

## OPERATION AND DEVELOPMENT OF ELECTRONIC MARKETS AS PROGNOSTIC INSTRUMENT FOR BUSINESS PLANNING

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*Received 19 08 2005; accepted 30 09 2005*

**Abstract.** Strategic planning is crucial for the survival of a company, wide-ranging decisions about future action must be taken. The information basis for such decisions is often gained from forecasts about the future with more or less accurate probability of the assumed event occurring. Electronic markets have been the subject matter of numerous investigations in recent years and if organized correctly show a high degree of accuracy in forecasting future events relevant to the business of a company. In major enterprises prediction markets have already been used successfully as a new kind of prognostic instrument. It is also suitable, however, for small and medium-sized enterprises for the gathering and assessment of the information available to the employees. When developing prognostic markets it is necessary to take into consideration psychological factors, which could favour incorrect results.

**Keywords:** Market mechanisms, electronic markets, prediction markets, management decisions, prognostic instruments, market research, strategic planning, project management, implied knowledge.

### 1. Introduction

Competition for private enterprises is aggravated by the worldwide increasing deregulation of the markets. Good knowledge of the markets on which the individual enterprise acts as well as the increasing understanding of the market activities are important factors of success for the management. Significant influences on the success of the enterprise can be broken down into the following segments [1]:

- Economy, e.g. inflation rates, interest rates, unemployment,
- Politics and law, e.g. tax law, patent law, political stability
- Socio-cultural influences, e.g. population development, age structure, consumer behaviour
- Technology, e.g. innovation, knowledge transfer

The analysis and processing of information about expected future occurrences in one of the above-mentioned segments is an essential basic principle of strategic planning. Thus, for example, the

determination of sales forecasts constitutes a central element within the business planning.

A precondition of successful planning is the preparation of the decision and the development of predictions for the future. A Statement that is accurate as possible about the probability of future events occurring is also an essential element of the risk management. Numerous instruments were developed for the drawing up of forecasts, in which a distinction is made between quantitative and qualitative methods. While quantitative prognostic instruments establish a connection between values forecast and the influencing factors considered for the forecast with the aid of a prognostic functions, qualitative prognostic instruments are based on estimates of future developments. They are especially suitable for developments and occurrences that are difficult to predict, e.g. for sales forecasts for new products, in the event of innovation or the evaluation of the effectiveness of new marketing measures.

Applicable methods for the prediction of a future occurrence can be described mathematically as follows:

The event that will occur on a point in time  $T$  will be indicated by  $S_T$ . Examples of  $S_T$  can be: prices for raw materials, sales figures, voting results etc. At a point in time  $t$ , which lies before the point in time  $T$ , a prognostic instrument should produce two results:

- (1) The estimate for the occurrence of  $S_T$  subject to the information available at point in time  $t$ .

$$\text{with } s_t := E(S_T / I_t),$$

in which  $S_T$  represents the prediction and  $I_t$  the status of the information at the point in time  $t$ .

- (2) An assessment of the reliability for the estimate.

Typically, this is a standard distribution subject to the information at the point in time  $t$ . In this, the standard variance is calculated as represented below

$$\sigma_{s,t} = \sqrt{E[(S_T - s_t)^2 / I_t]}.$$

## 2. The Delphi Method as an Established Prognostic Instrument

These methods include the Delphi method. The Delphi method is an established prognostic instrument, a qualitative technique of repeated questioning of experts that aims, through intensive questioning, at using the knowledge of the experts for the formulation of forecasts. In this, the experts in a specialist area are questioned in writing and anonymously about the subject matter of the investigation in several waves of questioning. Normally, each person questioned is initially asked to give a written forecast that is as differentiated and well-founded as possible. The results of this wave of questioning are then analysed and passed back to the experts before the next wave, all the while observing the anonymity of the persons, stating the average values and dispersion for the review of their own position and in particular their forecast given beforehand. In the second wave they are then asked with more specific questions to review their previous forecast once again and if necessary state reasons why they have revised or kept to their first forecast in the second questioning. The process can be continued until a clear majority has formed or the experts questioned are no longer prepared to revise their forecasts.

The basic concept of the procedure is the gradual achievement of a consensus through a feedback technique that deliberately tries to avoid the pressure to conform that frequently emanates from group discussions. There are, however, legitimate doubts whether this attempt succeeds, since a fellow traveller effect through the orientation of the experts to the

judgement of the group at least appears very plausible.

The Delphi method is in particular used for long-term technological forecasts. The advantage of this method is that the formation of consensus among experts striven for is normally achieved in practice and that the results gain in quality through repeated feedback. The disadvantage is the effect of the high cost in terms of time and finance and the relatively long throughput times. Moreover, it has become evident that the forecasts by the experts tended to be too optimistic and impediments to implementation and market antagonism were underestimated.

## 3. The Further Development to an Electronic-Based Prognostic Instrument

The functions of markets not only include the allocation of resources, but also the gathering of information about the value of these resources. An example of information that was gained from markets and used in enterprises is share prices that furnish the enterprises with information about the value of their activities. Futures and securities options sum up the expectations of the investor regarding the occurrence of future values of securities. In most cases, forecasts of the future are also a side-effect of the market activity. On the other hand, now, however, markets have been created with the main objective to evaluate the knowledge of the market participants for the gaining of information.

In the USA in recent years electronic bourses have been the subject matter of numerous studies. In the '80s, an electronic market place was created at the University of Iowa, originally to provide the students with the possibility to operate trade on an Internet platform and thereby to get to know market legitimacies [1]. This gave rise to the idea to use electronic markets for the aggregation of information. There arose so-called prediction markets with the objective to achieve a crystallization of information through the market's own dynamism and thus be able to make predictions of the future with a higher probability that the predicted event will occur. The observation of these markets is the subject matter of various scientific investigations that provide important results for the operation in enterprises.

## 4. The Recipe for Success of the Electronic markets

The system of the prediction markets uses the medium of the Internet for questioning, as the market place for

the probability that events will occur. In the electronic market, one of the basic problems of qualitative procedures relates to the difficulty in selecting experts who are able to make corresponding informative statements about the future. Electronic markets are distinguished by a high number of provided and buyers as well as through the absence of hierarchies. A uniform product is traded: the bet on the occurrence of an event.

For prediction markets, the following characteristics apply:

- Simplified market access, any time, any place.
- No information asymmetries, i.e. each participant obtains the same information about the product "bet".

The marketing results are influenced by the market participants and their expectations, experience and their interpretation of the market information. They are suitable as prognostic instruments, for they have a high rate of accuracy. This is also shown by the example of I.E.M Iowa Electronic Markets. Here, above all, bets are placed about the occurrence of political events; the predictions constantly outperform the results of other election polls.

Another successful example is the Hollywood Stock Exchange. In 2002, here 45 of 50 Oscars were forecast correctly; bets were made with play money, so-called Hollywood dollars. The probability of an accurate prediction is, however, lower when using play money than in the case of real bets. Bets on sporting occurrences can also be made in the Internet, e.g. on the website tradesports.

Instead of using the advice of a selected body of experts as a source of information, as in the case of the Delphi method, information accessible to the general public is sought in the Internet. In this, an incentive to pass on information is the game and the profit hoped for. In the game, the ambition of the market participant is aroused by the best information. Market results are all the more accurate the larger the number of those participating and the number of market activities and the fewer possible occurrences that are available for selection.

Electronic markets gather information from individual participants. The knowledge available to these, emanating from various sources, is assessed at the value of the resulting market price. Each participant invests all the more in a betting stake the more accurate his/her information is and the smaller his risk of loss is. In this, there are no hierarchies; everybody has just as much influence; all opinions are valid. In the scope of prediction markets, there are no

speculation bubbles, as, for example, are known from the stock markets, since they are normally made subject to a time limit and geared to a certain result. By setting a fixed deadline, in the end, everybody wants to "pass the buck" and unsound overvaluations are adjusted promptly. Many years of observations by Iowa Electronic Markets have shown that above all markets that are geared to occurrences lying in the near future provide particularly effective results [2].

Prediction markets thus open new ways for market research. In contrast to established procedures, they are distinguished in that they accumulate complex market information dynamically and thus make possible very much shorter reaction times than with traditional methods.

Prediction markets such as for example the Iowa Electronic Markets have more advantages compared with the questioning of experts or election polls. The participants take part in the market on their own initiative; this is not about, as for example in the case of election polls, coincidental, representative random sampling or, as in the case of the Delphi method, a specially selected committee. The IEM traders thus take part out of their own interest with the corresponding motivation. The market price achieved is a weighted average value that is dependant on the behaviour of the traders and the market dynamism. It reflects the degree of confidence in one's own opinion, but also a number of other factors such as aggressiveness, risk aversion, timing or the financial circumstances of the trader. Each trader can observe market changes by itself and in the course of this sees how the other market participants evaluate the situation. Since the individual can set his/her own behaviour in comparison with the behaviour of the other players, he/she is rather prepared to reconsider his/her own attitudes. The scientific observations of the Iowa Electronic Markets have shown that electronic markets react directly to new information [3]. These lead to increased market activities of the traders, so that a new pricing structure resulting from this arises very quickly.

## 5. The Function of the Prediction markets

The function of the prediction markets will be explained briefly in the following section.

One possibility of the development of electronic markets is the so-called linear markets [4].

- Bets are made on the occurrence of a future event with the possible variation  $v_1, v_2, v_3, \dots, v_n$ , whose result is the sum 1.

- A combination of the various variants  $x\%$  of  $v_1$ ,  $y\%$  of  $v_2$ , ... can occur, the probability of an event occurring corresponds to the average value.

Prediction markets that were supposed to predict such occurrences would thus have chances of winning corresponding to the occurrence of the events. If, for example, percentages that candidates achieve in an election are to be determined, a market would be created, in which the market participants deal with securities with the value that corresponds to the result of the election forecast. The market price of the betting slips results in the prediction of the election outcome.

- Bets are made on the election result of the individual parties in %.
- After the occurrence of the event, each security obtains 1 \$ multiplied by the share of the party that has betted in the overall result.

A second kind of prediction markets is the so-called "the winner takes it all" procedure.

- A complete number of events  $E_1, E_2, \dots, E_m$  is provided; the betting proceeds are dependant on the occurrence of the respective events.
- Only one variant can occur, either 100% of  $v_1$  or 100% of  $v_2$ , with the probability of the individual occurrence.

Represented using the example of the election, this shows the following market quality:

- Bets are made on a presidential candidate; one part of the bets for the candidate actually elected wins 1 \$.
- All shares are bundled as uniform portfolios consisting of all possible variants, put into circulation at a fixed price.
- Transactions between the traders occur at prices that were created by the market participants. The buyers can trade at the current market price or set limits.
- The prices for the betting slips regarding the individual candidates correspond to the election result forecast.

A third development possibility is the so-called qualified prediction markets.

- There is a first number  $v_1, v_2, v_3, \dots, v_n$  with index  $i$
- and a second number  $E_1, E_2, \dots, E_m$  with index  $j$ , in which the 2nd result will occur at the same time or before the 1st result.
- With this, a numbers of qualified occurrences can be formed,  $V_i / E_j$ .
- The probability that  $V_i$  will occur is determined subject to the condition that  $E_j$  applies.

Examples are qualified occurrences are e.g. election results for the Democratic candidates subject to the condition that a certain candidate A lines up for the Democrats, as against the election results for the Democrats subject to the condition that candidate B lines up for the Republicans.

## 6. Outline Conditions for the Gain of Information by Prediction Markets

An essential role in connection with the result of questioning about the probability of future events occurring is played by effects that influence the behaviour of the market participant in such a way that irrational decisions are made. The market prices in electronic markets thereby achieved thus no longer reflect the existing information basis. In the framework of scientific investigations into decision-making, two conspicuous features were discovered: the so-called certainty effect and the effect of immediacy [5].

The certainty effect describes the inclination to attach a disproportionately great importance to events that are certain to occur. If two test persons for example have to decide on the election for 30 \$ with a 100 % probability of the predicted event occurring or for 45 \$ with an 80 % probability of the predicted event occurring, the overwhelming majority would decided on the certain alternative for 30 \$. In a second attempt, the probabilities were kept in the same proportion, however, divided by the factor four. The test persons could now decide on the occurrence 35 \$ with the probability 25 % or on the occurrence 40 \$ with the probability 20 %. Here, most test persons selected the occurrence with the highest expected value, namely the occurrence 40 \$. Decision-makers thus do not make their decisions according to a linear function, corresponding to the probability of an event occurring, but as a rule also decide on a certain alternative, if available, when this rationally does not represent the best alternative. The closer the probability of an event occurring lies to 100 %, the more likely the persons selecting are to decide on this occurrence.

The effect of the immediacy shows parallels to this. In this, decision-makers attach disproportionate importance to immediately occurring occurrences. Thus, they preferred for example 30 \$ today in comparison with 45 \$ in one year. If both possibilities 30 \$ in one year or 45 \$ in two years could be selected, however, the test persons selected 45 \$. If a decision-maker this has the choice between an immediately occurring alternative or a possibility occurring only later, he/she will rather decide on the event occurring immediately, even if this alternative

is purely rational for him/her and not the most favourable economically.

A further characteristic feature of human decision-making that can lead to errors in forecasts is the effect of wishful thinking, also referred to as unrealistic optimism [6]. Studies by social scientists show that individual persons overestimate the spread of their own views in the population. For this reason, the chances of the party preferred by the selector are overestimated. This can now lead to the outcome that based on this overestimate more shares of the preferred party are acquired than would be expected on the basis of the existing information. Furthermore, it was also established that so-called “good news”, i.e. is favourable information for a party, tends rather to be spread by market participants where the party preferred by him/her is concerned.

Also, in electronic prediction markets arbitration effects can occur, which can falsify the result.

If prediction markets are to be used as prognostic instruments, phenomena such as those represented above must be taken into consideration both during the development of the market and during the evaluation of the results.

## 7. Future Possible Uses of Prediction Markets

Prediction markets are distinguished above all by the following characteristic features:

- They provide a stimulus for the search for information.
- They are an incentive for the true and accurate passing on of information.
- They bring about the aggregation of various opinions and are a collecting tank for information.
- They provide predictions with a high degree of accuracy in a brief period.

For these reasons, they are suitable to be able to provide enterprises with forecasts for occurrences that affect the future of the enterprise. By using the market information from artificial markets, risks can be better assessed and hence crises are anticipated.

For enterprises, this gives rise to the chance to gather the collective intelligence of their employees and use this as a valuable information basis for future management decisions. Especially in the service sector, the employees interact closely with the customers and, in this, gain essential findings about customer needs. It appears meaningful, therefore, to retrieve this experience and use it for the further

development of the range of goods and services provided by the enterprise. Thus, strategic business planning could no longer be determined by the executive management focussing on the main points, but on the basis of the knowledge existing in the entire enterprise.

Plott [7] describes the following operation of an artificial market for the prediction of future sales figures:

An enterprise wanted a forecast on the sales of a certain product at a certain set date a few months in the future. For this, the information, opinions and notions of the sellers were inquired into. In this, one assumed that each single seller only had little knowledge while the entire team would possess considerable knowledge. By gathering and organizing this information, one hoped for an additional positive effect on account of the fact that the individual seller could compare his/her experience and opinions with those of the other sellers and possibly revise these.

An electronic market has now been created with 10 possible alternatives for future sales figures for the product concerned for the month defined. In this, the sellers could in each case bet on one range; the result 1 represented the sales figures from 0 to 1500, the result 2 from 1501-1600 etc. Only the share with the range in which the sales actually achieved were in the month concerned generated a profit of 1\$. The development of the prediction market thus corresponds to a “the winner takes it all” procedure as described above. Each participant obtains 20 shares of each alternative at the beginning. The participants can then trade freely with the shares in the course of a few days. The objective was to show whether the price of the respective betting slips actually permitted a statement about future sales figures. In actual fact, the sales range from 1901 – 2000 achieved the highest price, i.e. the seller of the enterprise assumed these sales figures as the most probable. This experiment was repeated 16 times in the enterprises concerned, and the results ensuing from this were 15 times closer to the sales figures actually achieved than the predictions that were made with other prognostic instruments.

The enterprise Hewlett-Packard already uses artificial markets for sales forecasts. Employees could buy fictitious shares, depending on how they estimated the sales success. After three years, the predictions were 75 % more accurate than with traditional prognostic instruments. In this, while only a smaller group of employees were addressed, however, the employees

were selected from all departments of the enterprise in order to be able to tap as many different sources of information as possible. In addition, uninformed speculators were involved in order to ensure the liquidity in the market and to limit illogical market behaviour. In this, the market provided more accurate results than the management questioned.

Also in the case of Siemens, electronic markets are already used for predictions. In collaboration with The Vienna University of Applied Science [TU Wien] and Siemens Austria, a field test regarding the possible use of a prediction market in the project management was carried out [8]. A considerable challenge in project management is the controlling of set dates and deadlines and the associated costs. However, the sooner delays are established, the easier it will be to guarantee the success of the project. In the scope of a software development project from the telecommunications sector with ca. 200 employees and a planned term of 6 months two prediction markets were created. In this, the two questions put were: "Is the project completed on schedule?" and "How long will a possible delay be?" It turns out that the project employees recognized very early that delays would occur in the project, although the check of the official project time schedule still resulted in no deviations.

Particularly the construction industry, as a sector strongly influenced by fluctuating economic cycles, is independent of a good assessment of the future chances of the enterprise. Engineers and architects, as service providers, have the opportunity to collaborate closely with their customers. This concerns in particular the project teams, which mostly manage a building project in an interdisciplinary way jointly with the customer. For the executive management, it is now decisive for the success of the enterprise to request from their employees the information generated in the course of this regarding the requirements of their customers, but also regarding any future building materials. The electronic markets might be suitable for this. An operation in the planning office is quite conceivable, in particular also because in the offices of small and medium sized enterprises the work with the Intranet or with project-specific Internet-based project room has been established. Reservations of the employees with regard to the medium of the Internet are therefore not to be feared.

## 8. Summary

The high probability of accurate predictions of the electronic markets was in many cases evidenced experimentally in many scientific investigations. In the Internet numerous players took part in electronic bets

on the widest possible range of topics from the presidential election to the Oscar awards. Electronic markets are able to gather and aggregate widely scattered information, and publish the knowledge gained in the form of prices. For this reason, they can be used as a prognostic instrument for the management of decisions. For certain sets of questions, prediction markets provide very accurate results; particular features of human decision-making behaviour must be taken into consideration however. Prediction markets provide the best predictions for the occurrence of specific events; they are less good for combinations of results, many dissimilar variants or other more complex sets of questions. Participation by players with insider information should also be avoided.

Larger enterprises have already recognized the chances resulting from this and use internal bourses in order to retrieve information and implicitly available knowledge of their employees. The forecasts about the future are an essential part of the strategic business planning.

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