AUTOMATED MOBILE ALERTING SERVICES - TOWARDS A LEVEL PLAYING FIELD IN THE FINANCIAL COMMUNITY

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ABSTRACT

Prompt information processing is one critical factor for successful investments in volatile assets. Whereas web-based financial information systems have successfully contributed to improved information supply for private investors, mobile financial services still lead a shadowy existence. Therefore, this study examines the potential of mobile alerting services empowering private investors to react quickly to critical market events. The analysis of short-term (intraday) stock price movements can show the existence of abnormal returns following company announcements. As these effects persist for a timeframe of 23 minutes on average, a window of opportunity can be proven. To utilize these findings, the price effects are forecasted using a set of figures, metrics and an estimation function. As most of the price effect magnitude and effect delay can be estimated correctly, it is demonstrated how a suitable mobile notification model is able to combine a low level of user-intrusiveness with timely information supply. Furthermore, a prototypical financial notification system based on the proposed effect estimator and the notification model is presented. The approach illustrates how private investors can be notified in time and how to provide prompt decision support in order to enhance the information supply.

Keywords: Automated Mobile Customer Alerts; eFinance; Event Study

1. Introduction

In the financial area, mobile alerting services have been successfully introduced in order to reduce communication costs caused by customer call center calls [Pavich 2004]. Whereas these approaches focus mainly on cost reduction, this paper analyzes the potential of automated mobile alerting services in order to improve the information supply which empowers private investors to react to critical market events promptly. Consequently, the focus is on a mobile service providing additional value for customers being a significant factor for the adoption of mobile banking services [Mattila 2003].

Especially when sending notifications to mobile devices it is of utmost importance to assure a level of user-intrusiveness at a manageable dimension [Reichenbach et al. 1997]. Therefore, it is required to identify events which can have significant impact on the assets held by the investor. The analysis of intraday price behavior following company announcements provides evidence that significant short-term price effects can be observed. Consequently, this analysis is done in order to provide answers to two crucial questions. First, it is shown whether the observed events can have significant impact on the portfolio value and are therefore of interest for the investor. Secondly, the analysis of the period of time in which these significant price effects can be proven provides evidence whether there is a window of opportunity that can be exploited by appropriate mobile alerting services. If the observed price effects are completed within few minutes the investor would not be able to react in time. Otherwise, if the price effects persist for many hours or days a mobile alerting service would not provide much benefit as there would be plenty of time to react.

After reviewing prior studies regarding price effect analysis and effect estimation, an event study is introduced in order to evaluate potential price effects which can be exploited by private investors. Therefore, the observed market events (company announcements), the used dataset (intraday stock price series) and the methodology for calculating abnormal price effects are introduced in section three. The empirical results of this analysis provide evidence that significant short-term price effects can be observed and that these might open a window of opportunity for investors if these effects can be estimated.

The estimation of forthcoming price effects is realized by a multiple linear regression model introduced in section four in order to identify relevant market events and to support investors in making their investment decisions in time. Prior research examining the estimation of intraday price effects proposes text mining techniques in order to evaluate the information content of company announcements and their effects on the capital market. In contrast to

this, the application of company and stock price movement metrics being available from different impartial data sources might provide advantages when estimating intraday price effects following company announcements. As these data sources cannot be affected by the company which has published the announcement, potential manipulation can be eliminated. In this paper the estimation accuracy is evaluated by performing out-of-sample tests of effect predictability.

It is inferred that by using these effect estimators an appropriate mobile alerting service can be designed. As relevant market events can be identified, price effect magnitude and price effect delay can be estimated, an appropriate mobile alerting service is introduced in section five. After identifying service requirements, a prototype is described in order to illustrate how personalized push services can enhance the market transparency by providing prompt information supply. Furthermore, it is shown how the proposed effect estimators can realize mobile decision support for investors and how an integration of mobile push and pull services can provide additional benefits. These benefits address issues which have been identified as critical success factors for mobile banking and brokerage services [Magura 2003; Mattila 2003]. Therefore, the study provides evidence how the proposed brokerage service can provide additional value for customers and how to achieve service convenience by hiding technical complexity. I conclude with a discussion of my results.

2. Related Work

On an abstract level, Lanedri [2002] points out that mobile brokerage enables private investors to react promptly to changing market conditions as customers can be reached in an unrestricted environment. Mattila [2003] analyzes factors which affect the adoption of mobile banking services. Her results provide evidence that customers ask for mobile services which provide additional value and ease of use. Furthermore, insufficient service guidance has been identified as a central inhibiting factor for the adoption. Tse et al. investigate factors which most significantly affect mobile stock trading services [Magura 2003]. Their findings illustrate that service convenience is of paramount importance.

Several authors have analyzed the existence of significant abnormal intraday price movements following company announcements [Barclay and Litzenberger 1988; Patell and Wolfson 1984; Röder 2000; Woodruff and Senchak 1988] but none of these provide evidence how these short-term (intraday) price effects can be estimated.

Barclay and Litzenberger [1988] analyze intraday price reactions following announcements of new equity issues and find negative average returns for a period of fifteen minutes. Patell and Wolfson [1984] analyze the intraday speed of stock price reactions to earnings and dividend announcements and show that most of the observed price reaction is completed within the first fifteen minutes after the publication date. Röder [2000] analyzes intraday price effects following company announcements using intraday price data which is limited to one open, close and cash price per day. Consequently, it gives no insights regarding the speed at which the capital market reacts. Woodruff and Senchak [1988] find prompt price reactions persisting up to one hour after the publication of earnings results.

In this research area Mittermayer [2004] proposes the application of text mining techniques in order to analyze the content of published company announcements. This work is based on the assumption that announcements can be categorized into “good news”, “bad news” and “no movers” and therefore they correlate with corresponding intraday price movements. His results confirm a recognition rate for rating e.g. “good news” as “good news” of between 50 and 60 percent, lying significantly above random classification (33⅓ percent). The author indicates that there is a big problem when analyzing news content with data mining techniques that authors tend to falsify results by using adequate keywords perverting the text processing algorithm. Schulz, Spiliopoulou and Winkler [2003] also propose the application of text mining techniques. They show how to identify relevant announcements in order to reduce information overload by sending identified announcements to mobile devices. Their approach achieves a recognition rate of little more than 50 percent. They conclude that a better recognition rate has to be realized and more research has to be done in order to design an appropriate mobile information system.

3. Market Events, Dataset and Intraday Stock Price Effect Analysis

In this study, ad hoc disclosures pursuant to Section 15 of the German Securities Trading Law (WpHG) were chosen as the events to focus on. Equivalent regulations also exist in other countries, e.g. the Security Exchange Act 1934 in the US or Art. 72 (obligation to disclose price-sensitive facts) of the Listing Rules of the Swiss Exchange, which enjoin companies to publish material non-public information.

The publication of the ad hoc disclosures itself is in most cases done by companies being specialized in the distribution of company announcements on behalf of their clients. In Germany, most of these publications are done by the Deutsche Gesellschaft für Ad-hoc-Publizität (DGAP). Therefore, DGAP is chosen as data source for the ad hoc disclosures to be observed. The observation period covers the time frame between 2003-08-01 and 2004-08-30

during stock exchange trading hours. This limitation is mandatory, as events which do not occur during trading hours cannot cause prompt price reactions. Furthermore, the absence of an opening reaction to overnight announcements can be expected [Francis, Pagach and Stephan 1992]. To be able to isolate the price effect caused by an announcement, confounding events have been identified. If a company has published more than one ad hoc disclosure during a time frame of ten days these announcements were discarded. The used dataset consists of 213 ad hoc disclosures published during the observation period. For each announcement, the stock exchange symbol was identified automatically and the corresponding intraday stock prices were requested starting ten days before the publication date. This was realized by a batch script running each night on an application server being connected to a news feed server (providing the ad hoc disclosures) and a price feed server (providing intraday price series exact to the minute).

The analysis of intraday stock price reactions is based on the calculation of corrected absolute abnormal returns C*AAR*. These returns can be interpreted as returns adjusted by general market trends and lying above an average abnormal return which can be observed during a comparison period without any announcements. The general market trend is covered by the CDAX market index and the average is calculated for the ten days before the event day (period T2). This market index includes the shares of all domestic companies and represents the entire German equity market [Deutsche Börse Group 2005]. This second adjustment is done according to Carter and Soo [1999] but not standardized and can consequently be interpreted easily. C*AARs* were calculated for each announcement *i* and available price fixing *t/t2* exact to the minute.

$$CAAR_{i,t} = \left|R_{i,t} - R_{CDAX,t}\right| - 1/T2 \sum_{t2=1}^{T2} \left|R_{i,t2} - R_{CDAX,t2}\right|$$

The statistical test is based on the accumulation of these returns for different time frames (measured in price fixings) following the announcement date. Therefore, cumulated corrected absolute abnormal returns ($CCAAR_{i,t1,t2}$) were calculated for each announcement *i* and the sequential time frames (*t1,t2*) = (1,2); (3,5); (6,10); (11,15); (16,20). E.g. timeframe (1,2) corresponds with the period of time in which the first two price fixings (exact to the minute) can be observed on the capital market.

$$CCAAR_{i,t1,t2} = \sum_{t=t1}^{t2} CAAR_{i,t}$$

For each timeframe (*t1,t2*) a total number of 213 (number of observed announcements) *CCAARs* can be calculated and be interpreted as a distribution. In order to prove the existence of significant price movements for a specific time frame, the following null hypothesis is formulated for each time frame:

$$H_0 : E\left(CCAAR_{t1,t2}\right) = 0 \quad \text{vs.} \quad H_1 : E\left(CCAAR_{t1,t2}\right) > 0$$

If the hypothesis H_0 can be rejected for a time frame abnormal price movement can be proven for this time frame at a given significance level. The performed *T*-test provides information regarding this significance level which is illustrated in table 1.

Table 1. Intraday Price Effect Significance

	$CCAAR_{1,2}$	$CCAAR_{3,5}$	$CCAAR_{6,10}$	$CCAAR_{11,15}$	$CCAAR_{16,20}$
Mean	0.0334	0.0112	0.0063	0.0014	-0.0048
T-Value	5.94*	2.34*	0.92	0.22	-0.79

* indicates significance on the 1% level

As shown in table 1, significant price effects can be observed for the two sequential time frames (1,2) and (3,5). Consequently, the price reaction is completed within the first five price fixings (effect delay) following the publication date of the ad hoc disclosure (time frame (1,5) is significant with a *T*-value of 5.78*).

An appropriate financial alerting service would have to inform about the announcement promptly or the investor would not be able to react to this event. Consequently, private investors have to be informed via mobile push services, otherwise accessibility cannot be assured. As the number of price fixings does not provide evidence about how much reaction time (in minutes) is available, a conversion to minutes is required. As timestamps of all

price fixings are available, all time frames can be converted to minutes and an average can be calculated. According to this, the first five price fixings correspond with 23.2 minutes on average which can be interpreted as maximum reaction time for investors. Unfortunately, this average cannot be used for alerting services and concrete investment decisions as the number of minutes, which correspond with the first five price fixings, varies exceedingly from announcement to announcement (4 up to 160 minutes).

Accordingly, the observed price effects ($CCAAR_{1,5}$) vary from announcement to announcement. Consequently, specific consideration of each potential price effect is required for automated alerting services and concrete investment decision support.

4. Price Effect Magnitude and Effect Delay Estimation

The observed capital market effects caused by the publication of ad hoc disclosures can be categorized by two dimensions: price effect and effect delay. Whereas the first is the magnitude of the price movement following the announcement (measured by $CCAAR_{i,1,5}$), the second is the period of time after which the price effect is completed (measured by $\Delta t_{i,1,5}$).

In order to evaluate the necessity of an alerting notification, it is required to estimate whether a published ad hoc disclosure will cause a significant price reaction. If so, it is important to estimate the speed at which the capital market will react to this event which in turn determines the window of opportunity of the investors.

A suitable alerting service would have to inform about critical announcements which will cause significant price effects. Furthermore, it is of utmost importance to estimate the effect delay in order to evaluate the potential window of opportunity. As significant abnormal returns can be observed for the first five price movements following the announcement, it is required to estimate the expected value of $CCAAR_{i,1,5}$ and the maximum available reaction time measured by the time frame (in minutes) in which the first five price fixings can be observed ($\Delta t_{1,5}$). Consequently, the goal is to estimate the dependant variables $CCAAR_{i,1,5}$ and $\Delta t_{i,1,5}$ by independent variables. In this study, the expected price effect $E(CCAAR_{i,1,5})$ and the expected price delay $E(\Delta t_{i,1,5})$ are estimated by the following independent variables.

Table 2. Independent Variables for Intraday Effect Estimations

Variable Name	***Variable Description***
$CCAAR_{i,1,2}$	Cumulated corrected absolute abnormal return following disclosure *i* which can be observed for the first two price fixings (used to estimate $E(CCAAR_{i,1,5})$ only)
$\Delta t_{i,1,2}$	Time frame (measured in minutes) which correspond with the first two price movements following the announcements (used to estimate $E(\Delta t_{i,1,5})$ only)
$NoAnalysts_j$	Number of analysts covering company *j* (taken from a data feed provided by JCF Group)
$ln(MCap_j)$	Market capitalization in € of company *j* dated one day prior to the announcement date (natural logarithm taken)
$ln(TradingVol_j)$	Trading volume of the stocks of company *j* in € dated one day prior to the announcement date (natural logarithm taken)
$Index_j$	Index membership of company *j* ($Index_j$="1" if company *j* is member of one of the indices DAX, MDAX, TecDAX or "0" else)

As illustrated in table 2, the expected price effect and effect delay which correspond with the first five price fixings should be explained by the price effect and effect delay which correspond with the first two price fixings. The idea of this procedure is that the first two price fixings might imply a trend which can help to estimate the further development. As the expected price effect and effect delay can be estimated only after the first two price fixings following the announcement are available, one could criticize that this approach is not adequate because valuable time of the window of opportunity is lost. This concern can be neglected as there is a window of opportunity of an average of 12.9 minutes between price fixing two and five.

All other independent variables are available from different data sources or can be calculated promptly when a new ad hoc disclosure is published.

In the following section multiple linear OLS regression is used to estimate the intraday price effects and effect delays following the ad hoc disclosures in order to valuate the generalization performance. Furthermore, the effect estimation is not based on the analysis of the announcement content but on explaining variables which cannot be influenced by the company that has published the ad hoc disclosure.

The analysis is based on the dataset which was introduced in section three ($CCAAR_{i,1,5}$ and $\Delta t_{i,1,5}$ as dependant variables) and calculated or received from external data sources ($CCAAR_{i,1,2}$, $\Delta t_{i,1,2}$, $NoAnalysts_j$, $ln(MCap_j)$,

ln(TradingVol$_j$) and *Index$_j$* as independent variables). From the original data set of 213 it was possible to use 206 for the following analysis (for the remaining seven is was not possible to determine one of the dependant variables). The available dataset tuples were divided into training and testing set in order to evaluate the generalization performance. The analysis covers the forecast performance regarding price effect and effect delay. Therefore, three categories were defined for price effect and effect delay which is illustrated in table 3.

Table 3. Price Effect and Effect Delay Categorization

Price Effect Categories	***Category Definition***	***Category Members***
(1) Negligible Price Reaction	$CCAAR_{i,1,5} \leq 0.05\%$	73
(2) Medium Price Reaction	$0.05\% < CCAAR_{i,1,5} \leq 3\%$	69
(3) Strong Price Reaction	$CCAAR_{i,1,5} > 3\%$	64
Effect Delay Categories		
(1) Prompt Price Reaction	$\Delta t_{i,1,5} \leq$ 6 min.	62
(2) Medium Price Reaction	6 min $< \Delta t_{i,1,5} \leq$ 20 min.	66
(3) Slow Price Reaction	$\Delta t_{i,1,5} >$ 20 min.	78

If the frequency of category members of the training set differs significantly there might be a bias towards the more common category resulting in poorer prediction accuracy for the rarer categories [Groebner et al. 2000]. Therefore the learning dataset contains 50 elements of each category and the remaining 56 elements were used as testing set in order to evaluate the model accuracy.

The chosen explanatory variables might be correlated (e.g. there can be positive correlation between market capitalization and trading volume). Therefore, I performed stepwise multivariate ordinary least squares regressions. The regression was performed for estimating the price effect and effect delay with a tuple size of 150. Table 4 summarizes the results.

Table 4. Multiple Linear Regression Results

	R^2 adj.	Intercept	$CCAAR_{i,1,2}$ $\Delta t_{i,1,2}$	$\ln(MCap_j)$	$\ln(TradingVol_j)$	$NoAnalysts_j$	$Index_j$
I. Price Effect[a]							
	0.809	0.009	1.082*	-/-	-/-	-/-	-/-
II. Effect Delay[b]							
	0.871	46.923*	1.203*	-2.034*	-/-	-/-	-/-

[a] the price effect is measured by $CCAAR_{i,1,5}$; [b] the effect delay is measured by $\Delta t_{i,1,5}$
*indicates significance on the 1% level

Table 4 illustrates that most of the effects can be explained by $CCAAR_{i,1,2}$ and $\Delta t_{i,1,2}$. Furthermore, an increasing market capitalization decreases the effect delay. This finding is intuitive as we can expect that stocks of companies with large market capitalization are traded more frequently.

The respective correlations between the dependant variables and the independent variables are used to forecast the values $CCAAR_{i,1,5}$ and $\Delta t_{i,1,5}$ of the testing set in order to valuate the forecast accuracy of the linear regression model. This is done by comparing the actual category membership of each testing set tuple with the category membership which is forecasted using the linear regression model. If the algorithm is not able to detect any patterns in the training set a recognition rate of 33 percent on average can be expected. Table 5 illustrates the recognition performance of the multiple linear regression model.

The average recognition rate for price effect and effect delay is significantly above 33⅓ percent which provides evidence that the used model has recognized patterns. The worst recognition rate is achieved for price effect category 1 (33⅓ percent) which might be a result of a small category test sample size. Nevertheless, the average recognition rates lie at a level of 64.28 percent and 69.64 percent which is a good result compared to other studies working with data mining techniques [e.g. Mittermayer 2004].

Table 5. Forecast Accuracy of the Multiple Linear Regression Model

Price Effect Categories	***Category Frequency***	***Category Hits***	***Recognition Rate***
(1) Negligible Price Reaction	12	4	33⅓%
(2) Medium Price Reaction	16	13	81.25%
(3) Strong Price Reaction	28	19	67.86%
		Average	64.28%
Effect Delay Categories			
(1) Prompt Price Reaction	20	11	55%
(2) Medium Price Reaction	25	18	72%
(3) Slow Price Reaction	11	10	90.91%
		Average	69.64%

5. Suitable Mobile Financial Notification Services

5.1 Service Requirements and Notification Process

Dewan and Mendelson [1998] found that institutional traders with longer information processing realize lower profits per trade and that superior IT infrastructure can confer competitive advantages. As these institutional traders observe the market development all the time, mobile alerting services could move private investors towards a level playing field. To take into account that the mobile channel can be overloaded easily by a high quantity of push messages it is required to assure that only relevant events raise an alert. This requirement can be realized by the effect estimation proposed in the former sections. Only if a significant price effect and enough available reaction time (measured by effect delay) are estimated the investor will be notified by an alerting notification on the mobile device.

Figure 1 illustrates how an appropriate mobile alerting system would notify an investor about the publication of a relevant company announcement.

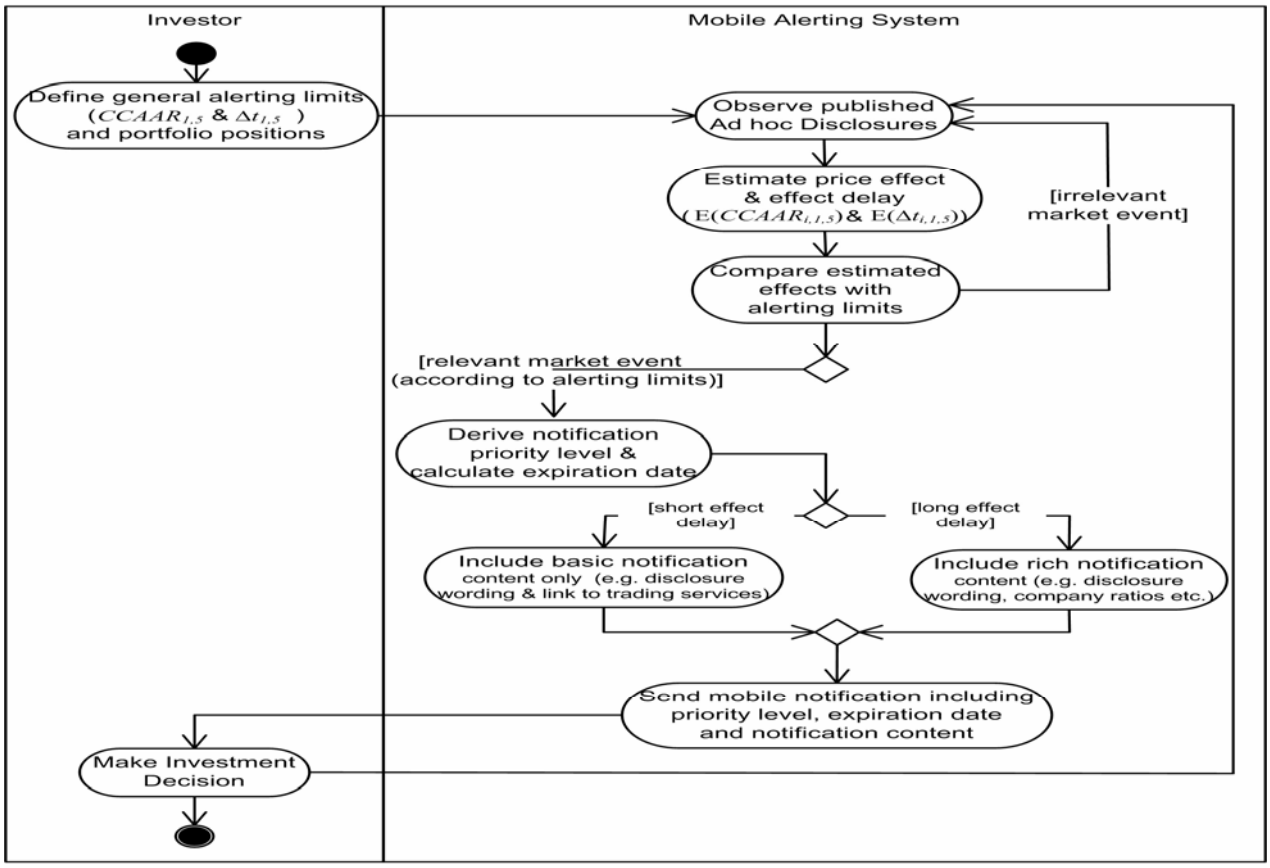

Figure 1. UML Activity Diagram of the Mobile Alerting Model

At first, the investor has to define general alerting limits in order to specify which effects are relevant for the personal investment decisions. The most relevant activity performed by the mobile alerting system is the estimation of the expected price effect and effect delay. This estimation can be done by applying the multiple linear regression model proposed in section 4. If these effect estimations comply with the alerting limits defined by the investor, a notification priority and expiration date (publication date + $E(\Delta t_{i,1,5})$) will be derived. If the derived priority level is appraised as negligible or the expiration date is too soon the publication is identified as an irrelevant market event and no notification will be send. If there is a strong market reaction estimated the notification priority will be set to 'high'. Furthermore, the content of the alerting notification depends on the estimated effect delay. If there are only few minutes available the alerting notification is limited to basic notification content (e.g. including the ad hoc disclosure header and the estimated price effect). These notification rules are summarized in the following table 6.

Muntermann and Güttler [2004] evaluated several mobile push services which can be used for financial mobile push services. Their results show that the WAP Push Service Indication (SI) is suitable as it provides most of the required service characteristics including priority level, expiration date and links to external web services (e.g. trading services to sell the affected portfolio position).

Table 6. Price Effect and Effect Delay Categorization

Estimated price effect category	***Category definition***	***Derived notification relevance***
(1) Negligible Price Reaction	$CCAAR_{i,1,5} \leq 0.05\%$	Irrelevant
(2) Medium Price Reaction	$0.05\% < CCAAR_{i,1,5} \leq 3\%$	Low
(3) Strong Price Reaction	$CCAAR_{i,1,5} > 3\%$	High
Estimated effect delay category		***Derived notification content***
(1) Prompt Price Reaction	$\Delta t_{i,1,5} \leq$ 6 min.	None (irrelevant)
(2) Medium Price Reaction	6 min $< \Delta t_{i,1,5} \leq$ 20 min.	Basic Notification Content
(3) Slow Price Reaction	$\Delta t_{i,1,5} >$ 20 min.	Rich Notification Content

5.2 Prototype Implementation

Building and evaluating IT artefacts (e.g. instantiations) are the two basic activities of design science research on information technology [March and Smith 1995]. In order to demonstrate that the proposed mobile alerting service can be built and to validate its ease of use and the achievement of a low level of user-intrusiveness, the prototype of a mobile financial notification server (MoFiNS) has been implemented. This proof-of-concept approach is one of the major roles of prototypes in research [Olivier 2004]. The prototype is applied for illustrating the capabilities of mobile financial alerting services in a realistic environment and it is proven whether the underlying service complexity can be hidden from the user. It is shown how relevant market events can be identified automatically according to a configuration made by the user. Furthermore, the prototype illustrates how a well-known and popular communication media (mobile messaging) can be utilized to support private investors in time-critical situations and how the integration of mobile push and pull services can provide additional benefits.

The server application was built using a server environment providing access to company announcements (ad hoc disclosures pursuant to Section 15 of the German Securities Trading Law (WpHG) whose price effects were proven in section 3), intraday stock prices and other financial metrics (which were taken to estimate market effects as proposed in section 4). These data sources are accessed via HTTP interfaces providing the requested information as XML data (e.g. there is an interface providing the disclosure body for a given ad hoc disclosure ID).

MoFiNS integrates these different information sources, identifies relevant market events according to the notification rules introduced in table 6 and sends a push message to the mobile device of the investor. These push messages are sent using the Now SMS/MMS Gateway Software which e.g. provides WAP Push Gateway functionality. The gateway uses a mobile phone connected to the server hardware as sending device (for this prototype a Nokia 6310i was used). The structure of the prototype is illustrated in figure 2 which depicts the underlying UML class diagram of the MoFiNS prototype.

So far, MoFiNS does not provide multi-user support because only one notification setting is configurable. Furthermore, all incoming ad hoc disclosures are evaluated regarding event relevance as portfolio specific proceeding would only reduce the number of evaluated events. Nevertheless, the prototype provides good capabilities for validating the applicability of the alerting notification concept. The central class *ServiceManager* is responsible for the entire application management. If a new company announcement is published a new object of MarketEvent is created. *EffectEstimator* is responsible for estimating the price effect and effect delay following the effect estimation rules developed in section 4. Depending on the *NotificationSettings* and the estimated price effects *ServiceManager* initiates a *PushMessage* to be send. Accordingly, MoFiNS evaluates the priority of a market event and calculates an expiration date (publication date of the event + estimated effect delay) for the WAP push message.

The chosen WAP Push Service Indication (SI) provides all these meta data fields for providing additional information [WAP Forum 2001]. The *GUI* of the *ServiceManager* allows e.g. configuring the *NotificationSettings* or observing incoming market events. This GUI, which is depicted in figure 3, includes three major tabs.

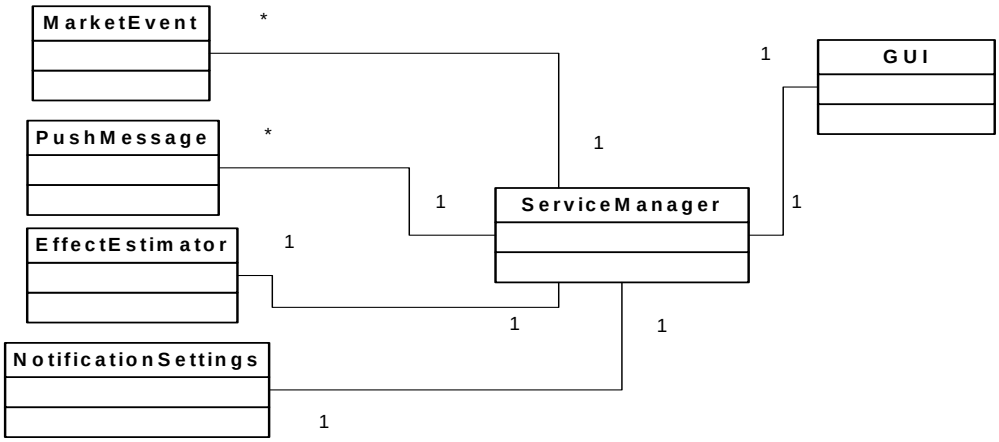

Figure 2. MoFiNS UML Class Diagram

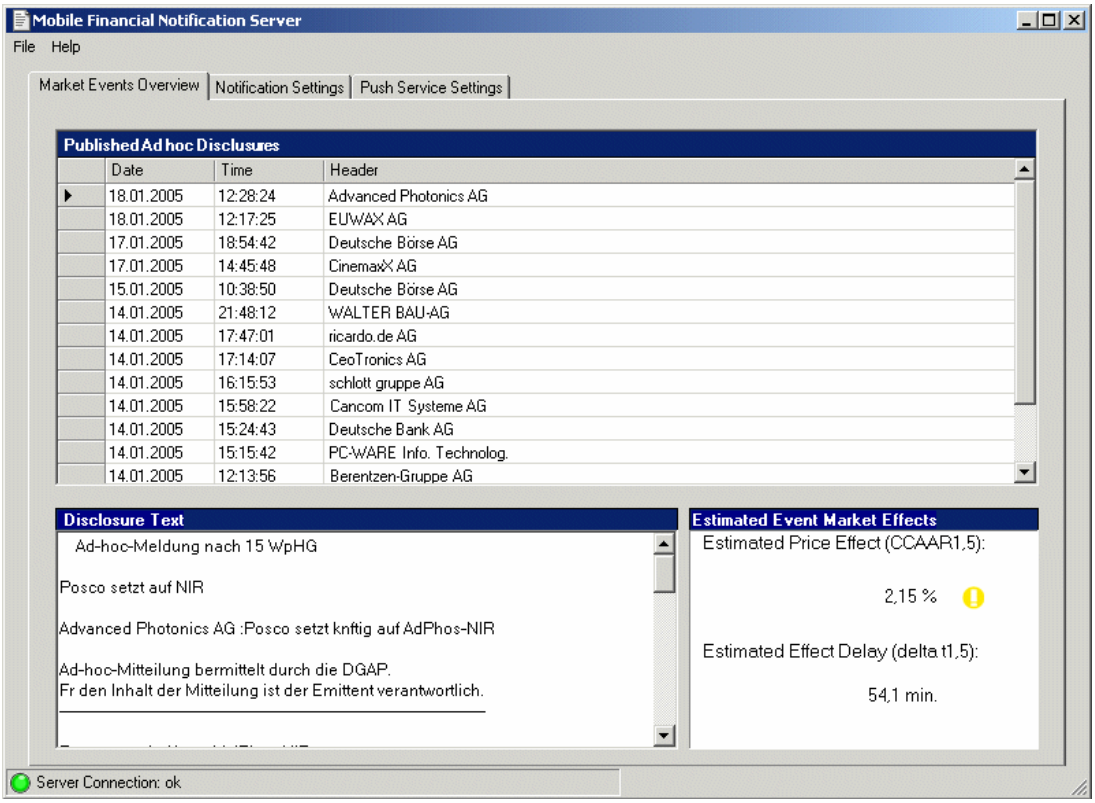

Figure 3. MoFiNS GUI

The first tab provides an overview of recent market events (published ad hoc disclosure headlines). Furthermore, the disclosure body (see bottom left) and the estimated price effect and effect delay are displayed (see bottom right) for a selected disclosure header. The yellow exclamation mark indicates that the estimated price effect is classified as medium price reaction according to the notification settings which can be configured via the second tab (here, the notification setting correspond to the configuration in table 6). Strong price reactions would result in a red exclamation mark and a high priority push message (the proposed WAP Push Messages provide the ability to define e.g. none, medium and high priorities [WAP Forum 2001]) and negligible price reactions will not trigger any push messages. The third tab provides functionalities to configure the push service settings (e.g. IP address of the

WAP Push Gateway, Phone number to which the notification should be sent and a service URL to which the notification should link to).

In the example event depicted in figure 3, MoFiNS will initiate a push message notifying about the ad hoc disclosure published on 18 January 2005 (12:28) by Photonics AG which is illustrated in figure 4.

Figure 4. Example WAP Push Event Alert (Nokia 3450)

As shown on the left, the WAP push message is handled as service message providing access to an external service (which e.g. links directly to external WAP based trading or further information pull services) and the message headline. By choosing the message headline, the mobile device displays the entire message body. Here the investor is automatically informed about the estimated price effect and the estimated period after which this effect will be completed. This data is also utilized to calculate meta information (message details) which can be displayed by the option menu. As shown on the right, the message details provide information regarding creation and expiration date. The latter is calculated automatically by adding up the estimated effect delay and the publication date on the disclosure. The expiration date also identifies messages which are already outdated. If, for example, the push message is received after the expiration date the used Nokia 3450 will discard the message automatically. This behavior reduces the level of user-intrusiveness as the user will not be disturbed by messages informing about events and their price effects which are already completed. As shown, the proposed service overcomes several inhibiting factors identified in former studies (e.g. insufficient guidance, use is complicated, no additional value) [Magura 2003; Mattila 2003]. The service combines clear user guidance and ease of use with additional value for the customer realized by an improved and prompt information supply.

6. Summary and Conclusion

Automated alerting services can provide new functionality to private investors. In recent years, mobile alerting services were mainly introduced in order to prevent customers from calling the cost-intensive customer call centers. Whereas these approaches focus on the reduction of cost at the bank side, this paper proposes the application of automated mobile alerting services notifying private investors about relevant market events (published ad hoc disclosures) in time. Furthermore, the study addresses typical inhibiting factors of current mobile banking services (e.g. insufficient guidance, no additional value, etc.).

Therefore, this paper provides evidence that significant short-term intraday price effects can be observed after the publication of ad hoc disclosures within a timeframe of 23.2 minutes on average and that these price effects can be successfully estimated by a set of describing variables and an estimation function evaluated via linear regression. Compared to prior research, superior forecasting accuracy can be shown for intraday price effects. By applying this forecast methodology, an appropriate mobile notification architecture and prototype has been designed. This prototype is capable of hiding most of the underlying service complexity and does therefore illustrate the adequacy of the approach as it combines ease of use with enhanced information supply. Furthermore, it can illustrate the benefits which can be achieved by the integration of mobile push and pull services. As the proposed notification (mobile push message) can directly link to external resources, it can be shown that this integration provides better user guidance because it is e.g. possible to link directly to a trading service which provides the functionality to trade the effected stock without any manual input (except authentication). Furthermore, it can be shown that a low level of user-intrusiveness can be realized by event filtering, message expiration dates and message priorities.

The presented study has provided insights in how suitable mobile alerting services can provide benefits for private investors but there are still various research questions. Measuring the business value of information technology is one major field in IS research [Barua et al. 1996; Bharadwaj 2000; Kohli and Devaraj 2003].

Consequently, one open question is how to measure the value of the proposed information technology which could e.g. be done by simulating different trading strategies resulting from different levels of information processing delays, trading volumes and trading costs.

Acknowledgements

The author thanks Deutsche Börse Group, DPA-AFX and JCF Group for providing the used data sources. Furthermore I would like to thank IS.Teledata AG on whose server-infrastructure the event study has been performed. The used SMS Gateway software has been provided by Now Wireless Limited. This work of Jan Muntermann is supported by grants from T-Mobile International. I gratefully acknowledge the support.

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