.91)	(-2.19)	(-0.31)	(0.04)
OS	-0.0006	-0.0005	-0.0004	-0.0003
	(-1.50)	(-0.95)	(-0.68)	(-0.44)
EOS	-0.0117	-0.0088	-0.0451**	-0.0532**
	(-0.70)	(-0.50)	(-2.08)	(-2.22)
ImVol	0.0011	0.0089	-0.0089	0.0068
	(0.11)	(0.91)	(-0.60)	(0.40)
CP-vol-spread	0.0420***	0.0048	0.0290	0.0231
	(2.67)	(0.22)	(1.01)	(0.59)
Cvol	0.0815	0.1383	-0.1378	-0.3672
	(0.56)	(0.87)	(-0.50)	(-1.16)
Pvol	-0.2345*	-0.2473*	0.0270	0.1675
	(-1.90)	(-1.66)	(0.10)	(0.53)
Iskew	-0.0211	-0.0234	-0.0153	-0.0229
	(-1.55)	(-1.61)	(-0.85)	(-1.09)
DisML		-0.0414**		-0.0319
		(-2.06)		(-1.54)
Adj. *R*-squared	0.10	0.11	0.16	0.16
No. cross-section	956	814	372	327

Online Appendix

Disagreement in the equity options market and stock returns

Benjamin Golez
University of Notre Dame

Ruslan Goyenko
McGill University

This Appendix presents additional results for the paper "Disagreement in the equity options market and stock returns."

Table OA.1: Monthly portfolio sorts (equal-weighted portfolios)

This table reports results for monthly portfolio sorts based on options disagreement (Disagreement), options disagreement that excludes written calls (DisagreementSC), and analysts' forecast dispersion (AnalystDis). Results are reported separately for all stocks (left panels) and for the subsample of the 500 largest stocks (right panels). Portfolio returns are equal-weighted and annualized. Portfolio alphas are evaluated using a four-factor Fama-French-Carhart model and Newey-West *t*-statistics with three lags. The sample period is from January 2005 to December 2018.

	All stocks				**500 largest stocks**		
Panel A: Disagreement							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	9.17	0.80	0.77	Low	9.91	2.71	2.74
2	9.13	0.37	0.40	2	9.26	1.69	2.11
3	7.64	-1.15	-1.19	3	8.58	1.06	0.96
4	6.15	-2.76	-3.03	4	8.03	-0.03	-0.03
High	4.63	-4.54	-3.58	High	7.27	-1.81	-1.31
High-Low	-4.54	-5.34	-4.40	High-Low	-2.64	-4.51	-3.45
Panel B: DisagreementSC							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	9.74	1.32	1.21	Low	11.08	3.96	4.11
2	9.51	0.74	0.66	2	8.97	1.39	1.33
3	7.66	-1.41	-1.46	3	8.72	0.89	0.88
4	6.04	-2.93	-3.43	4	7.03	-1.01	-1.23
High	3.92	-5.01	-4.75	High	7.25	-1.60	-1.20
High-Low	-5.82	-6.33	-5.81	High-Low	-3.83	-5.56	-4.07
Panel C: DisagreementSC (w/o 2008-09)							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	9.49	0.02	0.02	Low	12.76	4.12	4.59
2	9.79	-0.17	-0.15	2	11.03	1.87	2.07
3	8.10	-2.52	-2.43	3	11.06	1.38	1.67
4	7.38	-3.03	-3.35	4	9.27	-0.67	-0.83
High	6.04	-4.37	-4.55	High	10.02	-0.95	-0.88
High-Low	-3.45	-4.39	-3.89	High-Low	-2.74	-5.07	-3.68
Panel D: AnalystDis							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	8.57	1.29	2.04	Low	6.87	-0.04	-0.04
2	9.58	1.70	2.88	2	10.02	2.93	3.20
3	10.23	1.86	2.25	3	8.64	1.00	1.14
4	8.96	0.08	0.09	4	8.63	0.52	0.49
High	4.87	-5.01	-2.22	High	8.89	-0.36	-0.16
High-Low	-3.70	-6.29	-2.69	High-Low	2.03	-0.32	-0.12

Table OA.2: Monthly portfolio sorts: Directional trading

This table reports results for monthly portfolio sorts based on options directional trading (Directional). Results are reported separately for all stocks (left panels) and for the subsample of the 500 largest stocks (right panels). Panel A reports results for value-weighted portfolios, and Panel B reports results for equal-weighted returns. All returns are annualized. Portfolio alphas are evaluated using a four-factor Fama-French-Carhart model and Newey-West *t*-statistics with three lags. The sample period is from January 2005 to December 2018.

	All stocks				**500 largest stocks**		
Panel A: Value-weighted portfolios							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	7.74	0.51	0.57	Low	7.33	0.55	0.58
2	5.24	-2.00	-2.87	2	5.55	-1.46	-1.66
3	7.40	-0.60	-0.95	3	7.70	0.06	0.08
4	9.15	1.08	1.13	4	7.82	-0.35	-0.35
High	12.41	4.41	4.27	High	9.72	2.22	2.01
High-Low	4.67	3.90	3.24	High-Low	2.39	1.67	1.16
Panel B: Equal-weighted portfolios							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	4.22	-4.03	-4.81	Low	7.25	-0.16	-0.17
2	6.05	-2.58	-3.25	2	7.73	0.07	0.10
3	6.04	-3.08	-3.12	3	8.36	-0.12	-0.10
4	7.58	-1.42	-1.23	4	8.75	0.37	0.29
High	12.87	3.87	2.89	High	11.00	3.51	3.18
High-Low	8.65	7.89	6.44	High-Low	3.75	3.67	2.93

Table OA.3: Monthly portfolio sorts: Unscaled disagreement

This table reports results for monthly portfolio sorts based on options unscaled disagreement [Min(POS,NEG)]. Results are reported separately for all stocks (left panels) and for the subsample of the 500 largest stocks (right panels). Panel A reports results for value-weighted portfolios, and Panel B reports results for equal-weighted returns. All returns are annualized. Portfolio alphas are evaluated using a four-factor Fama-French-Carhart model and Newey-West *t*-statistics with three lags. The sample period is from January 2005 to December 2018.

	All stocks				500 largest stocks		
Panel A: Value-weighted portfolios							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	9.65	2.05	2.81	Low	9.46	2.69	2.92
2	8.92	1.31	1.62	2	7.96	0.72	0.94
3	9.27	1.62	2.13	3	8.20	0.89	1.05
4	8.50	0.82	1.19	4	8.12	0.42	0.65
High	7.01	-0.72	-2.38	High	6.79	-0.84	-1.30
High-Low	-2.64	-2.77	-2.95	High-Low	-2.67	-3.53	-2.54
Panel B: Equal-weighted portfolios							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	9.04	0.76	0.73	Low	9.74	2.70	2.88
2	8.69	0.08	0.07	2	8.36	0.61	0.67
3	8.09	-0.83	-0.77	3	9.03	1.37	1.35
4	6.21	-2.90	-2.73	4	8.65	0.22	0.18
High	4.72	-4.35	-4.57	High	7.32	-1.22	-1.01
High-Low	-4.31	-5.12	-4.45	High-Low	-2.43	-3.92	-2.63

Table OA.4: Monthly portfolio sorts: A five-factor Fama-French model augmented with the Carhart momentum factor

This table reports results for monthly portfolio sorts based on options disagreement (DisagreementSC). Results are reported separately for all stocks (left panels) and for the subsample of the 500 largest stocks (right panels). Panel A reports results for value-weighted portfolios, and Panel B reports results for equal-weighted returns. All returns are annualized. Portfolio alphas are evaluated using a five-factor Fama-French model augmented with the Carhart momentum factor and Newey-West *t*-statistics with three lags. The sample period is from January 2005 to December 2018.

	All stocks				**500 largest stocks**		
Panel A: Value-weighted portfolios							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	9.96	2.32	3.10	Low	10.77	3.84	4.32
2	8.60	1.27	1.56	2	8.87	1.71	1.76
3	10.01	2.61	3.18	3	8.37	1.06	1.31
4	8.14	0.52	0.78	4	6.38	-0.93	-1.25
High	6.42	-1.59	-2.90	High	6.33	-1.96	-2.13
High-Low	-3.54	-3.90	-3.69	High-Low	-4.43	-5.80	-3.91
Panel B: Equal-weighted portfolios							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	9.74	2.07	1.89	Low	11.08	3.85	3.77
2	9.51	1.97	1.85	2	8.97	1.29	1.24
3	7.66	-0.93	-0.97	3	8.72	0.99	0.97
4	6.04	-2.25	-2.89	4	7.03	-1.15	-1.32
High	3.92	-4.52	-4.51	High	7.25	-1.36	-1.09
High-Low	-5.82	-6.59	-5.66	High-Low	-3.83	-5.21	-3.69

Table OA.5: Monthly portfolio sorts: Customers and Firms

This table reports results for monthly portfolio sorts based on options disagreement measure that includes the trading volume of both customers and firms. Results are reported separately for all stocks (left panels) and for the subsample of the 500 largest stocks (right panels). Panel A reports results for value-weighted portfolios, and Panel B reports results for equal-weighted returns. All returns are annualized. Portfolio alphas are evaluated using a four-factor Fama-French-Carhart model and Newey-West *t*-statistics with three lags. The sample period is from January 2005 to December 2018.

	All stocks				**500 largest stocks**		
Panel A: Value-weighted portfolios							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	9.93	2.39	2.70	Low	9.13	1.90	1.77
2	8.68	0.88	1.09	2	8.08	0.83	0.78
3	8.14	0.24	0.25	3	8.39	1.30	1.21
4	7.65	0.20	0.28	4	5.64	-1.67	-2.08
High	7.00	-0.73	-1.20	High	7.89	0.07	0.07
High-Low	-2.92	-3.12	-2.39	High-Low	-1.24	-1.83	-1.00
Panel B: Equal-weighted portfolios							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	8.64	0.19	0.15	Low	10.08	2.70	2.40
2	7.86	-0.95	-0.93	2	8.28	0.76	0.83
3	6.87	-2.27	-2.49	3	9.46	1.79	1.48
4	6.39	-2.76	-3.15	4	7.53	-0.67	-0.63
High	5.48	-3.31	-2.80	High	6.73	-1.66	-1.48
High-Low	-3.16	-3.50	-2.86	High-Low	-3.35	-4.36	-3.14

Table OA.6: Monthly portfolio sorts: No written calls, no at-the money options

This table reports results for monthly portfolio sorts based on options disagreement measure that excludes at-the-money options and trades to sell calls. We define at-the-money options as those with absolute values for deltas between 0.375 and 0.625. Results are reported separately for all stocks (left panels) and for the subsample of the 500 largest stocks (right panels). Panel A reports results for value-weighted portfolios, and Panel B reports results for equal-weighted returns. All returns are annualized. Portfolio alphas are evaluated using a four-factor Fama-French-Carhart model and Newey-West *t*-statistics with three lags. The sample period is from January 2005 to December 2018.

	All stocks				500 largest stocks		
Panel A: Value-weighted portfolios							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	9.47	1.93	2.28	Low	9.82	3.34	3.86
2	8.72	1.04	1.24	2	8.98	1.87	1.77
3	9.29	1.72	2.92	3	7.48	0.47	0.58
4	7.71	0.31	0.44	4	7.10	-0.05	-0.06
High	6.61	-1.29	-1.84	High	7.28	-0.97	-1.06
High-Low	-2.86	-3.22	-2.66	High-Low	-2.53	-4.32	-2.92
Panel B: Equal-weighted portfolios							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	9.49	0.92	0.68	Low	10.66	3.79	4.47
2	8.50	-0.29	-0.28	2	9.74	2.18	2.31
3	8.11	-1.04	-0.99	3	7.90	0.29	0.23
4	6.23	-2.76	-3.11	4	6.93	-1.22	-1.25
High	3.00	-6.16	-5.82	High	6.92	-2.05	-1.63
High-Low	-6.49	-7.08	-5.22	High-Low	-3.74	-5.84	-3.87

Table OA.7: Monthly portfolio sorts: Disagreement measured using all days in a month

This table reports results for monthly portfolio sorts based on options disagreement (DisagreementSC) calculated as the volume-weighted average of daily disagreements over the whole month (rather than last 10 trading days). Results are reported separately for all stocks (left panels) and for the subsample of the 500 largest stocks (right panels). Panel A reports results for value-weighted portfolios, and Panel B reports results for equal-weighted returns. All returns are annualized. Portfolio alphas are evaluated using a four-factor Fama-French-Carhart model and Newey-West *t*-statistics with three lags. The sample period is from January 2005 to December 2018.

	All stocks				**500 largest stocks**		
Panel A: Value-weighted portfolios							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	9.48	1.71	2.10	Low	9.84	3.08	3.48
2	9.00	1.43	1.80	2	9.33	2.27	3.08
3	9.60	1.88	2.41	3	7.40	0.56	0.56
4	7.53	0.10	0.16	4	6.82	-0.43	-0.55
High	6.91	-0.91	-1.56	High	7.07	-1.05	-0.97
High-Low	-2.57	-2.62	-2.40	High-Low	-2.77	-4.13	-2.40
Panel B: Equal-weighted portfolios							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	9.45	0.90	0.69	Low	10.70	3.64	4.03
2	9.52	0.77	0.67	2	9.19	1.70	1.76
3	7.50	-1.72	-1.48	3	7.39	-0.24	-0.22
4	5.01	-4.05	-4.84	4	7.96	-0.12	-0.12
High	3.95	-5.01	-5.33	High	6.87	-2.05	-1.67
High-Low	-5.50	-5.91	-4.50	High-Low	-3.82	-5.69	-4.30

Table OA.8: Monthly portfolio sorts: Options opening volume disagreement

This table reports results for monthly portfolio sorts based on disagreement calculated from options volumes attributed solely to the opening of new positions. Results are reported separately for all stocks (left panels) and for the subsample of the 500 largest stocks (right panels). Panel A reports results for value-weighted portfolios, and Panel B reports results for equal-weighted returns. All returns are annualized. Portfolio alphas are evaluated using a four-factor Fama-French-Carhart model and Newey-West *t*-statistics with three lags. The sample period is from January 2005 to December 2018.

	All stocks				500 largest stocks		
Panel A: Value-weighted portfolios							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	9.02	1.36	1.51	Low	8.62	1.72	1.98
2	9.42	1.74	2.29	2	9.10	2.07	2.51
3	8.86	1.41	1.81	3	8.25	1.01	1.13
4	8.22	0.68	0.93	4	7.04	-0.33	-0.37
High	6.74	-1.08	-2.23	High	6.80	-1.18	-1.54
High-Low	-2.28	-2.43	-2.11	High-Low	-1.82	-2.90	-2.21
Panel B: Equal-weighted portfolios							
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	8.89	0.62	0.61	Low	9.83	2.72	3.02
2	9.57	0.91	0.87	2	8.34	0.97	1.08
3	6.81	-2.20	-2.40	3	9.08	1.30	1.08
4	7.11	-1.85	-1.85	4	7.65	-0.56	-0.63
High	4.43	-4.69	-4.51	High	8.17	-0.78	-0.58
High-Low	-4.46	-5.32	-4.75	High-Low	-1.67	-3.49	-2.53

Table OA.9: Weekly portfolio sorts (equal-weighted portfolios)

This table reports results for weekly portfolio sorts based on the options disagreement (DisagreementSC). Results are reported separately for all stocks (left panel) and for the subsample of the 500 largest stocks (right panel). Portfolio returns are equal-weighted and annualized. Portfolio alphas are evaluated using a four-factor Fama-French-Carhart model and Newey-West *t*-statistics with three lags. The sample period is from January 2005 to December 2018.

	All stocks				500 largest stocks		
	Raw Ret	Alpha	*t*-stat		Raw Ret	Alpha	*t*-stat
Low	9.68	1.12	1.01	Low	11.90	4.07	3.69
2	12.42	3.48	2.66	2	11.69	3.44	3.03
3	8.70	-0.42	-0.37	3	9.32	0.84	0.84
4	5.92	-3.21	-2.88	4	8.78	0.16	0.17
High	3.36	-5.78	-5.58	High	5.77	-3.38	-3.17
High-Low	-6.32	-6.90	-5.53	High-Low	-6.13	-7.45	-5.03

Table OA.10: Fama-MacBeth monthly return contemporaneous regressions

This table reports two-step Fama-MacBeth monthly return regressions, with the contemporaneous month's stock excess returns as the dependent variable, and *t*-statistics based on Newey-West correction with three lags. Section 3 in the paper defines all variables. DisagrementSC stands for a disagreement measure that excludes written calls. No. cross-section is the average number of stocks per month. The sample period is from January 2005 to December 2018.

	All stocks		500 largest stocks
DisagreementSC	0.0344***	0.0269***	0.0207***
	(12.35)	(9.31)	(6.09)
Directional	-0.0296***	-0.0253***	-0.0194***
	(-16.77)	(-15.29)	(-11.23)
AnalystDis	-0.0173	-0.0104	0.5685**
	(-1.26)	(-0.66)	(2.07)
StockTurn		0.0062	-0.0374***
		(1.03)	(-4.25)
MFDis		-0.3331***	-0.1053
		(-2.67)	(-0.78)
log(Size)		0.0073***	0.0048***
		(8.80)	(5.03)
BM		0.0029***	0.0010
		(2.94)	(1.21)
Ret(t-1)		-0.0179***	-0.0446***
		(-2.87)	(-5.62)
IdiosyncVol		0.1957***	0.1279***
		(9.88)	(4.73)
Mom		-0.0097***	-0.0073*
		(-2.81)	(-1.80)
OP		0.0008**	0.0007
		(2.10)	(1.01)
INV		-0.0034***	0.0007
		(-4.10)	(0.56)
ESS		7.0913***	1.0856
		(5.94)	(0.62)
SOI		0.4067***	0.2015***
		(15.36)	(11.07)
PIN		0.0984***	0.0192
		(8.69)	(1.45)
InstOwner		-0.0001	0.0154***
		(-0.04)	(4.64)
Open Interest		-0.0169***	0.0187***
		(-4.67)	(3.22)
Opt Volume		0.2791***	0.2352***
		(7.75)	(4.23)
OOI		-137.523***	-498.560***
		(-9.49)	(-13.41)
PP		-0.0166***	-0.0112***
		(-8.00)	(-3.96)
OS		-0.0013**	-0.0036***
		(-2.26)	(-4.30)
EOS		0.0754***	0.0353
		(3.70)	(1.54)
ImVol		-0.0591***	-0.0499***
		(-6.41)	(-3.43)
CP-Vol-Spread		-0.0109	0.1925***
		(-0.56)	(4.58)
Cvol		-3.1019***	-3.2019***
		(-13.16)	(-7.61)
Pvol		-1.1295***	-1.2686***
		(-5.37)	(-3.81)
Iskew		0.0652***	0.0483***
		(4.28)	(2.71)
Adj. *R*-squared	0.075	0.205	0.302
No. cross-section	1,602	956	372