BAYESIAN APPROACH TO FORECASTING IN SMALL FIRMS

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Abstract. The authors, represented the University of Huddersfield *in United Kingdom and Omsk financial university in Russia, investigate the problems of forecasting in small firms. On the basis of studying activity of Russian and English forms there are educed the barriers on the way of effective realization of a such important function of management as forecasting. It is proved that for small frims the Bayesian approach is the most acceptable for forecasting, the distinctive peculiarity of which is using, on the way with objective, subjective information, which may be obtained and systematized on the basis of subjective judgements of entrepreneurs who have a small business. As a practice shows, exactly subjective judgements play the significant role in making managerial decisions in small business.*

Keywords: forecasting, small firms, Bayesian approach, managers.

The need for the forecasting in small firms

This paper examines the forecasting practices of small firms and then goes on to discuss the application of Bayesian decision theory in the production of forecasts for small firms. The management of many SMEs feel unable to use formal objective forecasting techniques because of a lack of information to start off the forecasting procedure. Evidence from the authors own work suggests that the management of many small firms make no formal forecasts at all. However, a more robust procedure is available which overcomes the lack of initial starting information for forecasting - and this is based on Bayesian decision theory. In a sense many small firm entrepreneurs are inherently 'Bayesian' in their thinking approach to predicting events in that they often rely on subjective estimates at least for initial starting values. The basic principles of Bayesian forecasting procedures should be relatively easy for small business managers to grasp and apply. More importantly Bayesian forecasting utilises both subjective and objective methods. Small businesses should be both comfortable with, and have, subjective knowledge and experience, and encouraging them to use, in part, a more objective approach, can only strengthen their forecasting competence. Such a procedure should be well within the competence level of the majority of small business managers and has the added benefit of utilising their own experience and judgement. Hence such a procedure should not only be useful to the small business manager but should also have strong intuitive appeal as the initial starting conditions of the model is based on the managers own judgement SMEs make an invaluable contribution to the wider economy in both Russia and the UK (but which is often overlooked) including increasing competition, creating jobs, building effective networks, sharing knowledge and making a positive contribution towards social inclusion. The importance of small firms and entrepreneurship generally in achieving economic growth in contemporary economies is widely recognised both by policy makers and economists. Small firms are big business: they contribute significantly to employment, turnover and the number of businesses in the UK.

In the UK as a whole, SMEs account for over half of employment**.** This is also true for each region and counter in the UK except London. For each region and country in the UK, no more than 0.2 per cent of enterprises are large (250 or more employees), and at least 99.0 per cent of enterprises are small (0 to 49 employees).

The development of small business in Russia has been affected by crucial decisions of central government by which the taxes have been cut and 'red tape' reduced. As a result the registration of new enterprises has become both simpler and cheaper and consequently the number of small businesses has grown. The situation in Omsk region is indicative of Russia as a whole.

However, where Omsk does differ is that for many years it used to be one of the most important industrial centres in Soviet Union producing electronics, engines for aircraft, agricultural eqummeiit and many other engineered goods. However after perestroika Omsk industry has collapsed. Some years ago small businesses in Omsk mostly represented trade services. However since 2000 positive changes have come to life, industrial enterprises have started up, and the education and preparing managers for planning and forecasting practice became extremely important [1].

Alongside the positive trends mentioned above, Russian small business are experiencing

some particular obstacles at the moment. Research and monitoring at the Omsk University of Finance show that these obstacles as a whole are quite similar to these in Omsk region and can be summarized as: the lack of professional and political integration of businessmen. It means that there is no small business lobby in Russia which could influence some real official decisions; the lack of trust to the state and its representatives. Central and local government provide some assistance for small business but in practice businessmen either are not ready or don not want to get it.

We do believe that the successful development of small enterprises both in Russia as a whole and in Omsk region depends on cooperation and communication between businessmen themselves and between them and the state.

At the first stages of forecasting the recognition of *its importance* was first illustrated in the United States by Ledbetter and Cox [2]. They found that forecasting techniques were used by 88 per cent of the 500 largest US industrial companies. It was also established that no other class of planning techniques was used as much as forecasting. The central issue facing businesses is not whether to forecast, but *how* to forecast. The forecaster can choose 'subjective' or 'objective' methods or a mixture. Here we have to mention the works by E. Yanch who gave the classification of 100 methods of forecasting and by V. Byalkovskaya who outlined the ways of application of different methods in different functional areas of firms.

The availability of appropriate data is of central importance to the development of any forecasting system. Obviously dependent upon the degree of accuracy required, most forecasting techniques require a considerable amount of data collection and processing. The selection of the most suitable forecasting technique depends on the availability of existing data and/or company's ability to acquire such. For example, a technique requiring a long historical time series would be of little use if data was only available for the past year. If data accuracy or validity were questionable, it would hardly be worthwhile, or cost-effective, to spend time and effort using a sophisticated technique known for its precision. In forecasting, the principle of 'garbage in/garbage out' applies; a forecast will only be as good as the data used in its compilation.

The management of all firms - and SMEs are no exception- are involved in making decisions about the future *but* in the present. In a sense that is what the job of management is really all about, at least at the more strategic level. The act of preparing for the future whether in business or any other area of our lives implies forecasting, consciously or subconsciously, of tomorrow's condition. In our personal lives, such predictions are usually made on an informal, subjective basis. If they turn out to be wrong, we can usually adjust our personal circumstances. However, we rarely enjoy the same degree of flexibility in our working lives, particularly if we are an SME owner manager. Managerial decisions are usually of a more formal nature and of greater consequence. The very nature of such decision-making involves forecasting future conditions. It is not a question of whether managers should forecast or not but merely how are they to do it? Small firms are often considered to lack formal marketing skills and project management skills, however forecasting is fundamental to management's ability to plan, budget and control. They are the bedrock of all other management forecasts since they are dependent upon an accurate sales forecast. These forecasts then form the basis of budgetary control systems.

Managerial decisions are not always strategic and much of a busy manager's time is taken up with day-to-day operational issues which, although not of the same magnitude as strategic decisions, are nonetheless important to the manager because of the proportion of their time that they occupy. Management requires forecasting information to assist them in making operational decisions, although the required time horizon for such forecasts is shorter than for strategic decisions. For example, for the marketing manager to set monthly sales targets, operational expense or advertising budgets, they may require regular short-term forecasts for each product, broken down according to product type, size, colour, salesperson's territory, channel of distribution and even by individual customer. Whatever type of decision is being made, forecasting is required. Forecasting can make a contribution to the successful management of the small enterprise, whereas poor forecasting can lead to high inventories and associated stockholding costs which must be paid for out of working capital, or under-production and unrealized market potential.

Bayesian decision theory

All firms, of whatever size, need to make predictions or forecasts about future conditions. The term 'prediction' is often reserved for subjective 'qualitatively' based forecasts, for example: the sales force composite technique. Whereas the term 'forecasting' is often used for objective 'quantitatively' based forecasting

procedures e.g. moving averages, exponential smoothing, regression etc. Bayesian forecasting is a mixture of the two and involves both objective and subjective forecasting elements.

Forecasts may be required for an important 'one-off ' decision such as when a business may be considering expanding by acquisition, diversifying into a totally new market or modernising its production processes. Such decisions tend to be long-term and strategic, rather than operational. In such situations, because of the importance of the decisions being made, it is important that forecasting receives careful consideration, meaning an investment of time and money in the forecasting process. However many of the decisions the small firms managers have to make are more routine tactical or operational.

The need for an adequate and appropriate forecasting framework can be linked to the literature on growth and life cycle models related to small firms Scott and Brace argue that a small business develops by moving through five growth stages, each with their own characteristics [3]. Because the transition from one stage to the next requires change, it is accompanied by some crisis or another. Crises tend to be disruptive and problems of change can be minimised if managers are proactive rather than reactive. Thus crucially, forecasting may help them in this respect. Prior knowledge of what generates crises and of what to expect in each stage will smooth the process of change and may improve their chance of adequately dealing with the crisis and hence survival.'Scott and Bruce claim that they have tested the model and that it is robust enough for them to.

Be able to generalise across all small firms. Albeit that organisations move along the curve at different speeds and the spacing of crises are likely to differ between firms and industries. Indeed, the original authors were themselves aware of these limitations and argue that what they provided was:

«A diagnostic tool to assist in analysing a firm's present situation. It is also meant to be an indicator of what strategies appear suitable at various stages in an organisation's growth. It is, however, only a tool and cannot make the decisions for management. They must rely on their judgment for that. Hopefully that model will add to their information and thus enable them to make better judgments»

As indeed would the adoption of Bayesian forecasting that both exploits and plays up to the exercise of informed judgement.

Probability theory studies the possible outcomes of given events together with their relative likelihoods and distributions. In fact there is considerable debate about exactly what probability means in practice. Some mathematicians regard it as simply a component of abstract theory, while others give it an interpretation based on the frequencies of certain outcomes. However the Bayesian approach is a mixture of both subjectively derived probabilities and mathematically derived; likelihoods. This technique is named after Reverend Thomas Bayes (1702 to 1761), a statistician [4].

However some account of Bayes and his early work is of enough specific interest to the topic of this paper to discuss below. Bayes set out his theory of probability in 'Essay towards solving a problem in the doctrine of chances published in the Philosophical Transactions' of the Royal Society of London in 1764. The paper was sent to the Royal Society by Richard Price, a friend of Bayes, who wrote:

«I now send you an essay which I have found among the papers of our deceased friend Mr Bayes, and which, in my opinion, has great merit... In an introduction which he has writ to this Essay, he says, that his design at first in thinking on the subject of it was, to find out a method by which we might judge concerning the probability that an event has to happen, in given circumstances, upon supposition that we know nothing concerning it but that, under the same circumstances, it has happened a certain number of times, and failed a certain other number of times».

Despite the fact that Bayesian Decision theory was developed in the 18th century, it has only recently been widely adopted. The method incorporates the firm's guesses at data inputs for the statistical calculation of sales forecasts. It uses network diagrams showing the probable outcome of each decision alternative considered. These are shown together with expected values and associated probabilities, initially derived on a subjective basis Bayesian statistical forecasting, like all Bayesian statistics is based on two basic concepts. First, uncertainty about unknown quantities is expressed using the language of subjective probability, and, given new information or data, probabilities are updated using Bayes rule or procedure.

Many statisticians and forecasters believe that Bayesian inferential methods have advantages over classical statistical procedures for a wide range of inferential problems mainly because the initial stating probabilities are arrived at subjectively thus opening up the potential of statistical inference, including sales

forecasting applications, to a much wider range of problems, particularly those sorts of problems often found in marketing. One of the problems of using probabilities in a statistical model is in ascertaining initial probabilities to commence the forecasting process Bayesian statisticians differ from 'purist' statisticians in the respect that 'purists' view the concept of probability as the relative frequency with which an event might occur. The Bayesian view is that probability is a measure of our belief and that we can always express our degree of belief in terms of probability. Although the initial probabilities are derived subjectively (the figures are based on judgmental opinion, rather than on objective calculation) proponents of Bayesian theory believe that such probabilities are perfectly valid and hence perfectly acceptable as initial starting points in an extensive quantitative forecasting process. It is this subjective nature of arriving at the initial probabilities that makes the Bayesian approach useful in solving business problems for which initial probabilities are often unknown and are difficult or impossible to calculate using objective methods.

To use the Bayesian approach, the decision-maker must be able to assign a probability to each specific event. The sum of the probabilities of all such events considered must be unity (one). These probabilities represent the magnitude of the decision maker's belief that a particular event will take place. In business situations such decisions should be delegated to personnel who have the knowledge and experience to assign valid initial subjective probabilities to the occurrences of various business events. These initial probabilities are based on previous experience of information (such as published secondary data or simply the manager's own subjective judgement based on experience) acquired prior to the decision-making process. For this reason, the initial subjective probabilities are referred to as 'prior probabilities'.

When making business decisions, the financial implications of actions must be taken into account. For example, when a manager is considering investing a firm's surplus cash, they must consider the probability of making a profit (or loss) under different economic scenarios and also assess the probability of such scenarios or events occurring. Applying Bayesian decision theory involves selecting an option and having a reasonable idea of the economic consequences of choosing a particular course of action. Once the relevant future events have been identified, the decision-maker assigns prior subjective probabilities to them. The expected pay-off each

act is then computed and the act with the most attractive pay-off is then chosen. If pay-offs represent income or profit, the decision-maker usually chooses the act with the highest expected pay-off.

Evidence from the literature and from the primary research from case study one presented below, suggest that many managers and owners in small firms tend to favour their own subjective judgement when asked to make decisions involving predictions. Thus Bayesian forecasting procedures would seem to offer an interesting option given that it offers a good 'fit' between the forecasting requirements of small firms and those skills that small firms managers/ owners seem to rate most highly i.e. the use of their own subjective judgement [5].

Two obvious research questions follow on from this, firstly to what extent do those SME owners and/or managers who declare themselves to be entrepreneurial and/or marketing competent - or given the interests of the audience for this paper - both, feel more comfortable with a Bayesian approach. This could be crudely summed up as: are entrepreneurs Bayesian? Secondly what forecasting, if any, and of what type do SMEs practice?

Evidence from the empirical work suggested that the majority of small firms in the UK and Russia do not use forecasting procedures in any meaningful way.

Even so the use of a Bayesian type approach to strengthen forecasting is still a foreseeable possibility. Particularly because such forecasting is within the skill set of many small businesses particularly when a simple persona! computer programme can be adopted. Indeed the very notion of a Bayesian approach - the combination of subjective and objective methods allows the small business to be comfortable with utilising their subjective- knowledge and experience. Equally the combining of subjective knowledge within a more objective scenario might well encourage more thoughtful and accurate forecasting with the commensurate benefits as discussed in this paper. For those who need to be encouraged to start more formal forecasting, Bayesian decision trees, for example, could provide an intuitive and logical starting point. Forecasting should not simply be for the larger and more established SMEs.

Given that the evidence from the literature reveals that many small firms underperform or even fail completely because of poor planning skills, especially longer term planning skills, then forecasting using a Bayesian approach should be encouraged. Given that forecasting is needed at all time horizons if a business is to be

managed properly, small businesses should be encouraged not only to forecast better but to develop short, medium and long term forecasts for different types of decisions.

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БАЙЕСОВСКИЙ ПОДХОД К ПРОГНОЗИРОВАНИЮ В МЕЛКИХ ФИРМАХ

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Аннотация. *Авторы, представляющие университет г. Хаддерсфилд в Великобритании и Омский финансовый университет в России, исследуют проблемы прогнозирования в малых фирмах. На основе изучения деятельности российских и английских фирм выявлены барьеры на пути эффективной реализации такой важнейшей функции менеджмента, как прогнозирование. Показано, что для малых фирм весьма приемлемым является Вефианский подход к прогнозированию отличительной особенностью которого является использование на ряду с объективными, так называемой субъективной информации, которая может быть получена и систематизирована на основе субъективных суждений предпринимателей, занимающихся малым бизнесом. Как показывает практик, именно субъективные суждения играют значительную роль в принятии управленческих решений в малом бизнесе.*

Ключевые слова: *прогнозирование, мелкие фирмы, Байесовский подход, менеджеры.*

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