# Analyst Behaviour: the Geography of Social Interaction[☆]

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**Abstract**

An analyst who works in Germany is more likely to publish a high (low) price target regarding a DAX30 stock if other Germany based analysts are also optimistic (pessimistic) about the same stock. This finding is not biased by the fact that DAX30 companies are headquartered in Germany. In times of bull markets, price targets of analysts who regularly exchange their opinion are higher correlated compared to other analysts. This effect vanishes in a bearish market environment. This suggests that communication among analysts indeed plays an important role. However, analysts' incentives induce them not to deviate too much from the overall average during an economic downturn.

*Keywords:* Analyst Behaviour, Social Interaction, Herding, Word-of-Mouth
*JEL:* A14, D83, G12, G24

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## 1. Introduction

On June $30^{th}$ 2011 there have been roughly 42.000 actively traded stocks word wide.[1] Although financial markets are rather efficient regarding the availability of information nowadays, this quantity of investment opportunities makes it impossible for market participants to access and elaborate every piece of information. In this context, financial market analysts play a central role. They focus each on a few investment opportunities and use their sector expertise and tracking experience to provide forecasts of financial figures and thereof derive investment recommendations. The resulting impact analysts have on investment behaviour and market outcomes has led to a stream of literature that is concerned with how analysts derive their forecasts and recommendations and to what extend they are influenced by other analysts.
Empirical works of Hong et al. (2000); Krishnan et al. (2006) show that equity sell-side analysts[2] herd while providing earnings forecasts. Zitzewitz (2001); Bernhardt et al. (2006); Naujoks et al. (2009) find an anti-herding behaviour in the same context. Kim and Zapatero (2009); Jegadeesh and Kim (2010) among others use analysts' investment recommendation to provide empirical evidence for herding behaviour. The afore cited authors have in common, that they all assume that an individual analyst is homogeneously influenced by all other analysts.
Only few authors have assumed heterogeneous influence among analysts so far. Graham (1999) finds that analysts are more strongly influenced by a lead analyst who is defined by his reputation. Cooper et al. (2001) consider several lead analysts who are determined by past performance and market recognition. Welch (2000) postulates that an analyst's investment recommendation is influenced by the consensus recommendation and the two most recently published recommendations of other analysts.
With this paper, I set up on the assumption of heterogeneous influence. I contribute to the afore cited literature by providing a detailed analysis of the

[1] This number has been published by the World Federation of Exchanges members on www.world-exchanges.org and refers to the stocks that are traded on the 54 major stock exchanges in the world. Double counting has tried to be eliminated by only considering domestic stocks from the perspective of each stock exchange

[2] Hereafter, the term analyst always refers to an equity analyst. Due to empirical data availability, it is furthermore always referred to a sell-side analyst. See for instance Groysberg et al. (2007) for a detailed comparative analysis between buy-side and sell-side analysts.

geographical structure of influence and relating it to the prevailing market environment. My first hypothesis is that analysts are more strongly influenced by analysts that are geographically proximate. The theoretical foundation for this hypothesis is derived from the latest evidence in the psychological literature. Reis et al. (2011) found that individuals are more strongly attracted by individuals with whom they are more familiar. Translating this into the financial context, this means that forecasts and recommendations of analysts working in the same country could appear more reliable, as these analysts might be perceived to be more familiar due to the same language or a similar background. Analysts who work in the same city have a higher probability to know each other personally, which might amplify this effect. The hypothesis of familiarity is also motivated by the evidence that has already been provided in the context of portfolio selection (see e.g. Grinblatt and Keloharju (2001); Huberman (2001)).

In the analyst literature, authors so far have always postulated that influence among analysts only takes place via observation. It has mainly been argued that this is due to the fact that analysts work for different firms and thus are competitors. However, there are various theoretical settings that show that communication among competing participants on financial markets can be beneficial (Eren and Ozsoylev, 2006; Stein, 2008; Gray, 2010). The reason for this lies in the fact that through the exchange of opinion, also known as word-of-mouth[3], information and potential research advantage is not only given away. An analyst can also collect new pieces of information and learns about other analysts' views which helps to validate the own results.[4] Based on these theoretical considerations, my second hypothesis is that analysts are more strongly influenced by analysts with whom they exchange their opinion. This hypothesis is related to the first one, because the likelihood that two analysts know each other and exchange their opinion is higher, if they are geographically proximate. Evidence in favour of this hypothesis has already been provided in the context of institutional investors (see e.g. Shiller and Pound (1989); Hong et al. (2005)) as well as retail investors (see e.g. Ivkovic

[3]I use the term "exchange of opinion" in order to emphasise, that information is not only transmitted, but also discussed.

[4]One could also think of the situation where information is only given away, however, with the intention to influence other analysts such that they skew their valuation results into a desired direction, which makes the own already published result more credible for investors.

and Weisbenner (2007)).
With my third hypothesis, I state that effects of geographical proximity or the exchange of opinion are more strongly pronounced during an economic upturn compared to an economic downturn. I base this hypothesis on the incentive structure of analysts who are judged by their relative performance (Hong et al., 2000; Hong and Kubik, 2003; Chen and Jiang, 2006). This means, in times of a bull market they try to stand up from the crowd in order to distinguish themselves from competitors (Zwiebel, 1995). However, during an economic downturn which generally induces a high uncertainty, they try not to deviate too much from the overall average in order to limit the potential loss (Scharfstein and Stein, 1990; Clarke and Subramanian, 2006).
My database consists of price targets regarding the stocks of DAX30 companies that have been published by sell-side analysts in the period from 2005 to mid 2010. A price target refers to the value of a stock an analyst considers to be fair and therefore expects to be reached by the market price within a predefined horizon that usually equals one year. Hence, price targets represent investment recommendations and thus might have a direct impact on market participants. In an empirical setting, the advantage of the price target compared to the verbal investment recommendation (buy, hold, sell) lies in the fact that it is a continuous variable that quantifies how optimistic or pessimistic an analyst is about a stock. The motivation for the choice of DAX30 stocks lies in the fact that they have high analyst coverage. Moreover, it allows the analysis of a homogenous group of international analysts who have an indirect impact on one of the major European indices. Such a focus has not been considered in the analyst literature so far. The database is unique to the extent, that it represents a merger of the commonly used commercial database I/B/E/S provided by Thomson Reuters and the data of analyst reports that are publicly available on the webpage www.aktiencheck.de. While I/B/E/S is rather focussed on analyst reports of great brokerage houses and investment banks, the reports on www.aktiencheck.de include investment newsletters of research houses and daily newspapers that also have influence on market participants. The period of the database allows a very up-to-date analysis of analysts' behaviour before and during the recent financial and economic crisis that has also not been conducted in the analyst literature yet. In order to examine the influence that results from the exchange of opinion, one has to know which analysts actually exchange their opinion with each other. In the context of institutional investors, Hong et al. (2005) assume that the

exchange of opinion only or at least primarily takes place on the city level. In the context of retail investors, Massa and Simonov (2005) state that there are more characteristics that indicate the exchange of opinion, namely the profession and the former university attendance. In order to not having to rely on any assumption, I conducted a representative survey among DAX30 analysts with the intention to find out with whom a particular analyst exchanges his opinion.
Within the empirical analysis, I find that a German analyst increases his price target by 0.32 EUR (0.15%), if other German analysts increase their price target by 1 EUR (1%) while analysts working outside Germany keep their price targets constant. This corroborates the hypothesis of geographical proximity for German analysts. I show that this result is not related to the fact that DAX30 companies are headquartered in Germany, which one might think to be an informational advantage. Regarding the exchange of opinion, I discover a high correlation of price targets that are published before the economic crisis by analysts who exchange their opinion. Hence, my second hypothesis is affirmed at least for the period before the economic crisis. It is not approved for the period during the economic crisis which in turn however is consistent with my third hypothesis that analysts strongly align their price targets with the consensus in times of great uncertainty which is generally given during a crisis.
The remainder of this paper is structured as follows. In chapter 2, I present the dataset as well as the survey results and outline how this data is used for the empirical analysis. The results are provided in chapter 3. Chapter 4 concludes.

## 2. Data & Methology

The empirical analysis of this paper is based on the price targets regarding the stocks of the thirty German companies that were included in the index DAX30 as of May $31^{st}$ 2010. In order to avoid confusions in the following, the term company shall always refer to organisation having emitted a stock, whereas firm denotes the organisation an analyst is employed by. The period of analysis comprises the almost five and a half year time window from 1 January $^{st}$ 2005 to May $31^{st}$ 2010 and thus includes the stock market peak preceding the financial crisis in 2007/08 as well as the crisis itself. The price targets are primarily extracted from I/B/E/S, the common database of analysts' estimates provided by Thomson Reuters. This yielded

10,972 values for the period of analysis. Further price targets were collected from analyst reports being published on www.aktiencheck.de[5]. For the same period of time 27,175 reports have been evaluated and 16,821 price targets extracted. Both databases have then been merged as follows. The I/B/E/S database has been used as a basis. Price targets from analysts employed by firms that are not included in I/B/E/S have directly been added. For those firms that appeared in both databases, the publication dates regarding to a specific company have been compared. In the case they were equal, only the I/B/E/S data has been taken.[6] Otherwise, the price target from the analyst report on www.aktiencheck.de has been added. In order to avoid double entries due to differing publication dates, a time window of plus minus five days has been applied. Thereby, a buffer of ten days was generated cancelling out unreal price target updates. Moreover, firms' names instead of analysts' names have been used for this comparison in order to avoid double entries that result from the fact that two analysts of a research team who published one common price target appear with one analyst's name in the first database and with the other analyst's name in the second. Note, that data of I/B/E/S is adjusted by stock splits. As the analyst reports published on www.aktiencheck.de represent the original reports as being published at the time, the extracted price targets also had to be adjusted by stock splits to be consistent with the I/B/E/S data. The merger of both databases yielded 25,534 price targets. Dropping all firms that published less than 30 price targets during the whole period of analysis reduced the number of firms by one half and lead to a database of 24,893 price targets. The final database resulted by eliminating all entries where only the firm but not the corresponding analyst was known and consists of 17,898 price targets. This database is unique regarding to the following fact: While I/B/E/S primarily contains estimates of investment banks, reports on www.aktiencheck.de also comprise estimates from independent research firms and investment letters. The merger of both databases hence represents a broader spectrum of analysts' price targets. Table 1 gives an overview of firms included in the new database. Moreover, the original database and the corresponding number of

[5]aktiencheck.de AG is an independent research firm that collects analysts reports and publishes them together with own reports on its webpage.

[6]Ljungqvist et al. (2009) reported systematic errors in the historical I/B/E/S recommendation database. The comparison of price targets that appear in both databases, however, did not reveal remarkable deviations.

price target publications are indicated.

In order to analyse the geographic structure of influence, an analysts' working location has to be known. Although the city is indicated on the analyst reports on www.aktiencheck.de, the data could not be used as it usually only referred to the headquarter of the particular firm and not to the actual place of work of an analyst. Hence, for each analyst in the database the city and the corresponding country have been searched by hand on the internet. Table 2 shows the distribution of analysts by firm, country and city as well as the corresponding number of published price targets. Hereafter, an analyst's nationality is used interchangeably with the country where he works. This means for instance that a "German" analyst refers to an analyst who works in Germany although there might be German analysts who work abroad. Most of the firms are Germany based, however, closely followed by UK. London is the city, where most of the analysts work and is followed by Frankfurt, where less than a half of London based analysts work. German analysts published about 70% of all price targets. The portion of UK based analysts who all work in London equals approximately 20%. Analysts working in Frankfurt published about one third of all price targets.

In order to determine the influence that results from the exchange of opinion among analysts, a survey of DAX30 analysts in has been conducted. In the period from June $15^{th}$ to July $8^{th}$ 2010, all analysts in the price target database have been contacted by email and asked to fill in a questionnaire. Out of 1,184 analysts in the database 718 could be reached[7] and 195 replied. This corresponds to a response rate of 27.2%, which ensures the representativeness of the survey. The questionnaire consisting of eleven questions is shown in table 3. Concerning analysts' interaction and reciprocal influence from the exchange of opinions, the most important questions are the questions #5 and #7 asking for the number of analysts, an analyst had already social contact with and an analyst regularly exchanges forecast results with, respectively. The figures 1 and 3 plot the answers of these two questions. From the data, it can be seen that social contacts are quite numerous. Only 14.0% answered not personally knowing at least one other analyst. Additional comments of the respondents confirm that there is a community of analysts covering a stock wherein the members know each other and most

[7]The remaining analysts could not be contacted, as they either left their firm or because no or not a valid email address could be found.

**Table 1: Overview of the firms included in the new price target database**

| Firm | I/B/E/S | aktiencheck |
|---|---|---|
| ABN AMRO | - | 7 |
| AC Research | - | 38 |
| Actien-Börse | - | 82 |
| Ahorro Corporación Financiera S.V., S.A. | 17 | - |
| Banc of America Securities-Merrill Lynch Research | 3 | 302 |
| Banco Sabadell | 42 | - |
| Bankhaus Lampe | 104 | 198 |
| Bankhaus Metzler | 335 | - |
| Barclays Capital | 34 | 3 |
| Bear Stearns | 15 | 2 |
| Berenberg Bank | 46 | - |
| BHF-BANK | 359 | 28 |
| Cheuvreux | 595 | 222 |
| Citigroup | - | 625 |
| Collins Stewart | 32 | 2 |
| Commerzbank Corporates & Markets | 268 | 196 |
| Credit Suisse | 219 | 169 |
| Daiwa Securities SMBC Europe Limited | 26 | - |
| Der Aktionär | - | 189 |
| Der Aktionärsbrief | - | 58 |
| Deutsche Bank | 269 | 139 |
| Dexia Securities | 5 | 37 |
| DZ BANK | 236 | - |
| equinet AG | 163 | 238 |
| EURO am Sonntag | - | 172 |
| Evolution Securities | 31 | - |
| Exane BNP Paribas | - | 84 |
| FOCUS-MONEY | - | 59 |
| Fox Pitt & Kelton | 14 | - |
| Frankfurter Börsenbrief | - | 84 |
| Fuchsbriefe | - | 37 |
| Goldman Sachs | - | 281 |
| Helvea | 43 | 20 |
| HSBC | - | 106 |
| HypoVereinsbank | - | 802 |
| IIR Group | 16 | 16 |
| Independent Research | - | 1507 |
| ING | 1 | 78 |
| J.P. Morgan Securities | - | 324 |
| Jefferies & Co | 52 | 7 |
| Jyske Bank | 44 | 22 |
| Keefe Bruyette & Woods | 36 | 9 |
| Kepler Capital Markets | 201 | 64 |
| Landesbank Baden-Württemberg | 257 | 30 |
| Lehman Brothers | 53 | 25 |
| LRP Landesbank Rheinland-Pfalz | 217 | 898 |
| M.M. Warburg & CO | 448 | 143 |
| Macquarie | 59 | 4 |
| Merck Finck & Co. | - | 156 |
| Morgan Stanley | - | 206 |
| National-Bank AG | - | 159 |
| Natixis Securities | 143 | - |
| Nomura Equity Research | 171 | 19 |
| Nord LB | 112 | 583 |
| Oddo Securities | 117 | - |
| Piper Jaffray | 32 | 7 |
| Prior Börse | - | 48 |
| Raymond James | 39 | 14 |
| Sal. Oppenheim | 665 | 108 |
| Sanford C. Bernstein & Co | 157 | 34 |
| Santander | 37 | - |
| SEB | - | 1171 |
| SES Research | 10 | 83 |
| Société Générale | 235 | 374 |
| SRH AlsterResearch | 20 | 21 |
| Stockstreet.de | - | 30 |
| UBS | - | 261 |
| UniCredit Markets & Investment Banking | 374 | 516 |
| WestLB | 280 | 169 |
| | 6,632 | 11,266 |
| | 17,898 | |

The table displays the firms' names and the number of published price targets originating from the two different sources.

## Table 2: Distribution of firms, analysts and price targets by country and city

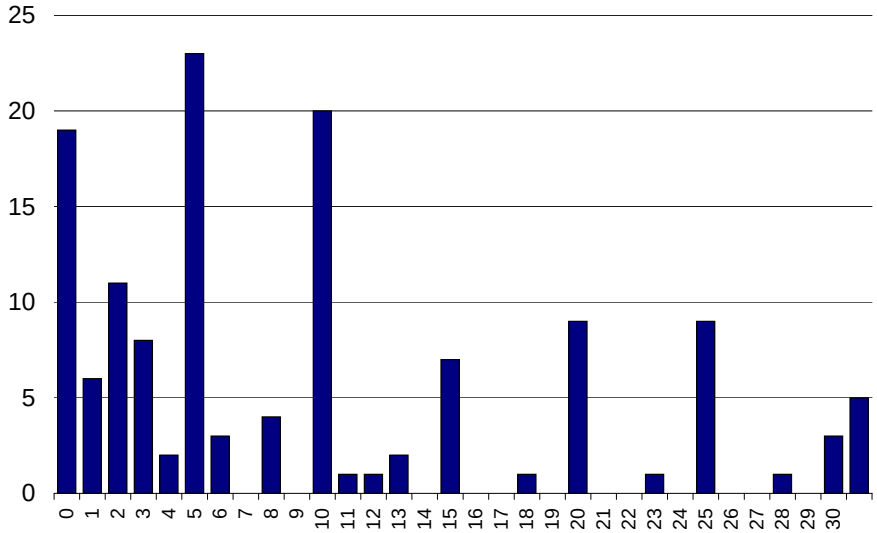
| country | city | number of firms | number of analysts | number of targets |
|---|---|---|---|---|
| Belgium | Brussels | 2 | 5 | 61 |
| China | Hong Kong | 1 | 1 | 1 |
| Denmark | Silkeborg | 1 | 5 | 66 |
| Germany | Berlin | 1 | 1 | 37 |
| | Detmold | 1 | 1 | 84 |
| | Düsseldorf | 6 | 34 | 815 |
| | Essen | 1 | 5 | 159 |
| | Frankfurt | 16 | 153 | 6.174 |
| | Hamburg | 4 | 25 | 739 |
| | Hanover | 1 | 17 | 695 |
| | Cologne | 2 | 4 | 303 |
| | Kulmbach | 1 | 1 | 189 |
| | Mainz | 2 | 12 | 1.152 |
| | Munich | 5 | 32 | 1.989 |
| | Stuttgart | 1 | 24 | 250 |
| | Westerburg | 1 | 3 | 38 |
| France | Paris | 13 | 80 | 882 |
| India | Bangalore | 1 | 1 | 3 |
| | Bombay | 1 | 12 | 32 |
| the Netherlands | Amsterdam | 3 | 5 | 44 |
| Austria | Vienna | 1 | 1 | 9 |
| Sweden | Stockholm | 1 | 1 | 1 |
| Switzerland | Geneva | 1 | 2 | 27 |
| | Zurich | 5 | 11 | 120 |
| Spain | Madrid | 4 | 18 | 94 |
| South Korea | Seoul | 1 | 1 | 22 |
| UK | London | 33 | 388 | 3.781 |
| USA | New York | 5 | 13 | 120 |
| | San Francisco | 2 | 2 | 11 |
| | | **117** | **858** | **17.898** |

The table displays the number of different firms, analysts and price targets on the country and the city level. Please not that firms that are based at different locations are double counted. The same applies for analysts who changed their working location during the period of analysis.

## Table 3: Questionnaire of the survey

| | |
|---|---|
| #1 | How long have you been working at your firm? |
| #2 | In which city do you work? |
| #3 | Where have you been employed before? |
| #4 | Which university did you attend? |
| **#5** | With about how many analysts, that cover at least one of the DAX30 companies covered by you, did you already have personal contact? |
| #6 | In which way do you most likely have contact with other analysts (e.g. telephone, meetings, events, lunch dates)? |
| **#7** | With how many analysts of question #5 do you exchange your opinion regarding **forecasts**? |
| #8 | How many analysts of question #7 work in the same **country** as you? |
| #9 | How many analysts of question #7 work in the same **city** as you? |
| #10 | How many analysts of question #7 work in the same **firm** as you? |
| #11 | How many analysts of question #7 attended the same **university** as you? |

**Figure 1: Histogram of the answers to survey question #5**



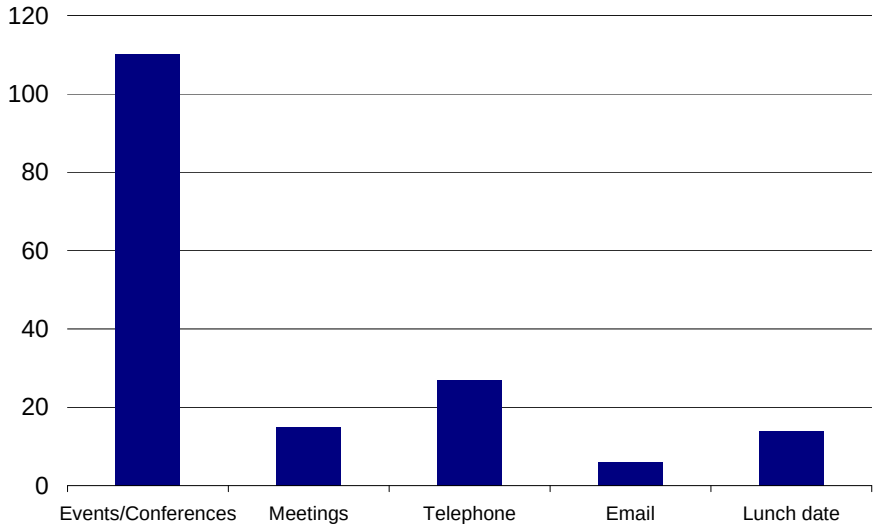

With about how many analysts, that cover at least one of the DAX30 companies covered by you, did you already have personal contact?

often already had a personal contact. Question #6 asking for the most regular way of contact with other analysts provides the answer to this phenomenon. Analysts meet frequently on events like investors' days or analysts conferences and hence communicate with each other often. The results of question #6 are shown in figure 2. Despite this regularly contact, forecast results are not the main topic of conversation. Following question #7, only 34.6%[8] of the analysts exchange their opinions regarding forecasts with at least one other analyst. Note, that this question is very delicate. Analysts in this context defined as sell-side analysts[9] are competitors. Hence, no one

[8]The results of the question #7 to #9 and #11 are adjusted by the number of intra-firm exchanges as being asked by question #10. This is done for two reasons. Analysts in the same firm act as one unity and only publish one result. Furthermore, the exchange of opinion in a research team takes place by definition and does not provide any insight.

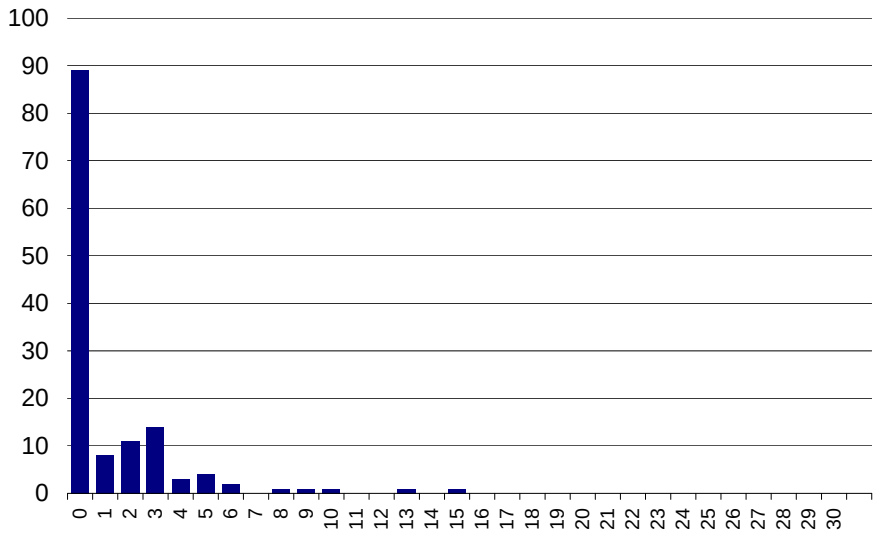
[9]Some respondents annotated that from the formulation of the questions it is not perceptible whether the word analyst refers to sell-side or buy-side analysts. Buy-side analysts are sell-side analysts' clients. Hence, the discussion of forecast results between these two types of analysts is natural and not worth of analysis. The fact that 95% of

**Figure 2: Histogram of the answers to survey question #6**




In which way do you most likely have contact with other analysts (e.g. telephone, meetings, events, lunch dates)?

**Figure 3: Histogram of the answers to survey question #7**




With how many analysts of question #5 do you exchange your opinion regarding **forecasts**?

is interested in giving away his research advantage or to reveal his findings. Formally, firms' policy even obliges analysts not to do so. However, the fact that more than a third admitted to exchange their results shows, that there is an informal component that weights stronger than policies or than obvious principles. As stated in the introduction, such behaviour can be beneficial, because an analyst who exchanges his opinion does not only loose a research advantage. Rather, he learns about other analysts' views which helps him to validate the own results. This is especially relevant for the determination of price targets, where also assumptions and valuation methods can be discussed without loosing a specific research advantage regarding an earnings forecast for instance. Indeed, some respondents that denied the exchange of forecast results, as question #7 was formulated, annotated that they nonetheless exchange assumptions and details about valuation techniques. This suggests

the answers to question #7 are below or equal five proves that the questions have been understood as being indented, if one assumes that number of sell-side analysts' clients is usually greater than five. As a precaution, the two answers above 15 have been taken off.

the actual number of analysts' reciprocal influence from the exchange of opinions to be higher. Another fact that supports this tendency is that through the delicate nature of the question maybe not all answers reflect the actual situation.
The basic intention of the survey was to determine with whom an analyst exchanges his opinion. In order to get an acceptable feed-back ratio, no analyst has been asked for the names of analysts with whom he exchanges his opinion. Instead, it is intended to reduce the universe of analysts that might be potential counterparts for the exchange of opinion. This is done by asking for the working location in questions #8 and #9. In the average 82% of the analysts that exchange forecast results work in the same country (median: 100%). This result is not biased by the fact that all analysts work in the same country as only 56% of the respondents work in the country where most of the respondents work (Germany). Regarding the city level, in the average only 44% of the analysts that exchange forecast results work in the same city (median: 50%). This number is consistent with the answers of question #6, where only 10% of the respondents answered to use lunch dates as a regular way of having contact with other analysts. However, in the two cities where with 26% and 22% most of the respondents work (Frankfurt and London), this number lies at 65% and 78% respectively.
With Question #11 asking for the former university attendance, it was intended to get another criterion to determine the analysts who exchange their opinion. I considered this characteristic, because it is used in other empirical studies in the context of the exchange of opinion (see e.g. Massa and Simonov (2005); Cohen et al. (2009)). However, it turned out not to be adequate, because in the average only 1% of the respondents that exchange forecast results attended the same university (median: 0%).

Within the empirical analysis of this paper, I do not determine the absolute magnitude of influence or whether analysts influence each other at all. This has already done in several prior studies (see e.g. Graham (1999); Hong et al. (2000); Welch (2000); Cooper et al. (2001); Zitzewitz (2001); Bernhardt et al. (2006); Krishnan et al. (2006); Kim and Zapatero (2009); Naujoks et al. (2009); Jegadeesh and Kim (2010)). Instead, I aim to analyse the structure of influence. Therefore, I divide the analysts of the database into groups. The composition of these groups varies with the hypotheses to be contrasted. In order to test the first hypothesis, for instance, one group consists of all analysts who work in the same country while the other group

is composed of analysts who work in different countries. The resulting basic regression is given by

$$P_{ict} = \alpha\overline{P_{ct}^{(g1)}} + \beta\overline{P_{ct}^{(g2)}}, \tag{1}$$

where $P_{ict}$ denotes the price target that is published by analyst $i$ regarding stock $c$ at time $t$. As not all analysts publish their price target on the same day, $t$ has to be understood as a time window. $\overline{P_{ct}^{(g1)}}$ represents the mean value of price targets that belong to a specific group of analysts from the perspective of analyst $i$. For instance, if analyst $i$ works in Germany then the first group could consist of other Germany based analysts whereas the second group refers to analysts who work outside Germany. In case the influence among analysts was homogeneous, then the coefficients $\alpha$ and $\beta$ should not differ significantly.

In order to determine the relevance of the exchange of opinion and thereby to contrast the second hypothesis, the first group has to be formed by analysts who exchange their opinion with analyst $i$, while the second group has to contain only analysts who don't. As stated above, I do not certainly know which analyst has to be assigned to which group, however, I can use the working locations to get a good guess. If for instance, there are four analysts who all cover Siemens and work for different firms in Düsseldorf and one of these analysts answered to exchange his opinion with two analysts who cover the same company and work in the same city, then taking randomly two out of three analysts in this city yields a probability of 100% to place at least one analyst correctly and a probability of 33% to assign all analysts to the correct groups. The latter probability also increases to 100%, if one of these three analysts answered not to exchange his opinion with any other analyst. However, it is not even necessary to place all analysts correctly. Under the null hypothesis $h_0$, a counterpart for the exchange of opinion has a higher influence compared to other analysts. Looking at the survey data and comparing the first and the second three columns in table 4 one observes, that the number of analysts with whom the opinion is exchanged (group $g1$) is generally smaller than the number of other analysts (group $g2$). As I always consider group averages, the influence of a singular analyst in group $g2$ is therefore very small. This means that if a counterpart for the exchange of opinion is wrongly placed in group $g2$, the coefficients $\alpha$ and $\beta$ still might be estimated correctly, if there are enough analysts that are correctly placed in group $g1$. In most of the cases, it is even sufficient that group $g1$ only contains one properly assigned analyst. Regarding the estimation of the

**Table 4: Overview of the analysts who regularly exchange their opinion with other analysts**

| country | city | same city | same country ex same city | other countries | exchange city level | exchange country level ex city level | exchange other countries |
|---|---|---|---|---|---|---|---|
| Germany | Düsseldorf | 3.5 | 36.5 | 42.0 | 2.0 | 0.0 | 2.8 |
| | Frankfurt | 14.7 | 14.3 | 50.0 | 2.3 | 0.8 | 3.7 |
| | Hamburg | 0.3 | 34.0 | 39.0 | 0.0 | 2.5 | 0.3 |
| | Mainz | 0.0 | 23.0 | 37.0 | 0.0 | 7.0 | 1.0 |
| | Munich | 1.3 | 29.3 | 33.3 | 0.3 | 1.3 | 0.6 |
| | Stuttgart | 0.0 | 26.5 | 32.0 | 0.0 | 2.2 | 0.3 |
| France | Paris | 3.0 | 0.0 | 44.7 | 0.7 | 0.0 | 1.3 |
| Switzerland | Zurich | 3.0 | 0.0 | 37.0 | 2.0 | 0.0 | 3.0 |
| UK | London | 14.0 | 0.0 | 43.7 | 1.3 | 0.0 | 1.7 |

The first three columns of the table provide the average number of analysts that are theoretically available for the exchange of opinion because they cover the same company at the same time. The second three columns show the average numbers of actual counterparts for the exchange of opinions. From the perspective of the analysts working in a particular city, the number of analysts in the same city, in the remaining country and in other countries are indicated.

overall regression, the coefficients $\alpha$ and $\beta$ can be correctly estimated, if from the perspective of at least half[10] of the analysts, the proper estimation of the coefficients is possible. In the appendix, I derive how to calculate the probability for estimating the correct coefficients of equation 1, if the analysts are randomly assigned to the groups and the restriction obtained by the survey are taken into account. The resulting value amounts to 73.28%. This means that running 100 simulations for the group assignment, the coefficients of equation 1 can be estimated correctly in 73 cases.

## 3. Results

With this paper, I intend to shed light on the structure of the influence among analysts. In this context, I test the relevance of geographical proximity, the impact of the exchange of opinion and the temporal change induced by the economic crisis starting in 2008. I begin with the analysis on the country level (see table 5). From the perspective of a particular analyst, all other analysts covering the same company are divided into those who work in the same country (group $g1$) and those who work in a different country (group

[10]In the following, I weight the number of analysts with the amount of price targets published by them.

## Table 5: Regression results for the structure of influence on the country level

| | | $\alpha$ | $\beta$ | const | $\alpha - \beta$ | $N$ | $R^2$ |
|---|---|---|---|---|---|---|---|
| (I) | all analysts | 0.5600*** | 0.4148*** | 1.0081*** | 0.1452*** | 12,186 | 0.8734 |
| | | (0.0124) | (0.0123) | (0.2117) | (0.0213) | | |
| (II) | only non German analysts | 0.3130*** | 0.6868*** | 0.8089*** | -0.3738*** | 3,946 | 0.9130 |
| | | (0.0194) | (0.0203) | (0.3134) | (0.0343) | | |
| (III) | only German analysts | 0.6453*** | 0.3250*** | 1.0027*** | 0.3203*** | 8,240 | 0.8556 |
| | | (0.0160) | (0.0155) | (0.2729) | (0.0271) | | |
| (IV) | without three German firms | 0.5853*** | 0.3777*** | 1.2923*** | 0.2077*** | 6,446 | 0.8306 |
| | with most of the price targets | (0.0191) | (0.0184) | (0.3342) | (0.0322) | | |
| (V) | time window of 45 days | 0.6658*** | 0.3040*** | 0.9453*** | 0.3617*** | 8,673 | 0.8616 |
| | | (0.0165) | (0.0160) | (0.2591) | (0.0280) | | |
| (VI) | time window of 15 days | 0.6189*** | 0.3554*** | 0.9324*** | 0.2635*** | 7,192 | 0.8404 |
| | | (0.0164) | (0.0159) | (0.3088) | (0.0277) | | |
| (VII) | normalised price targets | 0.4361*** | 0.2846*** | 0.3230*** | 0.1515*** | 8,240 | 0.1421 |
| | | (0.0175) | (0.0208) | (0.0251) | (0.0299) | | |
| (VIII) | influence of German analysts | 0.5096*** | 0.4754*** | 1.3713*** | 0.0343 | 3,991 | 0.9131 |
| | on foreign analysts | (0.0170) | (0.0166) | (0.3008) | (0.0289) | | |

The table provides the results of the basic regression 1 on the country level. From the perspective of a particular analyst group $g1$ contains domestic analysts, while group $g2$ is build of foreign analysts. This composition of the groups changes in specification VIII, where group $g1$ contains German analysts and group $g2$ is constructed by all other analysts. Specification I includes all analysts. Specification II and VIII only include analysts who work outside Germany. Specification III-VII only include Germany based analysts. A detailed description of the specifications is provided in the text. The significance of coefficients is indicated by stars (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$). Standard deviations are provided in parentheses.

$g2$). As time window, I consider the thirty days period before the publication of the price target of a particular analyst. This time window is so designed that an analyst can only be influenced by analysts whose price targets were observable prior his own publication. The length of thirty days guarantees that there are enough analysts to be included with their price targets, while the latter however are not too old. Estimating the coefficients of equation yields a significant difference of 0.1452 (specification I). This result, however, might be biased by the fact that most of the price targets are published by Germany based analysts. Indeed, considering only analysts working outside Germany on the left hand side of equation 1 leads to a negative difference of -0.3738 (specification II). This implies that the difference for German analysts is actually higher than estimated by the first regression. Indeed, this difference equals 0.3203 (specification III). This means, that a German analyst increases his price target by 0.32 EUR if other German analysts increase their price target by 1 EUR while analysts working outside Germany keep their price targets constant. In order to provide some robustness checks for this result, several out-of sample regressions have been run. First, the three German firms that provided most of the price targets are excluded. This still leads to a significant difference of 0.2077 (specification IV). Next, the time window has been varied. Considering a time window of 45 as well as 15 days prior the publication of a particular analyst's price target yields significant differences of 0.3617 and 0.2635, respectively (specification V and VI). Finally, I aim to suppress the bias of potential heteroscedasticity. Therefore, I normalised price targets by the market price of the corresponding stock on the day prior the publication. The resulting difference is significant and equals 0.1515 (specification VII). This means, that a German analyst increases his price target by 0.15%, if other German analysts increase their price target by 1% while analysts working outside Germany keep their price targets constant.

After having provided empirical evidence that the intra-country correlation of price targets only applies for Germany based analysts, one might assume that this correlation is not due to the common country but is due to the fact that the companies of the examined stocks are also headquartered in Germany. Due to this fact, German analysts might have or might at least be assumed to have a better set of information such that foreign analysts are more strongly influenced by German analysts than by their domestic colleagues. In order to analyse the influence that is generated by German analysts from the perspective of an analyst working outside Germany, I built

up a group of analysts that work in Germany (group $g1$) and a group of all other analysts (group $g2$). The difference between the estimated coefficients equals 0.0343 and turns out to be insignificant (specification VIII). Hence, an analyst who works outside Germany is not more strongly influenced by German analysts than by all other analysts. Nevertheless, a German analyst still might have a better set of information although this is not recognised by analysts working outside Germany. I contrast this alternative hypothesis by comparing the returns an investor would have realised, if he had followed the implicit investment recommendations provided by price targets. The returns are given by

$$r_{ict} = \left( \frac{P_{c,t+365} + d_{ct,t+365}}{P_{ct}} - 1 \right) \operatorname{sgn} \left( P_{ict} - P_{ct} \right), \tag{2}$$

where $P_{ct}$ is the market price of stock $c$ at time $t$ and $P_{c,t+365}$ is the stock price one year there after. The dividends that are paid during the period are given by $d_{ct,t+365}$. If an analyst publishes a price target that is higher than the current market price, then he considers the stock to be under valuated and implicitly recommends buying the stock. However, an analyst would not necessarily recommend buying a stock when his price target is only little higher than the prevailing stock price. Therefore, I use several thresholds for my analysis. These are 1%, 3% and 5%. By including dividends in equation 2, $r_{ict}$ represents a gross return. For the comparative analysis of German and non German analysts I consider gross as well as net returns, i.e. returns that are calculated by including and excluding dividend payments. The results are displayed in table 6. It can be seen that returns that result from recommendations of German analysts are slightly higher. However, none of the differences are significantly different from zero. Therefore, I can conclude that analysts working in Germany do not have better knowledge about DAX30 companies although they are also headquartered in Germany. This finding is in line with Bae et al. (2008), who show that local information advantage vanishes for large companies that operate globally and have a good disclosure policy.

Now turning to the city level, from the perspective of a particular analyst, all other analysts covering the same company are divided into those who work in the same city (group $g1$) and those who work in a different city (group $g2$). The resulting difference equals -0.3330 (specification IX). Hence, analysts are more strongly influenced by analysts who work in different cities compared to those who work in the same city. This result remains unchanged if only

**Table 6: Average performance of German and non German analysts**

| | Germany | not Germany | difference |
|---|---|---|---|
| gross return, threshold 1% | 6,98% | 6,11% | 0,87% |
| | (53,65%) | (51,75%) | |
| net return, threshold 1% | 5,46% | 4,43% | 1,03% |
| | (53,79%) | (51,78%) | |
| gross return, threshold 3% | 7,18% | 6,36% | 0,81% |
| | (54,28%) | (52,39%) | |
| net return, threshold 3% | 5,62% | 4,66% | 0,97% |
| | (54,38%) | (52,38%) | |
| gross return, threshold 5% | 7,46% | 6,62% | 0,84% |
| | (54,33%) | (53,06%) | |
| net return, threshold 5% | 5,81% | 4,89% | 0,93% |
| | (54,35%) | (53,07%) | |

The table shows average hypothetical returns that result from German and non German analysts' implicit recommendation provided by their price targets. The different methods of calculation are explained in the text. Standard deviations are provided in parentheses.

analysts working outside Germany or only German analysts are considered on the right hand side of equation 1 (specification X and XI). All regression results based on the city level are shown in table 7.

Up to now, only the influence from observation has been considered. In the following, I like to determine the relevance of the exchange of opinion among analysts. Therefore, I consider a time window of $\pm 30$ days, because it is not necessary that an analyst observes another analyst's price target. In chapter 2, I explained that I do not certainly know an analyst's counterparts for the exchange of opinion. However, the data of the survey can be used to get a good guess, if the analysts are randomly assigned to the group of analysts who exchange their opinion with analyst $i$ (group $g1$) and the group of those who don't (group $g2$). Under the null hypothesis $h_0$ that an analyst is more strongly influenced by those analysts with whom he exchanges his opinion, the probability for correctly estimating the coefficients in equation 1 equals 73.28%. This value results, if the probability on the level of a single analyst is weighted by all price targets he has published during the period of analysis (see equation A.3). However, an analysts might publish a price target in a period of time when no other analyst of those who are randomly

**Table 7: Regression results for the structure of influence on the city level**

| | | $\alpha$ | $\beta$ | const | $\alpha - \beta$ | $N$ | $R^2$ |
|---|---|---|---|---|---|---|---|
| (IX) | all analysts | 0.3245*** | 0.6576*** | 0.7394*** | -0.3330*** | 10,329 | 0.8741 |
| | | (0.0147) | (0.0150) | (0.2332) | (0.0256) | | |
| (X) | only non German analysts | 0.3155*** | 0.6839*** | 0.8180*** | -0.3685*** | 3,918 | 0.9123 |
| | | (0.0195) | (0.0203) | (0.3145) | (0.0343) | | |
| (XI) | only German analysts | 0.3012*** | 0.6702*** | 0.6959** | -0.3691*** | 6,411 | 0.8510 |
| | | (0.0212) | (0.0212) | (0.3228) | (0.0365) | | |

The table provides the results of the basic regression 1 on the city level. From the perspective of a particular analyst group $g1$ contains analysts who work in the same city, while group $g2$ is build of analysts who work in different cities. Specification (IX) includes all analysts. Specification (X) only includes analysts who work outside Germany. Specification (XI) only includes Germany based analysts. The significance of coefficients is indicated by stars (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$). Standard deviations are provided in parentheses.

assigned to group $g1$ published a price target. In this case, the observation has to be dropped for the regression 1. Hence, the weighting depends on the random composition of group $g1$ and $g2$, such that the probability for correctly estimating the coefficients varies slightly. Table 8 provides the results of 1000 simulations. It can be seen that the mean probability for a proper assignment equals 75.3%. The average difference $\overline{\alpha - \beta}$ is negative and the point estimate of this difference is positive in only 43.0% of the cases. Given the fact that under $h_0$ one would expect $\alpha - \beta$ to be significantly greater than zero in 75.3% of the cases, $h_0$ has to be rejected. Thus, I have to conclude that the exchange of opinion has no or at least less relevance than observation.

All afore presented results are obtained by using the whole database ranging from the beginning of 2005 to mid 2010. This is a time period where lots of changes took place on financial markets. There was a bull market until the beginning of 2007 when the U.S. subprime crisis began to develop to a global financial crisis. The consequences for non financial companies arose with the delay of one year, when the financial crisis became an economic crisis. Most of the companies in the DAX30 are non financial companies, such that it is of interest to examine changes in analysts' behaviour before and during the economic crisis. The beginning is marked by the collapse of the investment bank Lehman brothers on September $15^{th}$ 2008. This date is quite exactly in the middle of the analysed period and thus allows separating the whole

**Table 8: Regression results for the relevance of the exchange of opinion**

| $\overline{\alpha}$ | $\overline{\beta}$ | $\overline{const}$ | $\overline{\alpha-\beta}$ | $\overline{N}$ |
|---|---|---|---|---|
| 0.8265 | 0.4496 | 0.5465 | -0.0969 | 679 |
| (1.6738) | (0.3687) | (0.3570) | (0.7250) | |
| $\overline{P\left(\sum_{i=1}^{C} w_i I_i > r\right)}$ | $P(\alpha-\beta>0)$ | $P(\alpha-\beta>0 \wedge p<0.05)$ | | |
| 75.3% | 43.0% | 27.3% | | |

The table provides the mean results of the simulation with 1000 estimates of the basic regression 1 that is used to determine the relevance of the exchange of opinion. From the perspective of a particular analyst group $g1$ contains analysts with whom he exchanges his opinion, while group $g2$ is build of other analysts. $\overline{P\left(\sum_{i=1}^{C} w_i I_i > r\right)}$ is the average probability that for a random assignment of the groups the coefficients can be correctly estimated under the null hypothesis. $P(\alpha-\beta>0)$ is the portion of simulation runs, where the difference $\alpha-\beta$ turned out to be positive. $P(\alpha-\beta>0 \wedge p<0.05)$ is the portion of simulation runs, where the difference $\alpha-\beta$ resulted to be significantly positive. Standard deviations of the point estimates resulting from the simulation runs are provided in parentheses.

database into two sets of data with similar number of observations. In the following, I use these two temporal subsets in order to repeat the analyses on the country and city level as well as regarding the exchange of opinion. The results for the country and city level are shown in table 9. On the country level, I only consider German analysts, as prior results showed that the relevance of the country only applies for analysts who work in Germany. It can be seen that the difference $\alpha-\beta$ is considerably greater before the economic crisis than during it (specifications XII and XIII). Before the crisis, a German analyst increased his price target by 0.51 EUR, if other German analyst increased their price target by 1 EUR and other analysts kept their price targets constant. This is 0.34 EUR more than during the crisis. On the city level, $\alpha-\beta$ is negative before as well as during the crisis (specifications XIV and XV). However, this difference is slightly greater, i.e. less negative before the crisis. Table 10 shows the temporal differences for the exchange of opinion. During the economic crisis the mean difference $\alpha-\beta$ is negative and only 33.9% of the simulation runs yielded a positive difference $\alpha-\beta$. This is in line with the previously obtained results by using the whole dataset. However, looking at the period before the economic crisis, $\alpha-\beta$ turns out

## Table 9: Regression results for the temporal change on the country and the city level

| | | $\alpha$ | $\beta$ | const | $\alpha - \beta$ | $N$ | $R^2$ |
|---|---|---|---|---|---|---|---|
| (XII) | country level: German analysts | 0.7414*** | 0.2354*** | 1.0673*** | 0.5060*** | 2,845 | 0.9372 |
| | before econmic crisis | (0.0198) | (0.0186) | (0.3542) | (0.0330) | | |
| (XIII) | country level: German analysts | 0.5646*** | 0.4000*** | 0.9497** | 0.1647*** | 5,328 | 0.7665 |
| | during econmic crisis | (0.0227) | (0.0226) | (0.3980) | (0.0389) | | |
| (XIV) | city level: all analysts | 0.3498*** | 0.6300*** | 1.0152*** | -0.2802*** | 4,102 | 0.9376 |
| | before econmic crisis | (0.0181) | (0.0180) | (0.2965) | (0.0312) | | |
| (XV) | city level: all analysts | 0.3189*** | 0.6658*** | 0.5414 | -0.3469*** | 6,144 | 0.7874 |
| | during econmic crisis | (0.0217) | (0.0227) | (0.3553) | (0.0382) | | |

The table provides the results of the basic regression 1 on the country and the city level. In specification XII and XIII, only German analysts are considered. From the perspective of a particular analyst group $g1$ contains domestic analysts, while group $g2$ is build of foreign analysts. Specifications XIV and XV are based on all analysts. From the perspective of a particular analyst group $g1$ contains analysts who work in the same city while group $g2$ is build of analysts who work in different cities. The dataset is divided into two subsets with price targets being published before (specifications XII and XIV) and during the economic crisis (specifications XIII and XV). The significance of coefficients is indicated by stars (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$). Standard deviations are provided in parentheses.

## Table 10: Regression results for the temporal change of relevance of exchange of opinion

| | $\overline{\alpha}$ | $\overline{\beta}$ | $\overline{const}$ | $\overline{\alpha - \beta}$ | $\overline{N}$ |
|---|---|---|---|---|---|
| before economic crisis | 4.2817 | 0.5131 | 0.4173 | 0.0958 | 262 |
| | (1.7417) | (0.1701) | (0.1737) | (0.3425) | |
| after economic crisis | -3.4232 | 0.4001 | 0.7015 | -0.3014 | 415 |
| | (2.4488) | (0.8471) | (0.8189) | (1.6647) | |

| | $\overline{P\left(\sum_{i=1}^{C} w_i I_i > r\right)}$ | $P(\alpha - \beta > 0)$ | $P(\alpha - \beta > 0 \wedge p < 0.05)$ |
|---|---|---|---|
| before economic crisis | 63.4% | 64.8% | 45.2% |
| after economic crisis | 78.7% | 33.9% | 23.7% |

The table provides the mean results of the simulation with 1000 estimates of the basic regression 1 that is used to determine the relevance of the exchange of opinion. From the perspective of a particular analyst group $g1$ contains analysts with whom he exchanges his opinion, while group $g2$ is build of other analysts. The dataset is divided into two subsets with price targets being published before and during the economic crisis. $\overline{P\left(\sum_{i=1}^{C} w_i I_i > r\right)}$ is the average probability that for a random assignment of the groups the coefficients can be correctly estimated under the null hypothesis. $P(\alpha - \beta > 0)$ is the portion of simulation runs, where the difference $\alpha - \beta$ turned out to be positive. $P(\alpha - \beta > 0 \wedge p < 0.05)$ is the portion of simulation runs, where the difference $\alpha - \beta$ resulted to be significantly positive. Standard deviations of the point estimates resulting from the simulation runs are provided in parentheses.

to be positive. The corresponding probability for correctly estimating the coefficients $\alpha$ and $\beta$ equals 63.4% under $h_0$. The portion of simulations runs where $\alpha$ is greater than $\beta$ results to be 64.8%. This indicates that the influence from the exchange of opinion plays a considerable for price targets published before the economic crisis.
The afore-presented results corroborate the hypothesis of local proximity for German analysts and the hypothesis that analysts are more strongly influenced by their counterparts for the exchange of opinion (at least before the economic crisis). However, there might be an alternative explanation for these findings. An often cited caveat in the literature of social interaction (see e.g. Manski (1993); Brock and Durlauf (2001); Moffitt (2001); Blume et al. (2010)) is that individuals only appear to be influenced by peer group members. In truth, their actions are correlated, because peer group members have similar background characteristics that induce them to act analogously. In my context, this means for the first hypothesis that price targets of German analysts are only correlated, because all German analysts have for instance the same education and therefore use the same method for the evaluation of the market environment. For my second hypothesis, this would imply that analysts exchange their opinion with only those analysts who have a similar way of thinking about investment opportunities, such that price targets are correlated without any actual influence taking place. There are several aspects that can be used to argue against these alternative explanations. First of all, financial education nowadays follows international standards. There are even uniform certificates like the CFA. Therefore, it is not reasonable to assume that German analysts use a different tool box compared to their colleagues working outside Germany. Moreover, the structure of influence has been put in a temporal context. Hence, even if one does not trust the absolute results, there is a significant difference of behaviour before and during the economic crisis. This especially applies for the influence resulting from the exchange of opinion. If one still does not want to believe in the explanations of the structural patterns of influence, then there is at least a clear indicator that the influence among analysts is not homogenous as it is assumed in many empirical studies.

## 4. Conclusion

The results can be summarized as follows. German analysts are more sensitive to the DAX30 price targets of other Germany based analysts than to

price targets published by analysts who work in other countries. This effect is not due to the fact that DAX30 companies are also headquartered in Germany. There finding are consistent with the hypothesis of local familiarity. However, on the city level no empirical evidence in favour of this hypothesis could be provided. Comparing the influence that results from pure observation with the influence from the exchange of opinion, I cannot find relevance of the latter while considering the whole period from 2005 to 2010. However, dividing the dataset into two subsets with price targets before and during the economic crisis starting in 2008 yields, that before the crisis price targets of analysts who exchange their opinion systematically differ from those who don't. This tendency also applies for the analysis on the country level. Before the economic crisis, a German analyst is considerable more responsive to price targets of other German analysts than during the crisis.

Putting the results into perspective, one can draw the following conclusion. Before the economic crisis, analysts indented to differentiate from their peers. They tried to use research advantages provided by familiar analysts or those analysts with whom they regularly exchange their opinion. During the crisis in a time of great uncertainty, analysts were afraid of failing by providing estimates that are too far away from other analysts' results. Therefore, they rather aligned their price targets with the consensus such that the geographical influence and the influence from the exchange of opinion were not or at least less relevant.

On balance, I showed that the influence among analysts is dynamic and not homogenous. Therefore, it is reasonable to use an adequate structure of influence for further research of analysts' herding behaviour.

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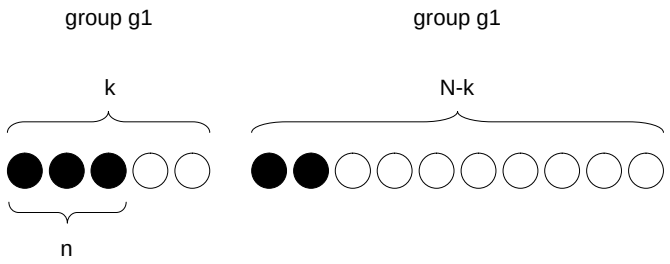
## Appendix A.

In this appendix, the calculation of the probability for correctly estimating the right coefficients of equation 1 in the context of the exchange of opinion among analysts shall be derived. The number of analysts that cover the same company and thus could be potential counterparts for the exchange of opinion from the perspective of a particular analyst shall be denoted by $N$, where $N$ is determined by the database of price targets. The group of analysts with whom a particular analyst exchanges his opinion shall be denoted as $g1$ and contains $k$ analysts, where $k$ is obtained by the answers of the survey. Group $g2$ consists of all other analysts who cover the same company. The number of analysts that are randomly correctly assigned to group $g1$ is represented by $n$. The afore described constellation is visualised by figure A.4. Under the null hypotheses $h_0$, an analyst shall be more strongly

**Figure A.4: Visualisation of the random group assignment**




The figure displays an example of a random group assignment. Filled circles represent analysts that are actual counterparts for the exchange of opinion from the perspective of a particular analyst.

influenced by analysts with whom he exchanges his opinion, i.e. by analysts of group $g1$, than by all other analysts. All analysts of group $g1$ shall have equal influence on a particular analyst. If $h_0$ holds true, then from the perspective of a particular analyst, the following inequality has to be fulfilled such that $\alpha$ is greater than $\beta$ in equation 1:

$$\frac{n}{k} > \frac{k-n}{N-k} \Leftrightarrow n > \frac{k^2}{N} \tag{A.1}$$

From the perspective of a particular analyst, the $k$ analysts of group $g1$ can be separated into $k_1$ analysts who work in the same city, $k_2$ analysts who do

not work in the same city but in the same country and $k_3$ analysts who do not work in the same country. $N_1$, $N_2$ and $N_3$ stand for the corresponding numbers of potential counterparts for the exchange of opinions. For each analyst $i$, the probability that inequality A.1 is fulfilled is given by

$$P_i = P(n > \frac{k^2}{N}) = \frac{\sum_{m=\lfloor \frac{k^2}{N} \rfloor + 1}^{k} \prod_{j=1}^{3} \binom{k_j}{m_j} \binom{N_j - k_j}{k_j - m_j}}{\prod_{j=1}^{3} \binom{N_j}{k_j}} \tag{A.2}$$

$$s.t. \quad k = \sum_{j=1}^{3} k_j$$

$$N = \sum_{j=1}^{3} N_j$$

$$m = \sum_{j=1}^{3} m_j, \; m_j \leq k_j$$

The indicator $I_i$ takes the value one, if inequality A.1 is fulfilled and zero otherwise. Now, the probability that $\alpha$ and $\beta$ can be correctly estimated under $h_0$ is given by

$$P\left(\sum_{i=1}^{C} w_i I_i > r\right), \tag{A.3}$$

where $r$ is the percentage of correct observations in equation 1 in order to be able to correctly estimate the coefficients. For the calculation of equation A.3 in this paper, $r$ is set equal 50%. As not every analyst published the same number of price targets, the weighting coefficient $w_i$ has been introduced. $C$ is the number of analysts who exchange their opinion with at least one other analyst, i.e. $k \geq 1$.