The role of real-life examples in teaching business statistics course

Andrei Kolyshkin [a]*, Department of Engineering Mathematics, Faculty of Engineering, Riga Technical University, LV-1001, Riga, Latvia.

Abstract

Case study method is one of the widely used methods in MBA programs around the world. Its effectiveness has been demonstrated for marketing and management courses. It is rather difficult to implement case study method for quantitative courses (such as a managerial statistics course). The challenge is to use this approach for basic statistics course assuming that students did not have statistics course before. In this paper we discuss a case study related to evaluation of study programs in Latvian universities and colleges in 2012. In addition, three real-life examples from different areas of statistics are also analyzed. The case study and real-life examples were gradually introduced in a business statistics course during the period of several years. Analysis of the results of the survey among students showed that not only the interest to the course has risen but also the willingness to apply statistical methods at work.

Keywords: Real-life problem; business statistics; measurement scales; regression analysis; sample.

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* ADDRESS FOR CORRESPONDENCE: **Andrei Kolyshkin**, Department of Engineering Mathematics,Faculty of Engineering, Riga Technical University, LV-1001, Riga, Latvia.
E-mail address: andrejs.koliskins@rtu.lv / Tel.: +371 67 089 333

1. Introduction

Teaching statistics for business majors is not an easy task. Some students do not have strong background in mathematics, some are not so interested in the course since it is viewed as "very theoretical" and from their point of view has little practical value. Business students nowadays prefer practically oriented courses so that case study method as a method of instruction becomes extremely popular (Yin, 2009). It is difficult to implement case study approach in teaching business statistics due to obvious reasons (most likely, the properties of a normal distribution cannot be discovered as a result of a discussion in class). Some attempts are made in the past to use case study approach in multiple regression: (Klibanoff et al., 2006), but knowledge of basic statistics is assumed as a prerequisite for the course.

Due to availability of statistical packages such as SPSS or Minitab the technical part of statistical computations can be explained rather briefly (at least in an introductory business statistics course). Excel can also be used for topics such as descriptive statistics, probability distributions, hypothesis testing, linear regression. The role of examples in this case becomes crucial: (Hanh & Doganaksoy, 2010). Business education includes such courses as economics, marketing, finances. It would be very beneficial for business students to see the link between the concepts that are discussed in statistics course and other courses taught at MBA programs.

In addition, such an important topic as multiple regression is hardly covered in elementary business statistics course. In a one-semester course instructors usually cover only simple linear regression and (perhaps) briefly mention multiple regression models without going into details. Recommendations on reorganization of a course with inclusion of multiple regression models are given in (Shah et al., 2012).

In the present paper four examples which are used for several years to teach business statistics course are presented and discussed in detail. The first two examples are based on real cases that took place in India and Latvia. One example is based on a real story related to advertising. P&G quoted in their ad in India a sample estimate for the market share of their product which generated a very quick response from the competitor, HUL. This example allows the instructor to explain the difference between sample estimates and population parameters as well as to analyze a variety of sampling methods.

The next example (which also can be called a case study) is related to a problematic use of an ordinal scale as a "quasi-interval" scale in real project implemented in Latvia with the objective to analyze the quality of study programs in universities and colleges in Latvia. In both cases students are learning the concepts (sampling in the first example and measurement scales in the second example) by trying to answer the question: "What went wrong in these two cases"? The other two examples are related to applications of multiple regression. One example dealing with consumers' price recall accuracy is based on the paper by (Estelami & Lehmann, 2001). The authors discuss different variables which may affect price recall accuracy. A multiple regression model is derived and analyzed in detail. The next example deals with an important issue: how to keep customers loyal to a particular e-shop. Nonlinear multiple regression model is presented and the factors affecting customers' loyalty are analyzed. Despite the fact that the model is nonlinear, for computational purposes it can be linearized. This allows an instructor to demonstrate that we can extend (in some cases) the class of regression models in applications beyond linear models without considerable increase in computational complexity. In addition, in both examples the major objective is to identify the most important predictors, no attempt is made by the authors to predict quantitatively the dependent variables since the coefficient of determination was quite low (which is usually the case in practice).

These examples are gradually introduced in managerial statistics course taught at Riga Business School during the last few years. Two surveys are conducted in 2011 (before cases and examples are introduced) and in 2015 with the objective to trace any changes in students' responses. The analysis of

the results of the surveys shows that the proportion of students claiming that they have learned a lot during the course has increased considerably.

2. Example in Marketing

The first example is based on a real story related to P&G advertising campaign in India (Vijayraghavan, 2010). The company decided to advertise their new product: shampoo brand Pantene. The ad had the following form: "A Mystery Shampoo! 80% women say is better than anything else". Such ads appeared in Mumbai on July 23, 2010. The company had a plan to unveil the brand name on August 1. During the 10-day period they conducted a campaign with the aim to distribute the product among ladies in Mumbai and asked them to write a diary about their impressions related to the use of the new product. The winners are awarded. Bolliwood stars (Neha Dhupia, for example) participated in the campaign by meeting people in Mumbai shopping malls and advertising the new product.

However, P&G received a very quick reply from the competitor (the company HUL). Just 5(!) days later (on July 28, 2010) another ad appeared in Mumbai in front of the P&G ad: "There is no mystery. Dove is the No. 1 shampoo". This case generated a lot of discussions among specialists in marketing (see, for example, (Simple lesson from Mystery shampoo versus Dove, 2010)). One of the reasons that the reaction from the competitor was so quick is related to a very high sample estimate quoted by P&G: it is really very difficult to believe that 80% of all women use Pantene while many other brands are also available on the market.

The example discussed above allows the instructor to raise the issue of representativeness of a sample. In addition, simple surveys conducted by the instructor among female students in class showed that in students' sample the percentage of ladies using Pantene is much smaller than the figure quoted by P&G. The natural continuation of a discussion in class is to analyze different sampling methods and their area of applicability.

3. Ranking of Universities and Colleges in Latvia

This case study is related to evaluation of study programs in Latvian universities and colleges in 2012. The Council of Higher Education of Latvia decided to conduct a survey with the objective to identify weak study programs. A group of foreign experts is asked to perform the evaluation. Funds from ESF project "Evaluation of higher education study programs and proposals for quality improvement" are used for the study (Council of Higher Education, 2012). In total, 854 study programs are evaluated. The ranking is performed using 62 criteria. The following four-point scale is used in the study:
- Excellent rating, unimportant shortcomings may be present;
- Good rating, minor shortcomings may be present;
- Satisfactory rating, major shortcomings may be present but there are ways to improve the situation;
- Unsatisfactory rating.

As a result of the analysis recommendations are formulated with respect to each study program and the programs are divided into three groups: A - good quality study programs; B - programs of satisfactory quality (improvements are needed); C - programs whose existence is doubtful. It is explained in the informative letter of the Council of Higher Education that evaluation is done using four major groups of factors: quality, resources, long-term sustainability and uniqueness of the program (to what extent the content of the program is repeated in other study programs offered by other universities and colleges). The evaluation scheme assumed that a program is of a good quality if none of the 62 criteria used in the study received the lowest rating (category 1) and not more that 15% of all criteria received the second lowest rating (category 2). The scale used in the study (ordinal scale) does not allow to compute the mean or to add ratings.

The study is initiated by Ministry of Higher Education and Science of Latvia with the objective to reduce the number of study programs by closing programs of unsatisfactory quality and redistribute the

funds between good-quality programs (there were 59 universities and colleges in Latvia in 2012, this number was too large for a country with the population of about 2 million people). The results of the study showed that only a relatively small number of programs (45) received the lowest ranking. In addition, admission to some programs (which are considered of a poor quality) has already been terminated. The Ministry planned to conduct reforms in higher education and there was a belief that the actual number of low quality study programs should be larger. As a result, the Ministry decided to revise the results of the study and presented an alternative evaluation of study programs. Note that the survey was not repeated (the Ministry used the data from the published report). The following assumptions are used in the alternative evaluation: (1) the number of criteria used for the evaluation of study programs was reduced to 17 (so-called "main criteria"); (2) arithmetic manipulations with the ranks are performed (for example, the ranks were added for all 17 criteria and then the mean was computed); (3) if there is no grade assigned to a certain criterion this criterion is omitted in the calculation of the mean; (4) all study programs are evaluated using the same criteria (that is, experts from different areas all have the same vision on what is good and what is not satisfactory). Using the above assumptions, the following coefficient K is computed for each study program: $K = (M + O)/2 - 0.25$, where M and O are the normalized (divided by 4) ranks for the main and other criteria. The coefficient K can take on values in the interval (0, 0.75). The study programs are divided into three categories (A, B and C defined above) depending on the value of the coefficient K. The following procedure is used: the program is in category A if K is in the interval (0.651, 0.75); the program is in category B if K is in the interval (0.551, 0.65) and in category C if K is smaller than 0.55. Using the methodology described above the Ministry concluded that 162 study programs have to be closed down since all these programs have K < 0.55. Criticism of such an approach is given by (Hazans, 2012).

This example allows the instructor to discuss that there are limitations on what you can do with data depending on the type of measurement scale you are using. In particular, there are debates between statisticians (Keller 2015) whether an ordinal scale can be treated as a "quasi-interval" scale. Such an approach is assumed to be justified is some cases where the number of categories in the ordinal scale is relatively large (from 5 to 7), but the question arises: "Can one make an important decision related to financing of a study program based on a formal conversion of ordinal scale with four categories to an interval scale"?

4. Example of Price Recall Accuracy

The first application of multiple regression is based on the paper by (Estelami & Lehmann, 2001). Classical economic theory is based on the assumption that consumers are knowledgeable about prices. The study conducted by (Estelami & Lehmann, 2001) shows that it is not always the case. Their objective was to analyze the accuracy of consumers' recalled prices and identify the major factors that affect price recall accuracy. The authors defined the following groups of factors which can affect price recall accuracy: respondent demographics, product category, task characteristics, economic environment. The dependent variable is defined as follows:

Percent deviation = |Actual price – Recalled price|/Actual price.

Linear multiple regression models are used to analyze the problem. The coefficient of determination $R^2 = 0.28$ is rather small, but the null hypothesis that there is no linear relationship between the dependent variable and independent variables is rejected. Test on significance of the regression coefficients shows that the independent variables "task size", "percentage female" and "income" are statistically significant. These are the factors that affect price recall accuracy. This example shows that in applications (from a managerial point of view) it may be more important to identify a set of predictors rather than try to make predictions using the regression model (since the coefficient of determination is rather small predictions will be associated with large errors).

5. Customer Loyalty in E-commerce

The authors used exploratory multivariate techniques such as factor analysis and nonlinear regression analysis to analyze the problem (Srinivasan et al., 2002). At first factor analysis is used to determine 8 factors which can affect e-loyalty: customization, contact interactivity, cultivation, care, community, choice, convenience, character. Then these factors are used as independent variables in a nonlinear multiple regression model. The analysis shows that all variables except "convenience" are found to be statistically significant. As in the previous example related to price recall accuracy, no attempt is made by the authors to make predictions with the model. Managerial recommendations from the analysis are the following: managers should constantly monitor the seven factors and make corrective actions if the values of the corresponding variables fall below acceptable levels.

The advantage of using this example in class is twofold. First, students see that regression analysis can help managers to solve (at least partially) a managerial problem related to customer loyalty in e-commerce. Second, it gives the opportunity for the instructor to show the use of variable transformations (in this case logarithmic transformations) in regression analysis. The idea of linearization of the proposed nonlinear relationship by logarithmic transformation can be explained using this example.

6. Survey Results

The results of survey among MBA students at Riga Business School are presented below. The surveys are conducted in 2011 and 2015. In 2012, the instructor decided to change the textbook for the course (since then the book by G. Keller is used (the recent edition is (Keller, 2015)) and introduced all the cases and examples presented above. The book by G. Keller contains several interesting case studies which are either discussed in class or assigned as a group work to groups of 2-3 students. Thus, the illustrations of statistical methods are based (since 2012) on a large number of real-life examples and cases.

The results of the surveys conducted in the end of fall semesters in 2011 and 2015 are shown in Tables 1 and 2. The following questions are asked:

Question 1. The textbook and readings used are (not relevant, relevant);

Question 2. The textbook and readings used are (boring, stimulating);

Question 3. Overall, how much do you feel you have learned in this course (very little, a lot).

The five-point scale (from 1 to 5 points) is used for each question where the first and second responses in the parentheses correspond to the lowest and highest ratings, respectively.

Table 1. Evaluation results (2011)

Questions	1	2	3	4	5
Q1	7.1	25	25	28.6	14.3
Q2	0	25	35.7	28.6	10.7
Q3	0	3.6	28.6	46.4	21.4

Table 2. Evaluation results (2015)

Questions	1	2	3	4	5
Q1	0	0	0	14.3	85.7
Q2	0	21.4	14.3	35.7	28.6
Q3	0	14.3	14.3	14.3	57.1

The number of responses in 2011 and 2015 is 28 and 26, respectively. Each cell in the tables shows the percentage of respondents who answered a particular question with a certain rating. It is seen from the tables that the percentage of students who considered relevance and stimulating effect of textbook

and readings has increased in 2015. In addition, the percentage of students who felt that have learned a lot in the course has more than doubled. On the other hand, the total percentage of students who gave 2 or 3 points to Question 3 stays almost the same. This fact can be partially explained as follows. The business school admits students on the basis of intellectual test and TOEFL. Applicants may have different bachelor degrees (for example, in law or philology). Thus, some of the students (typically about 10-15%) do not have previous knowledge of statistics. Managerial statistics course is rather difficult for them. As a result, students may not be fully satisfied with the fact that they have to do a lot of work in order to pass the course with a good grade. In addition, the following open-ended question is asked in 2015 survey: "What do you like most about this course"? More than a half (52.9%) of all students answered: "Case studies or real-life examples".

7. Conclusion

Several real-life examples and case studies used in teaching managerial statistics course at Riga Business School are discussed in the paper. One example and one case study are based on real cases that took place in India and Latvia. The results of the surveys conducted before and after the cases and examples are introduced have shown that the proportion of students who felt that they have learned a lot during the course has increased considerably.

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