Individual Investor Sentiment and Stock Returns - What Do We Learn from Warrant Traders?

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Abstract

In this paper, we propose a measure of individual investor sentiment that is derived from the market for bank-issued warrants. Due to a unique warrant transaction data set from a large discount broker we are able to calculate a daily sentiment measure and test whether individual investor sentiment is related to daily stock returns by using vector autoregressive models and Granger causality tests. Our sentiment measure should be, ex ante, the preferred measure when compared to other sentiment measures proposed in the literature that are based on the closed-end fund discount, stock market transactions, the put-call ratio or investor surveys as it circumvents problems that are associated with the measures used in prior studies. We find that there exists a mutual influence between sentiment and stock market returns, but only in the very short-run (one and two trading days). Returns have a negative influence on sentiment, while the influence of sentiment on returns is positive for the next trading day. The influence of stock market returns on sentiment is stronger than vice versa. Our results cast doubt on whether sentiment measures are useful to predict the market over horizons of more than one day. Even our improved measure is hardly able to do so. Nevertheless, sentiment measures provide evidence on how investors trade and which factors influence their expectations.

Keywords: Sentiment, Bank-issued Warrants, Covered Warrants, Individual Investors, Investor Behavior

JEL Classification Code: G1

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In this paper, we propose a measure of individual investor sentiment that is derived from the market for bank-issued warrants. Due to a unique warrant transaction data set from a large discount broker we are able to calculate a daily sentiment measure and test whether individual investor sentiment is related to daily stock returns by using vector autoregressive models and Granger causality tests. Our sentiment measure should be, ex ante, the preferred measure when compared to other sentiment measures proposed in the literature that are based on the closed-end fund discount, stock market transactions, the put-call ratio or investor surveys as it circumvents problems that are associated with the measures used in prior studies. We find that there exists a mutual influence between sentiment and stock market returns, but only in the very short-run (one and two trading days). Returns have a negative influence on sentiment, while the influence of sentiment on returns is positive for the next trading day. The influence of stock market returns on sentiment is stronger than vice versa. Our results cast doubt on whether sentiment measures are useful to predict the market over horizons of more than one day. Even our improved measure is hardly able to do so. Nevertheless, sentiment measures provide evidence on how investors trade and which factors influence their expectations.

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1 Introduction

Researchers and practitioners struggle to predict stock prices since decades. Besides fundamental and technical measures, investor sentiment indicators are increasingly important. Researchers try to precisely measure consumer sentiment (see Dominitz and Manski (2004)), sentiment measures are widely discussed in the media (see, for example, Abeter (2006) in the BusinessWeek), and stock exchanges provide sentiment measures on their home pages (see, for example, the home page of Deutsche Börse Group[1]). Furthermore, sentiment measures are used in practice as fund managers claim to base their decisions (among other things) on sentiment measures. Are investor sentiment measures useful to predict the market? There is huge empirical literature, that analyzes the mutual influence between stock returns and investor sentiment measures. Empirical studies differ in various dimensions. Most importantly, studies usually differ in the way they measure investor sentiment. This might be one reason why the evidence concerning the forecasting ability of sentiment is mixed and sentiment measures based on different data sources (e.g. questionnaires, stock transactions) yield different results. Thus, sentiment measures seem to be somehow useless in practice, in part because of the obvious weaknesses of existing measures. Our goal is to propose another sentiment measure that, ex ante, should be a better measure of investor sentiment as it circumvents some of the obvious weaknesses of the other measures mentioned above. We show that this new measure is indeed able to predict what is going on tomorrow: When individual investors are optimistic today, stock prices are going up tomorrow. However, predictive power is low and even our sentiment measure is not able to predict the future over longer horizons. As our conclusion, we argue that sentiment measures nicely capture what a specific group of investors thinks and does, but these measures are useless for asset management in practice.

[1]See http://boerse-frankfurt.com/pip/dispatch/en/pip/private_investors/aktuelles/marktsentiment (21.03.2007).

Our sentiment measure is designed as follows. Due to a unique transaction data set, we are able to propose a measure of investor sentiment that is based on the individual holdings of bank-issued warrants by private investors who are customers of a large German online broker. We compare the number of investors who hold call warrants (positive expectations about the future price of the underlying) to investors who hold put warrants (negative expectations) on an individual level and on a daily basis. This way of measuring sentiment circumvents the main drawbacks of existing measures. Individual investor sentiment measures based on stock transactions (such as in Kumar and Lee (2006)) face the problem that, due to short sale constraints, it is harder to express negative sentiment for a stock through a sale compared to expressing positive sentiment through a purchase. The decision to sell a stock that one holds in his portfolio already can have several reasons apart from the expectation that the respective stock price will decline in the future. Examples include the demand for liquidity, portfolio rebalancing, or the (irrational) reluctance to sell stocks with a loss. In contrast, the purchase of a put warrant is a clear sign that investors expect falling prices of the underlying.[2] In addition, it is difficult to calculate individual investor sentiment measures based on aggregate transaction data, for example from the option market (such as in Wang, Keswani, and Taylor (2006)), since it is impossible to disentangle individual investors' transactions from the transactions of other investor groups, such as institutional investors. Survey based sentiment measures that are analyzed for example in Solt and Statman (1988), Shiller (2000), or Brown and Cliff (2005) are confronted with the problem that investors might act differently in the market, where real money is at stake, as compared to questionnaire answers. Furthermore, Glaser, Langer, Reynders, and Weber (2007) show that stock return expectations, which are the basis for these studies, are easily influenced by the specific elicitation mode used in

[2] An obvious counterargument to this revelation of negative expectations could be that another motive for holding a put warrant might be hedging. There are several points that make it unlikely that hedging is the main focus of individual investors in the warrant market. A further discussion on this topic is provided in Section 4.3.

questionnaire studies (i.e. whether forecasters have to state future price levels or directly future returns). We argue that our sentiment measure simultaneously avoids the problems mentioned above.

After the construction of our measure, we then test whether individual investor sentiment is related to daily stock returns by using vector autoregressive models and Granger causality tests and find that there exists a mutual influence between sentiment and stock market returns in the very short-run (one to two trading days). Returns have a negative influence on individual investor sentiment, which in turn influences the return of the following day positively. This means that private warrant investors trade on negative feedback and that their expectations about the underlyings are correct in the short-run. The impact of stock market returns on sentiment is stronger than vice versa. We find no evidence for stronger influence of sentiment on small stock returns than big stock returns as it was suggested by different authors.[3] The sentiment, derived from German private investors, is a predictor for next days stock market returns in Germany but (unsurprisingly) not in the US, although both German and US stock returns influence the sentiment of the German investors.

The remainder of the paper is organized as follows. In Section 2, we start with a description of the institutional characteristics of bank-issued warrants in Germany. In Section 3, the data set and the methodology are described. Empirical results are reported and discussed in Section 4. Section 5 concludes.

[3] See e.g. Kumar and Lee (2006) and Neal and Wheatley (1998).

2 Institutional Characteristics of Bank-issued Warrants

Bank-issued warrants[4] (warrants hereafter) securitize the right, but not the obligation, to buy (call) or sell (put) a certain amount of the underlying security for a previously specified price up to (American-style warrant) or on (European-style warrant) a previously specified maturity date. The payoff structure of those warrants is the same as for plain-vanilla options, although warrants are legally obligations from the issuer directly to the owner.[5] These typical retail banking products are issued by financial institutions only and are bought predominantly by individual investors. Since short-selling (i.e. writing) warrants is impossible for individual investors, no margin accounts are required and the size of the contracts is much smaller than in the options markets. Typically, the owner of one warrant has the right to buy or sell one-tenth or one-hundredth of the underlying with this contract (expressed by the conversion ratio), resulting in a median purchase price of 1.45 Euro per warrant in our sample. Furthermore, transaction costs are close to those of stocks (median transaction costs per trade are 12.06 Euro), which makes warrants affordable for individual investors. The buying and selling procedure for the warrants is similar to that of stocks. Customers of the online broker trade these warrants within the same technical environment that they are used to from trading stocks. The only additional requirement is that you sign a form in which you confirm that you are aware of the risks associated with this kind of securities.

Bank-issued warrants are well-known securities in continental Europe, Australia and in some markets in Asia. They are less common in the UK and not existent in the US.[6]

[4]Sometimes the synonyms *covered warrants* or *third-party warrants* are used.

[5]While in the option market a clearing institution fulfills the obligations of a writer of an option who fails to fulfill his obligation, there is no such institution in the warrant market. Since all issuers in the warrant market are financial institutions this default risk should be small and have only minor price impacts.

[6]For more details on the market for bank-issued warrants, see Glaser and Schmitz (2007).

By far the largest market for warrants with regard to listed securities (see Figure 1) as well as turnover exists in Germany. In 2000, the turnover volume of warrants on German exchanges was 83.30 billion Euros, which accounted for approximately 1.5% of total exchange turnover in Germany.[7] Another indicator of the importance of warrants in the German market is the growth of the number of securities. While 100 warrants were listed in different German market places in 1990, this number rapidly increased to 4,500 at the beginning of our sample period in January 1997. At the end of our sample period (mid of April 2001), 23,500 warrants were listed in Germany, and this number grew to nearly 50,000 in December 2006. Why are there so many warrants? Unlike options, warrants are not written on demand, but are rather issued, similar to bonds, on one particular date in a quantity defined in advance. Regardless of whether all warrants are sold at the day of issuance, they can be traded anytime within their lifespan. Furthermore, an issuing institution does not normally offer only one warrant with one strike price on one underlying but rather a whole series of warrants on one underlying. The warrants in a series vary with respect to the type of the warrant (i.e. call or put), the strike price and the maturity date. Every single security that was designed in such a way is listed as a separate warrant with a separate ISIN security identifier. As a result, there is a large heterogeneity of securities in the market for bank-issued warrants.

This high degree of diversity of warrants causes some coordination problems that led to a strong market maker structure in this market. The market makers, i.e. the issuing banks, are committed to provide liquidity for their own products, because otherwise, high costs of finding a contract partner within the group of individual investors could cause a market breakdown. The issuers provide liquidity by quoting bid and ask prices for their warrants permanently. The consequence is that individual investors predominantly trade directly with the market maker. Although the issuers can vary the prices freely, including

[7] See Voirin (2001), p. 2.

the possibility to raise prices if investors' demand is high for these products, they are restricted in the maximum bid/ask-spread[8] and the minimum number of securities they are willing to buy or sell for the bid or ask price. That means that the issuers also have to buy back the warrants for the higher price, making it less attractive for the issuers to quote high prices if the demand is high.[9]

3 Data Set and Methodology

We derive our sentiment measure from a data set of daily transactions of individual investors who had accounts at a big German online broker between January 1997 and April 2001. The data set contains transaction data[10] at the individual level for different groups of securities. While research on individual investor behavior has predominantly focused on stock trades[11], we analyze individual investors transactions in the market for bank-issued warrants. Information about stock market returns and the warrants traded[12] are obtained from different data sources. Returns of the different market indexes are from Datastream. The German online broker reported the warrant information for roughly half

[8]Often, the market makers commit to quote spreads not greater than 2% of the absolute value of the warrant.

[9]Wilkens, Erner, and Röder (2003) find that for similar products which are traded on the same markets as warrants (i.e. discount certificates and reverse convertibles), prices are too high at the beginning of the lifespan of these products but convert to their fair values as they approach maturity. Their *order-flow hypothesis* states that this is due to the fact that at the beginning of the lifespan the risk that many investors sell back their warrants to the issuer is smaller than at the end of the lifespan, simply because less products are outstanding.

[10]The data set contains the account number of the individuals, the date of the transaction, the security identifier (WKN), the number of securities traded, a purchase or sale indicator, the traded price per security, the transaction costs per trade, the total transaction volume, and the currency of the security.

[11]Examples are Gervais and Odean (2001), Odean (1998), and Odean (1999). Barber, Odean, and Zheng (2005) and Brown, Goetzmann, Hiraki, Shiraishi, and Watanabe (2002) look at the transactions of individual investors in the market for mutual funds.

[12]The information consists of the type (call or put), the underlying, the strike price, the issuer, the maturity date, the style (European or American), and the conversion ratio of the warrants.

of the warrants traded. In addition to this data set, we obtained data from the Euwax[13], which provides data from November 1999 onwards, and from the Karlsruher Kapitalmarkt Datenbank (KKMDB), a capital markets research data base in Germany. The data sets from various suppliers make it possible to double-check our data. In the category "warrants", the online broker also includes structured retail products like discount certificates and reverse convertibles that are traded on the same market places as the plain-vanilla warrants. We excluded those products (3,868) which are identified as non-plain-vanilla warrants, and these (667) for which the necessary information was not available (e.g. no strike price, type etc.). In addition, we excluded all warrants with currencies (1,067), interest rates (95), and commodities (77) as underlyings. After matching the information about the transactions and the attributes of the warrants, we checked whether the reported total volume traded equals the number of warrants traded multiplied by the trade price. This was not the case in 78 transactions, which we excluded. We also excluded the 415 transactions in warrants that are not quoted in DEM or EUR. The remaining sample of plain-vanilla bank-issued warrant transactions consists of 90,342 transactions in 6,827 warrants from 1,457 investors[14] (see Table 1).

To deepen our understanding of the relationship between investors sentiment and stock market returns, we divided our data into different sub-samples. We account for the fact that there exist warrants on stock market indexes as well as single stocks. Therefore we also derived our sentiment measure for holdings in warrants on stocks and warrants on indexes separately. Although the majority of warrants in the sample have a stock as underlying (67.26%), most of the transactions are in index warrants (54.87%) (see Table

[13]The European Warrant Exchange (Euwax) was the biggest exchange for bank-issued warrants worldwide in the year 2000. More than half of all warrants worldwide are issued in Germany (see Voirin (2001), p. 4) and more than 80% of all trades in Germany were executed on the Euwax (see Euwax (2001)).

[14]887 individual investors trade index and stock warrants, 209 trade index warrants while 361 trade stock warrants only.

2). A justification for this division is that there might well be a difference in trading patterns with these warrants as one can see from Table 2. While call and put warrants on indexes are almost evenly often traded by the private investors, the vast majority of trades in warrants on single stocks are in call warrants. Additionally, indexes could not, in contrast to other underlyings, be purchased directly on the stock market during our sample period. Furthermore, potential insider information is not very likely to play a role in the investment decision in index warrants. These points make warrants on indexes especially interesting to analyze.

We further divided our sample into the region where the underlying company is from. More than 93% of all transactions are in warrants on underlyings from Germany (71%) and the US (22%). The small rest, including warrants on companies from Europe (3%, excluding Germany), Japan (4%), and other countries (<1%) were not analyzed as single categories. The third criterion for the division was whether or not the underlying of a warrant was the main index or was included in the main index in Germany (DAX) or the US (Dow Jones Industrial Average). For example, warrants directly on the Dow Jones as well as warrants on General Electric would fall into this category *main*. As one can see from Table 3, different indexes often were among the most traded underlyings. Therefore we also looked at the relationship between sentiment derived from warrants on those indexes and the respective index as the most direct test one can conduct. Unfortunately, there were less transactions in warrants on single stocks. To nevertheless be able to calculate a sentiment measure from transactions in warrants on single stocks, we aggregate all transactions from warrants on stocks within one of our categories. E.g., the category *main German underlyings (stocks only)* includes all transactions in warrants on single companies, that are included in the DAX. Altogether we end up with 16 different sentiment measures. Table 4 shows the mean and median number of investors per day in the 16 categories described above.

When we look at the sentiment measure from all underlyings we need an appropriate market return index to which we can relate the sentiment measure. We constructed a composite index in the following way: We categorized all underlyings based on the index in which they are included.[15] The weighted average of the return of those indexes is our composite index, while the weights are proportions of transactions in warrants on the underlyings from the different indexes. The same procedure was used within the "other" categories. In Germany we used returns of the Nemax and the MDAX and in the US of the Nasdaq and the S&P 500.

We constructed our sentiment indicator as follows:

$$Sent_t(u) = \frac{Opt_t(u) - Pess_t(u)}{All_t(u)} \tag{1}$$

with $All_t(u) = Opt_t(u) + Neut_t(u) + Pess_t(u)$

and $Opt_t(u) = \sum_{i=1}^{N_t} 1_{\{Call_t(u);NOPut_t(u)\},it}$

and $Neut_t(u) = \sum_{i=1}^{N_t} 1_{\{(Call_t(u);Put_t(u)) \vee (NOCall_t(u);NOPut_t(u))\},it}$

and $Pess_t(u) = \sum_{i=1}^{N_t} 1_{\{NOCall_t(u);Put_t(u)\},it}$

where $Opt_t(u)$ ($Neut_t(u)$; $Pess_t(u)$) is the number of optimistic (neutral; pessimistic) individual investors on day t derived from holdings in warrants with u meaning warrants on underlyings from the 16 categories of underlyings. It is the sum of dummy variables that indicate the N investors who hold warrants on day t. The dummy for optimists is equal to 1 if the investor i holds at least one call warrant but no put warrant ($\{Call_t(u); NOPut_t(u)\}$) on day t. For neutral investors, the dummy is 1 if he hold calls as well as puts or if he does not hold any warrants ($\{(Call_t(u); Put_t(u)) \vee (NOCall_t(u); NOPut_t(u))\}$), and it is

[15] The indexes are the DAX (main German index), the Nemax (German index for technology stocks), the MDAX (German index for mid-size companies), the Dow Jones Industrial Average (main US index), the Nasdaq 100 (US index for technology stocks), and the S&P 500 (broad US index; here excluding Dow Jones and Nasdaq 100 stocks).

1 for pessimists if an investor holds puts but no calls ($\{NOCall_t(u); Put_t(u)\}$). $All_t(u)$ is the sum of all individuals who hold the underlying u at least once during the sample period.[16] $Sent_t(u)$ is constructed as the difference of optimists minus pessimists normalized by the number of all traders in the respective period.[17] The $Sent_t(u)$ values are in the range from -1 to 1. The indicator is 1 if there are only optimists in the market and -1 if there are only pessimists. The existence of neutral investors always moves the indicator closer to 0, ceteris paribus. If the $Sent_t(u)$ is 0.5 it could, for example, mean that in that period 3 times more optimists than pessimists held warrants (no neutral investors), but it could also be that the same number of optimistic and neutral investors (no pessimists) had warrants in their portfolio. To make the sentiment indicator comparable with stock market returns and to avoid autocorrelation problems, we used the first difference of our indicators ($\Delta Sent_t(u)$) throughout our analysis.

We use different methods to investigate the relation between individual investor sentiment and stock market returns. To test whether there is a time structure in the relation, we estimate vector autoregressive (VAR) models. 10 lags are included in our daily investigation.[18] We estimate the following two regressions simultaneously:

$$\begin{aligned} M_t^a &= \alpha_1 + \sum_{i=1}^{P} \beta_{1i} M_{t-i}^a + \sum_{i=1}^{P} \delta_{1i} Sent_{t-i}(u) + \varepsilon_{1t} \\ \Delta Sent_t(u) &= \alpha_2 + \sum_{i=1}^{P} \beta_{2i} M_{t-i}^a + \sum_{i=1}^{P} \delta_{2i} Sent_{t-i}(u) + \varepsilon_{2t} \end{aligned} \tag{2}$$

where M^a is the return of the stock market for market index a ($a \epsilon \{$All; DAX; Ne-

[16] We do not report results for a volume-weighted sentiment indicator for several reasons discussed in chapter 4.4.

[17] This measure is similar to the buy-ratio of Lakonishok, Shleifer, and Vishny (1992) and is used as sentiment indicator by Dorn, Huberman, and Sengmueller (2007), but they use buy and sell transactions instead of portfolio holdings. Analogously to the buy ratio of Dorn, Huberman, and Sengmueller (2007), we also calculated a sentiment measure that compares purchases in calls (instead of stock purchases) and puts (instead of stock sales) for every investor in a specific time period. The results (unreported here) are the same with regard to the direction of influence, but we obtain less observations per day, making the results a little less reliable.

[18] Besides results from prior research, this lag length choice is motivated by the short warrant holding periods of the investors in our data set. The median holding period is 9 days.

max+MDAX; Nemax; Dow Jones; Nasdaq+S&P 500; Nasdaq; S&P 500}) and $Sent(u)$ is our sentiment measure. The βs are the coefficients for the lagged stock returns while the δs are the coefficients for the influence of the lagged sentiment indicator on the dependent variable. βs in the first equations and δs in the second equations of the VAR model in equations (2) are coefficients for autocorrelation. P is the number of lagged periods ($P = 10$) while t is the respective day.

To get closer insights into whether sentiment influences returns or returns influence sentiment we also apply Granger-causality tests.[19] The null hypothesis of this test is that all coefficients of the variables that are not lags of the dependent variable in an equations (2) type of regression are jointly zero. This would imply that there is no influence on the dependent variable. Inversely, a variable Granger-causes another if the lags of this variable help to explain the value of the dependent variable.

Three studies that are methodologically close to ours are those of Wang, Keswani, and Taylor (2006), Brown and Cliff (2004), and Dorn, Huberman, and Sengmueller (2007). The first two test various proxies for investor sentiment within a vector autoregressive (VAR) model to investigate the mutual influence between those measures and market variables like returns and volatility. Wang, Keswani, and Taylor (2006) find that sentiment, measured for example by the put-call trading volume and open interest, do not Granger-cause stock market returns (S&P 100) or stock market volatility. Similar results are provided by Brown and Cliff (2004). They first test different sentiment measures (e.g. put/call ratio, closed end fund discount, number of IPOs) and find strong contemporaneous relations between changes in these proxies and near-term stock market returns. Relying on principal component analysis, they elicit their own sentiment indicator to obtain a cleaner measure of investor sentiment. They test the mutual influence of their indicator and stock

[19]For details see Granger (1969).

market returns in a VAR model and show only limited evidence that their sentiment measure forecasts stock market returns. In contrast, they find strong evidence that returns influence the level of as well as changes in the sentiment measure. Dorn, Huberman, and Sengmueller (2007) test the forecasting power of a sentiment variable, the buy ratio[20], for stock returns with a VAR model. They find a positive relation between net trading by individuals and returns.

4 Empirical Results

4.1 Mutual influence of sentiment and stock markets: VAR regression results

In Table 5 we present the full results of one VAR model described in the previous section as an example. Here we tested the mutual influence of our Composite Index returns and changes in our sentiment measure that is based on holdings in warrants on all underlyings. The bold coefficients are those we are interested in, because they show the influence of returns on sentiment and vice versa. The other coefficients are of minor interest, but one needs to control for potential autocorrelation. We find a small amount of autocorrelation in the first lag, as also additional test of (partial-)autocorrelation exhibit.[21] Since this fact holds for all specifications of our model, for the other VAR models we only present coefficients for the lagged variables, that are not lags of the dependent variable.[22]

[20]The buy ratio is similar to the sentiment measures of Kumar and Lee (2006) and Kaniel, Saar, and Titman (2004) but uses the numbers of investors instead of the volume bought and sold. This makes the measure robust against the behavior of a few wealthy individuals.

[21]Additional tests of the all VAR models show there is no autocorrelation in the residuals of the VAR models (see Johansen (1995)) and that all eigenvalues lie inside the unit circle, meaning that the VAR models satisfy stability conditions, which is also important for the interpretation of impulse-response functions.

[22]We only report βs and δs for the first 5 lags, although the VAR model is specified with 10 lags, for the reasons of lucidity and because we found no systematic significance in higher lags.

From Panel A in Table 6 it can be seen that mutual influence is mainly present in the first two lagged periods, meaning that there exists an influence only in the very short-run. The impact from our sentiment measure derived from holdings in warrants on all underlyings on returns of our composite index is significantly positive with a lag of one period.[23] This means that, in aggregate, investors are right with their expectations, at least for the day following a change in their holdings of warrants. When we look at the influence of market returns on sentiment, we find that the influence is significantly negative for lags 1 and 2. Investors tend to open or increase their positions in call (put) warrants if the composite index declines (increases) the two days before. They engage in negative feedback trading. These results are in line with the contrarian behavior also found by other authors.[24] The R^2s are higher, which indicates that the influence of the returns on sentiment is stronger than it is the other way around. This effect was found by most of the other empirical studies on the comovement of sentiment and stock returns as well.[25] The orthogonalized impulse-response functions in Figure 2 and Figure 3 confirm our findings graphically. An increase in the orthogonalized shock to the returns of the composite index causes a decrease in the changes in sentiment in the following periods, but these changes rapidly fall back to a level near zero (see Figure 2). The opposite is true for increases in the sentiment shocks. The cause a strong decrease of the composite returns in the next period, before reverting to zero and slightly below (see Figure 3).

When we split our sample into warrants on indexes and warrants on single stocks, we find a similar picture (see Table 6, Panel B.). For the relation between the returns of the composite index and the sentiment measure derived from holdings in warrants on indexes, the results are similar. The R^2 for the influence on sentiment is sightly higher. If

[23]Dorn, Huberman, and Sengmueller (2007) and Qui and Welch (2004) find similar results.

[24]See e.g. Kaniel, Saar, and Titman (2004).

[25]See Brown and Cliff (2004), Otoo (1999), Solt and Statman (1988), and Wang, Keswani, and Taylor (2006).

holdings in warrants on single stocks are considered the positive one period influence of sentiment on returns is also existent. But in contrast to former results, the returns of the composite index does not seem to have influence on private investors sentiment. This fact could be explained by the attention indexes receive in the media. Important TV-news and newspapers regularly report changes in the main indexes but rarely price changes in single company stocks. Much more attention is drawn to index returns and attention increases trading activity from private investors.[26]

The results from the VAR models with further partitions of our data into the sub-samples, described in Section 3, are shown in Table 7. For the category *main German underlyings* (see Panel A of Table 7), which includes warrants on the DAX and warrants on different stocks included in the DAX, the above mentioned results hold as well. There is negative influence from DAX returns on changes in the sentiment measures for two trading days, which is stronger, measured by the R^2s, than the positive influence of sentiment on returns the next trading day. We also find a stronger mutual correlation for the sentiment measure derived from holdings in index warrants, than for single stock warrants and the DAX returns.

Panel B of Table 7 reveals that a mutual dependency does not exist for warrants on stocks of smaller, more technology oriented companies. This finding does not coincide with the conventional wisdom that individual investors have a stronger impact on small stock returns, at least if company size is a proxy for the ratio of institutional to private holdings of the shares in that company and thus for the influence of individual investors on the stock price.

For US underlyings (see Panel C and D of Table 7) we find an even longer lasting negative influence from stock market returns on investor sentiment of three periods. But by looking

[26]See Barber and Odean (2007).

at the coefficients, we find weaker effects than in the category for main German underlyings. Not only the coefficients are smaller, but returns also explain less of the variation of the sentiment. The weakest relation can be found between returns and sentiment measures based on warrants on single stocks. In contrast to the sentiment based on German underlyings, the sentiment derived from warrants on US indexes and stocks is not able to forecast index returns. Since we are looking at private investors at a German discount broker, this result is not surprising. The movements of the most important indexes in the world (Dow Jones, S&P 500, Nasdaq) might well influence expectations of German investors, but it is very unlikely that those investors have an influence on the returns of these indexes.

4.2 Mutual influence of sentiment and stock markets: Granger-causality tests

To gain further insights into the direction and the strength of the relationship between individual investor sentiment and market returns we apply Granger-causality tests for the first two lags of both variables in all specifications.[27] Tables 8 and 9 confirm the results from Section 4.1. When all underlyings are considered, the hypothesis that composite returns do not have an influence on sentiment can be rejected at lower p-values as the hypothesis that sentiment has no influence on returns. In addition, the coefficients are much higher. But in both directions of the influence, the null hypothesis can be rejected at a 1% significance level, meaning that there exists a mutual influence for one and two lags.

[27] We did not optimize the lag length by using information criteria because we wanted to investigate the influence on the following two trading days and obtain better comparable results across all categories. Different information criteria (Akaike's IC, Schwarz's IC, and Hannan and Quinn IC) show that the modal optimal lag length is two lags for two of the three information criteria. Only the Hannan and Quinn information criterion shows an optimal lag length of one period for most of the model specifications.

The results from the division in warrants on indexes and warrants on single stocks (see Panel B of Table 8) are also in line with the results stated above. For the index category, we find similar mutual dependencies between returns and sentiment as for all underlyings, while there only exists a weak influence of sentiment on returns and non the other way around, for sentiment measures on a single stock basis. For the subcategories, shown in Table 9, the VAR results are also confirmed. We find mutual influence in the main German underlyings category (see Panel A), no influence with other German underlyings (see Panel B), and influence from returns on sentiment but not the other way round for all US underlyings (see Panel C and D). The correlations between sentiment from single stocks and market returns are always lower as when sentiment is measured by holdings of index warrants.

4.3 Discussion

Taking all results together, we find that there is a mutual influence of sentiment, measured as holdings of warrants, and stock market returns in the very short-run. Since warrants are held for a very short time period (median holding period is 9 days for all warrants), it is not surprising that there only exists influence in the days surrounding a change in the holdings. An additional result is that the statistical influence of market returns on sentiment is stronger than vice versa. This is also not surprising, because the main indices receive a lot of attention and thus may strongly influence beliefs of individual investors about future stock prices. However, since private investors usually only hold a small portion of the shares outstanding of listed companies, their influence on prices (in comparison to institutional investors) might also be small. Theory suggests that the influence of individuals is greater if they hold relatively more shares in a company. When this amount is approximated by the size of the companies, we cannot confirm this prediction in our data set.

Recent related studies show that past market returns have a strong influence on trading activity. Glaser and Weber (2005) show that the effect of past market returns on subsequent trading volume of individual investors is stronger than that of own past realized portfolio returns. Statman, Thorley, and Vorkink (2006) find that "not only does that impact of past market returns on a typical security's trading activity survive the inclusion of lagged security returns in the same regression, it appears that the lagged market return impact is actually larger"[28]. Nicolosi, Peng, and Zhu (2003) also find in their regressions that the impact of past market returns on stock purchases is stronger than the effect of past portfolio returns.[29] All these studies have in common that past returns that are highly visible to investors affect behavior more than returns that are less visible or that have to be calculated by investors themselves, such as own past realized portfolio returns or the returns of some individual stocks.

For our sentiment measure we assume that the holding of a put warrant is the revelation of negative expectation for the underlying. A common opinion is, that people also might use put warrants to hedge their stock positions in the portfolio and thus it might not be the expectation of these investors that we measure. But several points show, that hedging is not the main motive for individual investors to hold put warrants. The first is that the median holding period for all warrants in our data set is only 9 days and even less (6 days) for put warrants. Another point is that only 8% of all transactions in warrants on individual stocks are in put warrants, and for warrants on indexes, where 43% were

[28]Statman, Thorley, and Vorkink (2006), p. 22.

[29]See Nicolosi, Peng, and Zhu (2003), Table 2.

put warrants[30], a direct hedge[31] was not possible, since private investors were not able to replicate an index in their portfolio. In addition, by looking at the stock portfolios of the investors we find that only 87 put purchases (0.66% of all put purchases) were committed when the investor holds the underlying of the put warrant in his portfolio. In a survey of a weekly investor magazine and a German discount broker, 4,345 individual investors were asked for their motives to trade warrants. Only 8% stated that hedging was their main motive to buy warrants.[32] In addition, Bartram and Fehle (2004) compare bid-ask spreads of similar derivatives on the German warrant and option markets and find that prices are higher but spreads are smaller in the market for bank-issued warrants. They conclude that it is more likely that hedgers (i.e. institutional investors) trade on the option while speculators (i.e. individuals) trade on the warrant market.[33] Altogether, we argue that hedging only plays a minor role, if any at all, in the market for bank-issued warrants. And even if investors buy warrants to hedge their long-term investment in the underlying with a put in the short-run, this means nothing else than that they see an increased probability of a decline in the price of the underlying in the short-run. This is a change in their short-term sentiment.

4.4 Robustness

To see whether our results are also valid for sub-samples we conducted some robustness checks. We divided the sample into different periods and repeated the VAR analysis as

[30]See Table 2. Lakonishok, Lee, Pearson, and Poteshmann (2007) find similar results for the US option market. They show that only a small part of non-market-maker trading volume to open an option position is in purchased puts. They conclude that protective put strategies, often cited in option textbooks, are not an important strategy for private investors.

[31]"Direct hedge" means holding the underlying and a put on the same underlying.

[32]See Klotz (2004), p. 16.

[33]In a follow-up paper Bartram and Fehle (2007) they show that product competition in the two markets reduce the bid-ask spreads of warrant and options but spreads in the warrant market remain smaller.

well as the granger causality tests (see Table 10). First, the sample was separated into a rising and a declining stock market. The bullish market period lasted from the beginning of our sample until March 7th, 2000, when the DAX reached its high with 8,064.97 points at that day's closing bell. The bearish market started the next day and lasted up to the end of our sample. We additionally subdivided the sample into single years. The analysis shows that the results were qualitatively similar in all periods with regard to direction of the influence. The influence of returns on sentiment for all underlyings (see Panel A in Table 10) is highly significant in every sub-period, but much stronger in the upward moving market. The influence of sentiment on returns is only significant in the bull market, meaning that the hypothesis that two lagged variables of sentiment jointly do not cause composite returns cannot be rejected at conventional significance levels. The same patterns hold for the sentiment measure from index warrants. For the sentiment measure based on single stock warrants, we find a low causal relationship in both directions in the bull market and non in the downward moving market. All together, we find stronger results in upward moving stock markets.

The specification of our sentiment measure, as shown in Equation 1, might be another factor that is driving our results. We tested our models with two other specifications of our sentiment measure. First, we changed the definition of the neutral investor. In the new specification the dummy for the neutral investor becomes one, only if the investor holds call and put warrants at the same time. Thus we only consider investors that are invested in warrants on the particular day in time. The second alternative in the calculation of our measure is, that we defined the difference of optimists and pessimists as our sentiment indicator. We chose this measure to investigate whether the absolute number of investors is an important factor in our analysis. The following simple example should support this argument. While our original measure would have the same value if there are 2 optimists and 1 pessimist or if there are 200 optimists and 100 pessimists in the market, the alternative measure would indicate more positive sentiment in the latter case. But the alternative would yield the same sentiment if there are 2 and 1 or if there are 200 and 199 optimists and pessimists. The VAR models with these two alternative specifications of our sentiment measure show similar results.

Since our sentiment measure is censored between -1 and 1 we also applied a Tobit regression model of the type

$$\Delta Sent_t(u) = \alpha + \sum_{i=1}^{10} \beta_i M_{t-i}^a + \sum_{i=1}^{10} \delta_i Sent_{t-i}(u) + \varepsilon_t \tag{3}$$

to test whether the censoring of the dependent variable has an effect on the results. The results from the Tobit regression replicate the results concerning the influence from returns on sentiment from the VAR models closely.

Another concern about the robustness of our results is that only a few traders could drive the results in our study. By looking at the maximum trades per account in Table 1, one can see that there is at least one person that traded more than twice per day, on average. However, in our measure, these intra-day traders could account for only one data point per day because we are comparing the number of traders and not the volume they trade. That makes our measure less sensitive to the behavior of a few wealthy traders.[34] In addition, investors are classified as neutral if they hold call and put warrants in one period, which is more likely for investors who trade a lot. Since there are on average 531 people for all warrants classified as positive or negative investors (see Table 4), these intra-day traders should only play a minor role. To be sure that this is true, we excluded all those traders who trade on average more than once per day. There were 11 traders in that category, accounting for 15,009 transactions which we excluded. The results remained almost unchanged.

[34] Dorn, Huberman, and Sengmueller (2007) specified their buy-ratio in a similar way (number of traders) while others, Kaniel, Saar, and Titman (2004) and Kumar and Lee (2006) among them, used a volume buy-ratio.

We argue that the better measure to infer investor sentiment is to look at the number of optimists and pessimists in the market, because the way we specified our sentiment measure is robust against this behavior of a few wealthy individuals.[35] Obviously, a test to get further insights, whether a few wealthy people could change the results is to look at a volume-weighted sentiment measure. The average trading volume per trade and investor is positively skewed (median: 1,659; mean: 2,687; STD: 3,659; skewness: 5.76), implying that there are some traders who trade high volume per trade but many who trade small volumes. Unfortunately, we are not able to test a volume weighted sentiment measure analogously to our measure, because we do not have the prices for the warrants on days where no transaction took place in the warrant, implying that we do not know the market values of the warrant positions during the holding periods. We addressed this issue in the two following ways: First, we assumed, that the Euro amount invested at the purchase date of the warrant is the fixed invested amount throughout the whole holding period. With this procedure we get qualitatively similar but much less significant results. We secondly test a volume-weighted sentiment measure that is not based on holdings in warrants but on the volume differences in purchases of call and put warrants. Since we are considering only purchases in those securities, we also avoid the problems related to different motives of selling decisions (see Section 3) but obtain much less observations per trading day. The results from this analysis for all warrants as underlyings show qualitatively similar results as those reported for our main VAR models. Both volume-based sentiment measures have weaknesses that are severe enough to put not too much emphasis on the results. That is why we do not report the results in detail here.

[35] See Dorn, Huberman, and Sengmueller (2007), p. 10.

5 Conclusions

Several sentiment indicators have been proposed and investigated over the last 10 to 15 years. Overall, the empirical evidence for an influence of these sentiment indicators on stock market returns and vice versa is mixed. Some authors find a significant influence, others do not. In this paper we propose a measure of investor sentiment which is based on the holdings of bank-issued warrants by individual investors. Our findings contribute to the ongoing research in the sentiment literature as well as the literature on the behavior of individuals in financial markets. Additionally, we are (to our best knowledge) the first who empirically analyze investor behavior in the warrant market.[36]

We test the mutual relationship of our sentiment measure with stock market returns in a VAR model and with Granger-causality test. We find that there exists such a relationship, but only in the very short-run (one to two trading days). The influence of stock market returns on sentiment is negative and stronger than the influence of sentiment on returns.

Although we used a sentiment measure that ex ante should measure individual investor sentiment more precisely than other existing measures, we only find a very short-term influence on stock returns. That makes sentiment a tool of doubtful use for asset management in practice, because normally asset managers have much longer investment horizons, but only investors with a very short investment horizon might use the sentiment measure outlined in this study for their investment decisions. Nevertheless, our sentiment measure provides evidence on how investors trade and which factors influence their expectations.

[36]Lakonishok, Lee, Pearson, and Poteshmann (2007) demonstrate stylized facts of the trading behavior in the US option market at a more aggregated level. Many of the facts reported can be found in our data as well. In addition we are able to look at the trading behavior of private investors at an individual portfolio level.

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Table 1: Online Investors' Warrant Transactions

Observations as well as transactions per account and transactions per warrant are numbers, the other figures are in EUR. Panel A shows summary statistics of all 103,904 transactions in 8,066 warrants by 1,499 investors. In Panel B, the transaction data is divided into purchases and sales, while Panel C shows a further division into the four warrant transaction categories. There are more purchases than sales because investors tend to build positions in a warrant in more transactions with a smaller number of warrants. The same position of a warrant is sold in fewer transactions with a higher number of warrants sold at the same time.

	obs.	mean	std.dev.	median	min.	max.
Panel A						
all transactions						
transactions per account	1,457	62.0	160.9	18	1	2,243
transactions per warrant	6,827	13.2	31.5	4	1	620
transaction costs per transaction	90,342	19.2	21.8	12.2	0	645.3
Panel B						
purchases						
volume per transaction	49,619	4,635.7	11,303.6	1,885.8	5.4	511,937.1
sales						
volume per transaction	40,723	5,549.2	12,777.1	2,136.3	0	295,914.5
Panel C						
call purchases						
volume per transaction	36,523	4,664.6	11,254.9	1,863.8	5.4	281,813.5
call sales						
volume per transaction	29,350	5,767.0	13,095.5	2,190.5	0	237,130.4
put purchases						
volume per transaction	13,096	4,555.0	11,438.4	1,943.2	9.0	511,937.1
put sales						
volume per transaction	11,373	4,987.0	11,898.2	2,010.9	0	295,914.5

Table 2: Number and Transactions of Call and Put Warrants

This Table shows the number of warrants traded (Panel A) as well as the transactions in call and put warrants (Panel B) on all underlyings and separately for warrants on indexes and stocks. The last rows of Panels A and B present percentage of put warrants traded and percentage of transactions in put warrants, respectively.

	all warrants	index warrants		stock warrants	
	frequency	frequency	percent	frequency	percent
Panel A					
number of warrants	6,827	2,235	32.74%	4,592	67.26%
number of calls	5,472	1,269	23.19%	4,203	76.81%
number of puts	1,355	966	71.29%	389	28.71%
% of put warrants	19.85%	43.22%		8.47%	
Panel B					
transactions	90,342	49,570	54.87%	40,772	45.13%
call transactions	65,873	27,399	41.59%	38,474	58.41%
put transactions	24,469	22,171	90.61%	2,298	9.39%
% of put transactions	27.08%	44.73%		5.64%	

Table 3: The Ten Most Traded Underlyings (397 Underlyings Overall)

When counting the most traded underlings, we summed all transactions in different warrants on that underlying. The column *warrants* shows how many different warrants of a particular underlying were traded during the observation period. The column *transactions* shows how many transactions took place within warrants on that underlying. The underlings in the table are ranked by the number of transactions.

	warrants		transactions	
underlying	frequency	percent	frequency	percent
DAX 30	1,212	17.75	36,734	40.66
S&P 500	173	2.01	3,150	3.47
Commerzbank	238	3.49	2,689	2.98
Dow Jones 30	134	1.96	2,355	2.61
Nasdaq 100	170	2.49	2,282	2.53
SAP	178	2.61	1,804	2.00
Nikkei 225	129	1.89	1,634	1.81
Deutsche Bank	142	2.08	1,612	1.78
Volkswagen	129	1.89	1,491	1.65
Nemax 50	184	2.70	1,415	1.57
total	2,689	39.39	55,166	61.06

Table 4: Classified Warrant Holders Per Trading Day

Optimists (*Pessimists*) is the number of investors per trading day, who hold call (put) warrants only. *Neutrals* are those investors, who hold call and put warrants at the same time or none of them. Means and median are reported. *Investors* shows the total number of investors, who hold a warrant at least once in our observation period. Intraday transactions were excluded. In the column *Underlyings* one finds the different categories of the underlyings. They are sorted and combined by three criteria: Type of the underling (stock market index or stock), main (included or not included in the main market index), and origin (all, German or US). For small US firms, there exist two indexes (Nasdaq and S&P 500), that were important underlyings for the traded warrant (see Table 3). We show them separately here. The Composite Index is a weighted average of the returns of the Indexes DAX, MDAX, Nemax, Dow Jones, Nasdaq, and S&P 500. The weights are determined by the portion of transactions in warrants with these indexes or stocks from these indexes as underlyings.

		Optimists		Pessimists		Neutrals	
Underlying	Investors	mean	median	mean	median	mean	median
Panel A							
All Underlyings (Indexes and Stocks)	1,455	453.57	441	92.94	90	908.49	911.5
All Underlyings (Composite Index only)	1,093	169.69	161	114.85	108	808.45	804
All Underlyings (Stocks only)	1,245	425.96	404	17.96	18	801.08	821
Panel B							
Main German Underlyings (Index and Stocks)	1,294	338.86	353	81.40	76	873.75	862
Main German Underlyings (DAX only)	944	115.06	114	91.51	83	737.43	738
Main German Underlyings (Stocks only)	1,058	295.76	298	13.87	13	748.36	744
Panel C							
Other German Underlyings (Indexes and Stocks)	694	117.67	99	6.29	4	570.04	593
Other German Underlyings (Nemax only)	204	11.18	3	5.67	2	187.16	199
Other German Underlyings (Stocks only)	624	111.89	98	2.43	2	509.68	525
Panel D							
Main US Underlyings (Index and Stocks)	531	46.70	45	37.81	33	446.49	440
Main US Underlyings (Dow Jones only)	250	9.96	9	17.75	15	222.28	221
Main US Underlyings (Stocks only)	415	39.63	39	23.59	22	351.79	349
Panel E							
Other US Underlyings (Indexes and Stocks)	698	128.14	105	15.26	15	554.60	575
Other US Underlyings (Nasdaq only)	195	12.14	3	9.16	7	173.70	185
Other US Underlyings (S&P 500 only)	258	7.12	7	23.42	21	227.46	228
Other US Underlyings (Stocks only)	633	123.19	102	8.57	8	501.24	519

Table 5: Example for Results of one Vector Autoregressive Model

The reported βs, δs, and p-values are from the VAR model with 10 lags. The dependent variables are the DAX returns and changes in our sentiment indicator, that is based on holdings in warrants on all underlyings.

$$M_t^a = \alpha_1 + \sum_{i=1}^{P} \beta_{1i} M_{t-i}^a + \sum_{i=1}^{P} \delta_{1i} \Delta Sent_{t-i}(u) + \varepsilon_{1t}$$
$$\Delta Sent_t(u) = \alpha_2 + \sum_{i=1}^{P} \beta_{2i} M_{t-i}^a + \sum_{i=1}^{P} \delta_{2i} \Delta Sent_{t-i}(u) + \varepsilon_{2t}$$

The bold coefficients show the influence of the lagged value of one indicator on the other indicator. The other coefficients show potential autocorrelation. The Composite Index is a weighted average of the returns of the Indexes DAX, MDAX, Nemax, Dow Jones, Nasdaq, and S&P 500. The weights are determined by the portion of transactions in warrants with these indexes or stocks from theses indexes as underlyings. *** (**, *) indicates significance on the 1% (5%, 10%) level.

	Dependent variable			
	Composite index return		ΔSent(All)	
	Coefficient	p-value	Coefficient	p-value
Composite returns				
$\beta_{\bullet 1}$	0.114	(0.000)***	**-0.069**	(0.000)***
$\beta_{\bullet 2}$	-0.035	(0.284)	**-0.032**	(0.000)***
$\beta_{\bullet 3}$	-0.009	(0.793)	**-0.009**	(0.246)
$\beta_{\bullet 4}$	0.019	(0.567)	**0.004**	(0.582)
$\beta_{\bullet 5}$	-0.010	(0.762)	**0.004**	(0.660)
$\beta_{\bullet 6}$	-0.043	(0.190)	**0.006**	(0.469)
$\beta_{\bullet 7}$	-0.060	(0.071)*	**0.004**	(0.603)
$\beta_{\bullet 8}$	-0.003	(0.925)	**0.008**	(0.347)
$\beta_{\bullet 9}$	0.031	(0.355)	**0.004**	(0.594)
$\beta_{\bullet 10}$	0.047	(0.140)	**0.001**	(0.914)
ΔSent(All)				
$\delta_{\bullet 1}$	**0.418**	(0.001)***	0.079	(0.012)**
$\delta_{\bullet 2}$	**-0.100**	(0.435)	0.050	(0.109)
$\delta_{\bullet 3}$	**-0.109**	(0.395)	0.031	(0.327)
$\delta_{\bullet 4}$	**-0.149**	(0.227)	0.041	(0.195)
$\delta_{\bullet 5}$	**-0.154**	(0.232)	0.013	(0.682)
$\delta_{\bullet 6}$	**0.025**	(0.847)	-0.027	(0.393)
$\delta_{\bullet 7}$	**-0.112**	(0.383)	0.013	(0.680)
$\delta_{\bullet 8}$	**-0.014**	(0.913)	-0.007	(0.834)
$\delta_{\bullet 9}$	**-0.096**	(0.449)	0.008	(0.790)
$\delta_{\bullet 10}$	**0.037**	(0.760)	0.047	(0.114)
Constant	0.001	(0.074)*	0.000	(0.018)**
R^2	0.0405		0.1271	

Table 6: Vector Autoregressive Model Results

The reported βs, δs, and p-values are from the VAR model with 10 lags. The dependent variables are the market index returns and the change in our sentiment indicator.

$$M_t^a = \alpha_1 + \sum_{i=1}^{P} \beta_{1i} M_{t-i}^a + \sum_{i=1}^{P} \delta_{1i} Sent_{t-i}(u) + \varepsilon_{1t}$$
$$\Delta Sent_t(u) = \alpha_2 + \sum_{i=1}^{P} \beta_{2i} M_{t-i}^a + \sum_{i=1}^{P} \delta_{2i} Sent_{t-i}(u) + \varepsilon_{2t}$$

We only report βs and δs for the first five lags for the reason of lucidity. For the same reasons we do not report coefficients for the variables that are lags of the dependent variable. The first two columns specify the combination of the different sentiment measures with the two market return indicators on which the mutual influence is measured by the VAR model. Obs. are the numbers of warrant transactions on which the sentiment measure is based. 6,562 intraday transactions were excluded. The Composite Index is a weighted average of the returns of the Indexes DAX, MDAX, Nemax, Dow Jones, Nasdaq, and S&P 500. The weights are determined by the portion of transactions in warrants with these indexes or stocks from theses indexes as underlyings. *** (**, *) indicates significance on the 1% (5%, 10%) level.

			Influence Returns on Sentiment							Influence Sentiment on Returns						
Sentiment	Returns	obs.	β_{21}	β_{22}	β_{23}	β_{24}	β_{25}	const.	R^2	δ_{11}	δ_{12}	δ_{13}	δ_{14}	δ_{15}	const.	R^2
Panel A																
All Warrants	Composite Index	84,332	-0.0693	-0.0318	-0.0094	0.0045	0.0036	0.0003	0.1271	0.4183	-0.1002	-0.1091	-0.1486	-0.1535	0.0008	0.0405
			0.000***	0.000***	0.246	0.582	0.660	0.018**		0.001***	0.4346	0.3952	0.2471	0.2320	0.074*	
Panel B																
Index Warrants	Composite Index	44,663	-0.1007	-0.0350	-0.0136	0.0077	-0.0114	0.0002	0.1666	0.2837	0.0126	-0.0720	-0.0237	-0.2492	0.0008	0.0412
			0.000***	0.001***	0.181	0.446	0.263	0.128		0.006***	0.904	0.488	0.820	0.016	0.068*	
Stock Warrants	Composite Index	39,669	-0.0067	-0.0105	-0.0001	-0.0033	0.0046	0.0003	0.0187	0.4050	-0.1722	-0.1957	-0.3356	0.0464	0.0008	0.0372
			0.2269	0.058*	0.979	0.550	0.407	0.002***		0.022**	0.332	0.271	0.059	0.794	0.092	

Table 7: Vector Autoregressive Model Results - Detailed

The reported βs, δs, and p-values are from the VAR model with 10 lags. The dependent variables are the market index returns and the change in our sentiment indicator. We only report βs and δs for the first five lags for the reason of lucidity. For the same reasons we do not report coefficients for the variables that are lags of the dependent variable. The first two columns specify the combination of the different sentiment measures with the market return indicators on which the mutual influence is measured by the VAR model. In the column *Sentiment* one finds the different categories of the underlyings on which our sentiment measure is based. They are sorted and combined by three criteria: Type of the underlying (stock market index or stock), main (included or not included in the main market index), and origin (all, German or US). For small US firms, there exist two indexes (Nasdaq and S&P 500), that were important underlyings for the traded warrant (see Table 3). We show them separately here. Obs. is the numbers of warrant transactions on which the sentiment measure is based. 6,562 intraday transactions were excluded. *** (**, *) indicates significance on the 1% (5%, 10%) level.

			Influence Returns on Sentiment							Influence Sentiment on Returns						
Sentiment	Returns	obs.	β_{21}	β_{22}	β_{23}	β_{24}	β_{25}	const.	R^2	δ_{11}	δ_{12}	δ_{13}	δ_{14}	δ_{15}	const.	R^2
Panel A																
Main German Underlyings	DAX	52,741	-0.0695	-0.0456	-0.0071	-0.0013	0.0011	0.0002	0.1462	0.6107	-0.1366	-0.0915	-0.2530	-0.0772	0.0009	0.0429
(Index and Stocks)			0.00***	0.00***	0.38	0.87	0.89	0.01**		0.00***	0.30	0.49	0.06*	0.56	0.06*	
Main German Underlyings	DAX	32,812	-0.0960	-0.0531	-0.0094	-0.0014	-0.0070	0.0002	0.1576	0.4542	0.0410	-0.0697	-0.1236	-0.2758	0.0009	0.0447
(DAX only)			0.00***	0.00***	0.36	0.89	0.50	0.31		0.00***	0.70	0.51	0.24	0.01***	0.06*	
Main German Underlyings	DAX	19,929	-0.0148	-0.0118	-0.0010	-0.0026	0.0048	0.0002	0.0404	0.3758	-0.5000	-0.0424	-0.3749	0.3114	0.0009	0.0300
(Stocks only)			0.00***	0.02**	0.83	0.60	0.32	0.04**		0.05*	0.01***	0.83	0.05*	0.11	0.07	
Panel B																
Other German Underlyings	Nemax,	6,456	-0.0037	-0.0034	-0.0003	0.0014	0.0013	0.0002	0.0169	0.3799	-0.0319	-0.2065	0.2564	-0.2297	0.0010	0.0383
(Indexes and Stocks)	MDAX		0.21	0.25	0.92	0.65	0.67	0.01***		0.25	0.92	0.53	0.44	0.48	0.23	
Other German Underlyings	Nemax	1,291	-0.0171	-0.0054	-0.0037	-0.0037	-0.0052	0.0003	0.0977	0.1105	-0.4755	-0.2546	0.0451	-0.0400	0.0014	0.0423
(Nemax only)			0.00**	0.30	0.48	0.48	0.33	0.02**		0.56	0.01**	0.19	0.82	0.84	0.12	
Other German Underlyings	Nemax,	5,165	0.0017	-0.0034	0.0008	0.0030	0.0018	0.0002	0.0221	0.1357	0.5074	-0.1962	0.0512	-0.1061	0.0009	0.0438
(Stocks only)	MDAX		0.57	0.26	0.78	0.32	0.55	0.04**		0.68	0.12	0.55	0.88	0.74	0.28	
Panel C																
Main US Underlyings	Dow Jones	6,408	-0.0395	-0.0212	-0.0219	-0.0165	0.0121	0.0001	0.0575	-0.0461	-0.0073	0.0208	-0.0234	0.0334	0.0005	0.0169
(Index and Stocks)			0.00***	0.02**	0.02**	0.07*	0.19	0.57		0.66	0.94	0.84	0.82	0.75	0.19	
Main US Underlyings	Dow Jones	2,135	-0.0454	-0.0153	-0.0199	-0.0014	0.0076	0.0000	0.0400	-0.0317	-0.1141	0.0128	0.0463	-0.0196	0.0005	0.0173
(Dow Jones only)			0.00**	0.20	0.09*	0.90	0.52	0.97		0.69	0.15	0.87	0.56	0.81	0.18	
Main US Underlyings	Dow Jones	4,273	-0.0246	-0.0182	-0.0201	-0.0198	0.0100	0.0001	0.0416	-0.0307	0.1123	0.0013	-0.0920	0.0951	0.0005	0.0183
(Stocks only)			0.01***	0.05*	0.03**	0.04**	0.30	0.42		0.76	0.26	0.99	0.36	0.34	0.18	
Panel D																
Other US Underlyings	Nasdaq,	11,739	-0.0176	-0.0090	-0.0089	-0.0013	0.0001	0.0003	0.0505	0.2654	-0.0835	-0.0962	-0.2742	-0.1300	0.0015	0.0276
(Indexes and Stocks)	S&P 500		0.00***	0.01**	0.01**	0.72	0.99	0.00***		0.32	0.76	0.72	0.31	0.63	0.08*	
Other US Underlyings	Nasdaq	1,977	-0.0262	-0.0140	-0.0134	-0.0053	-0.0095	0.0004	0.0714	0.0458	-0.0563	-0.3871	0.0279	-0.0001	0.0017	0.0471
(Nasdaq only)			0.00***	0.01**	0.02**	0.35	0.09*	0.01**		0.79	0.74	0.02**	0.87	0.99	0.04**	
Other US Underlyings	S&P 500	2,882	-0.0219	-0.0241	-0.0232	-0.0106	-0.0059	0.0001	0.0352	0.0032	0.1902	0.0137	-0.1157	-0.0050	0.0006	0.0275
(S&P 500 only)			0.07*	0.05**	0.06*	0.38	0.63	0.74		0.97	0.01**	0.86	0.14	0.95	0.14	
Other US Underlyings	Nasdaq,	6,880	-0.0140	-0.0089	-0.0056	0.0005	0.0008	0.0004	0.0423	0.1209	-0.1447	-0.1025	-0.4597	-0.0302	0.0015	0.0291
(Stocks only)	S&P 500		0.00***	0.01**	0.12	0.90	0.83	0.00***		0.65	0.59	0.70	0.09*	0.91	0.09*	

Table 8: Granger-causality Tests

This table reports the χ^2-statistics of the Granger-causality test between our sentiment measures and stock market returns. Column 1 indicates which warrants are used to calculate the sentiment measure. Column 2 shows the direction of the influence. Columns 3 and 5 report the χ^2-statistic and Columns 4 and 6 the respective p-values. The tested hypothesis is that the indicator named first in the column "Direction of Influence" does not influence the indicator named after the arrow.

		One Lag		Two Lags	
Underlyings	Direction of Influence	χ^2	p-value	χ^2	p-value
Panel A					
All	Sent → Composite	12.71	0.0004	10.32	0.0057
	Composite → Sent	87.24	0.0000	110.05	0.0000
Panel B					
Indexes	Sent → Composite	10.35	0.0013	7.04	0.0296
	Composite → Sent	114.96	0.0000	134.65	0.0000
Stocks	Sent → Composite	4.87	0.0274	5.57	0.0617
	Composite → Sent	1.97	0.1603	5.99	0.0499

Table 9: Granger-causality Tests for the different Categories

This table reports the χ^2-statistics of the Granger-causality test between our sentiment measures and stock market returns. Column 1 indicates which warrants are used to calculate the sentiment measure. Column 2 shows the direction of the influence. Columns 3 and 5 report the χ^2-statistic and Columns 4 and 6 the respective p-values. The tested hypothesis is that the indicator named first in the column "Direction of Influence" does not influence the indicator named after the arrow.

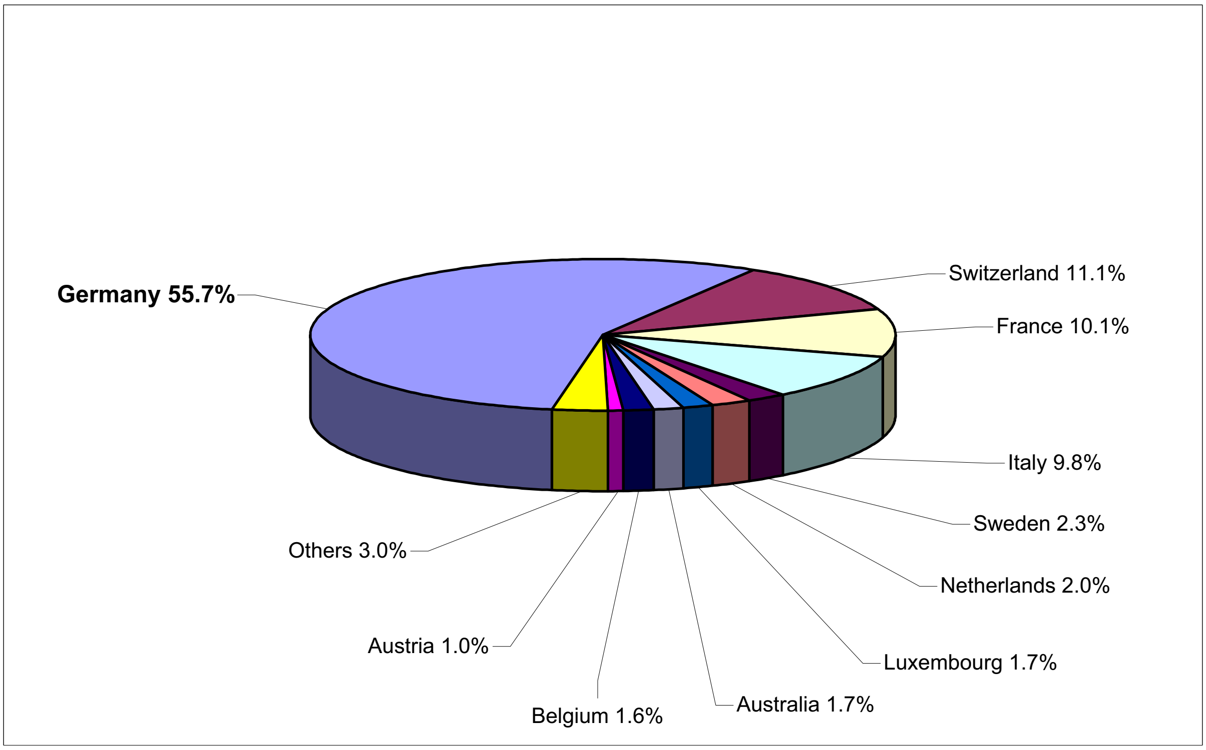
		One Lag		Two Lags	
Underlyings	Direction of Influence	χ^2	p-value	χ^2	p-value
Panel A: Main German Underlyings					
All	Sent → DAX	24.35	0.0000	23.46	0.0000
	DAX → Sent	83.33	0.0000	122.93	0.0000
DAX	Sent → DAX	22.20	0.0000	19.46	0.0001
	DAX → Sent	94.25	0.0000	122.18	0.0000
Stocks	Sent → DAX	3.70	0.0545	9.89	0.0071
	DAX → Sent	9.09	0.0026	15.78	0.0004
Panel B: Other German Underlyings					
All	Sent → MDAX, Nemax	1.62	0.2037	1.71	0.4260
	MDAX, Nemax → Sent	2.21	0.1370	3.92	0.1408
Nemax	Sent → Nemax	1.40	0.2373	7.66	0.0217
	Composit → Sent	17.40	0.0000	18.91	0.0001
Stocks	Sent → MDAX, Nemax	0.40	0.5289	2.45	0.2944
	MDAX, Nemax → Sent	0.17	0.6839	1.50	0.4730
Panel C: Main US Underlyings					
All	Sent → Dow Jones	0.00	0.9559	0.11	0.9445
	Dow Jones → Sent	15.78	0.0001	20.72	0.0000
Dow Jones	Sent → Dow Jones	0.01	0.9402	1.94	0.3789
	Dow Jones → Sent	13.01	0.0003	14.95	0.0006
Stocks	Sent → Dow Jones	0.01	0.9057	1.37	0.5052
	Dow Jones → Sent	6.28	0.0122	9.24	0.0099
Panel D: Other US Underlyings					
All	Sent → Nasdaq, S&P 500	2.01	0.1565	1.27	0.5306
	Nasdaq, S&P 500 → Sent	22.18	0.0000	27.86	0.0000
Nasdaq	Sent → Nasdaq	0.33	0.5655	0.11	0.9458
	Nasdaq → Sent	16.69	0.0000	20.17	0.0000
S&P 500	Sent → S&P 500	0.01	0.9281	6.94	0.0312
	S&P 500 → Sent	3.51	0.0610	6.48	0.0391
Stocks	Sent → Nasdaq, S&P 500	0.65	0.4199	0.58	0.7474
	Nasdaq, S&P 500 → Sent	14.56	0.0001	19.43	0.0001

Table 10: Granger-causality Tests Over Time

This table reports the χ^2-statistics of the Granger-causality test with a lag of two periods between the changes in our sentiment measures and stock market returns. Column 1 indicates which warrants are used to calculate the sentiment measure. Column 2 shows the direction of the influence. Under the χ^2-statistic one can find the respective p-values. The results in Columns 3 and 4 are Granger causalities for the rising ("bull") stock market from 01/02/1997 to 03/07/2000 and the declining ("bear") market from 03/08/2000 to 04/12/2001. Columns 5 to 8 report results for single years. Year 2001 is not considered since data only exists up to the middle of April. The tested hypothesis is that the indicator named first in the column "Direction of Influence" does not influence the indicator named after the arrow.

Underlyings	Direction of Influence	Bull market	Bear market	1997	1998	1999	2000
All	Sent → Composite	7.88	3.54	3.75	5.73	5.24	1.65
		0.0195	0.1707	0.1534	0.0571	0.0727	0.4383
	Composite → Sent	102.57	9.18	51.40	31.87	13.40	34.71
		0.0000	0.0101	0.0000	0.0000	0.0012	0.0000
Indexes	Sent → Composite	8.44	0.25	6.32	1.81	6.57	2.12
		0.0147	0.8829	0.0424	0.4039	0.0374	0.3458
	Composite → Sent	126.98	14.40	63.40	50.00	13.80	34.54
		0.0000	0.0007	0.0000	0.0000	0.0010	0.0000
Stocks	Sent → Composite	5.03	1.54	1.24	6.37	4.24	1.07
		0.0808	0.4633	0.5385	0.0414	0.1203	0.5868
	Composite → Sent	6.81	0.51	2.84	0.93	0.71	11.05
		0.0333	0.7756	0.2418	0.6275	0.6996	0.0040

Figure 1: Listed Warrants on Exchanges Worldwide in the Year 2000



Source: International Warrant Institute (I.W.I.)

Figure 2: Orthogonalized Impulse Response Function: Influence of shocks in the returns of the composite market index on sentiment

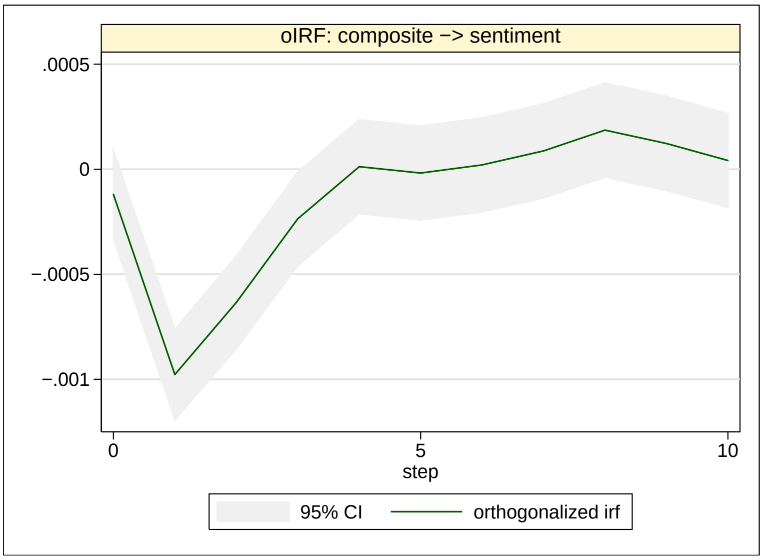


Figure 3: Orthogonalized Impulse Response Function: Influence of shocks in the sentiment indicator on composite market index returns