COMPARING THE RESULTS OF MATHEMATICS EXAMS BETWEEN THE INFORMATICS AND ECONOMICS STUDY PROGRAMMES

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Abstract

In this article, we compare students´ results in mathematics during the last four years. We focused on students of Prague University of Economics and Business. In 2016, it was introduced a new course, called "Mathematics for Informatics" (MFI) which differed from the previous course "Mathematics for Economists" (MFE) in a number of hours of lessons. The syllabus is almost the same in both courses, but the course of MFI has two times more seminars than the course of MFE. The analysed data are the results of exams of students in these courses from the academic year 2016/2017 till 2019/2020. The aim of this paper is to determine whether students of different mathematics courses had different results in the exam of Mathematics during these years. We use t-tests to prove a hypothesis whether the success rate of students depend on the type of the course. Using t-tests we obtained that there are no statistically significant differences in the grade of the exam of Mathematics between students of economics and informatics.

Key words: course Mathematics for Economists, course Mathematics for Informatics, test scores

JEL Code: C12, I21

Introduction

In this article, we compare the results of students from two different courses of Mathematics. We focus on students at Prague University of Economics and Business (VŠE). All students of VŠE have to pass one semester course of Mathematics. Our students are provided a brief introduction to various mathematical topics that play a key role in economics. Motivated by economic applications, we introduce students to key mathematical ideas through an economic viewpoint, starting from linear algebra and the real line and moving to 3-dimensional spaces. Students of VŠE have to pass the entrance exams from Mathematics and other subjects depending on their specialization. Some remarks on the difficulty of math test variants in

admission process and evaluation of tests can be found, for example, in (Klůfa, 2016) and (Otavová and Sýkorová, 2016). Passing the entrance exams from Mathematics has positive effect on the results of MFE and MFI. In addition, in (Jansen and Suhre, 2010), they show that time management and learning skills does have a positive impact on college students' first year study behaviour and academic achievement. Therefore, we insist on regular learning and active attendance during our classes. As well as in (Smith and Bath, 2006), they confirm that the interactive, social and collaborative aspects of students' learning experiences, are also very important determinants of graduate outcomes. not only teaching and program quality.

We compare students of all faculties of VŠE. They are obliged to complete one of the courses of Mathematics depending on their field of study. There are two courses: "Mathematics for Informatics" (MFI) and "Mathematics for Economists" (MFE). Both courses consist of linear algebra and mathematical analysis. For more details see course books (Klůfa, 2019), (Otavová and Sýkorová, 2020). We compared results of exams in MFI and MFE during the years 2016-2020. We were interested if there would be some differences between scores depending on the type of the course.

The results of tests from Mathematics at VŠE were investigated in (Klůfa, 2020). From this paper follows that there are significant differences between average number of points in the final test in Mathematics depending on ways of acceptance students to study at Faculty of Informatics and Statistics. In (Otavová and Sýkorová, 2014), there is presented another analysis of scores from mid-term and final test in Mathematics.

Another interesting results can be found in (Ulrychová and Bílková, 2019). This paper deals with testing the students' ability to formulate maths definitions. In addition, in (Ulrychová, 2016) they deal with the relationship between the knowledge of definitions and the ability to solve exercises.

Comparing of math success of students from another Czech university can be seen, for example, in (Krejčová, 2016) and (Pasáčková, 2020).

1 Overview of math courses

The difference between two courses of Mathematics is primarily in the number of hours of seminars. The course MFI has 2 hours of lectures and 4 hours of seminars a week. The course MFE has 2 hours of lectures and 2 hours of seminars a week. Examinations in these courses include one test in the middle of a semester, final test and oral exam during the exam period.

During a semester, students write one test consisting of four problems and can obtain 20 points. There is not any lower limit for the first test. These points are sum to the points from the final exam. Final exam has an oral and a written part. The written part is a test with 8 math problems. From each part of the final exam (oral, written) can be obtained 40 points. This means that the grand total of score is 100. To pass the exam students need 60 and more points.

We use the classical method to evaluate students. They have to calculate some problems and during the oral exam the emphasis is put on knowing definitions and theorems and their application in problems. Some notes about evaluation see in (Iannone and Simpson, 2015). They examined mathematics students' preferences of assessment methods. They found that mathematics students differentially prefer traditional assessment methods such as closed book examination.

2 The success rate in exams

We started to teach MFI in the winter semester in 2016. The first two years we taught MFI only during the winter semester. Now, students can choose MFI as well as MFE every semester. In the following Table 1, we see numbers of students enrolled in the courses in all semesters. Successful students are students who passed the exam with the grade 1 – 3.

Tab. 1: Number of enrolled and successful students

	semester and year								
	2016/2017		**2017/2018**		**2018/2019**		**2019/2020**		
	winter	**summer**	**winter**	**summer**	**winter**	**summer**	**winter**	**summer**	
enrolled students	1106	827	1062	770	1042	838	1348	840	**MFE**
successful students	666	510	616	508	643	537	840	711	
success rate	60%	62%	58%	66%	62%	64%	62%	85%	
enrolled students	348	-	386	-	405	54	424	30	**MFI**
successful students	208	-	213	-	223	17	243	15	
success rate	60%		55%		55%	31%	57%	50%	

Source: own construction from data: insis.vse.cz

We observe that the success rate is in MFE from 58 to 85% and in MFI from 31 to 60%. The biggest difference for MFE is in the summer semester in 2020. It was the period when the COVID-19 pandemic started. This summer semester started by face-to-face teaching, but then it was converted into on-line form. Thus, this increasing of success rate was influenced by these

unpredictable changes. The investigation whether the online teaching and face-to-face teaching had influenced exam results in MFI can be found in (Pasáčková, 2021).

The success rate in all semesters is not very high, but the unsuccessful students are not only students who passed the exam with grade 4, but there are more students, who did not try to pass the exam and students who finished their studies during this semester as well. To be precise, there is a distribution of these students in the Table 2. For example, in the winter semester 2016, there were 188 students who obtained grade 4 and it was 43% of all unsuccessful students in this semester.

Tab. 2: Distribution of unsuccessful students

	semester and year								
	2016/2017		**2017/2018**		**2018/2019**		**2019/2020**		
	winter	**summer**	**winter**	**summer**	**winter**	**summer**	**winter**	**summer**	
unsuccessful students	440	317	446	262	399	301	508	840	**MFE**
students with grade 4	188	109	198	94	175	131	201	30	
	43%	34%	44%	36%	44%	44%	40%	4%	
unsuccessful students	140	-	173	-	182	37	181	30	**MFI**
students with grade 4	41	-	58	-	50	10	57	6	
	29%		34%		27%	27%	31%	20%	

Source: own construction from data: insis.vse.cz

It implies that majority of unsuccessful students are students who really did not try to pass the exam.

3 Comparing the results

We compared results of students depending on the type of math course and the year. We calculated only with students who were presented at the exam. We present numbers of students with grades 1 – 4 in the following table.

Tab. 3: Scoring in Mathematics exam

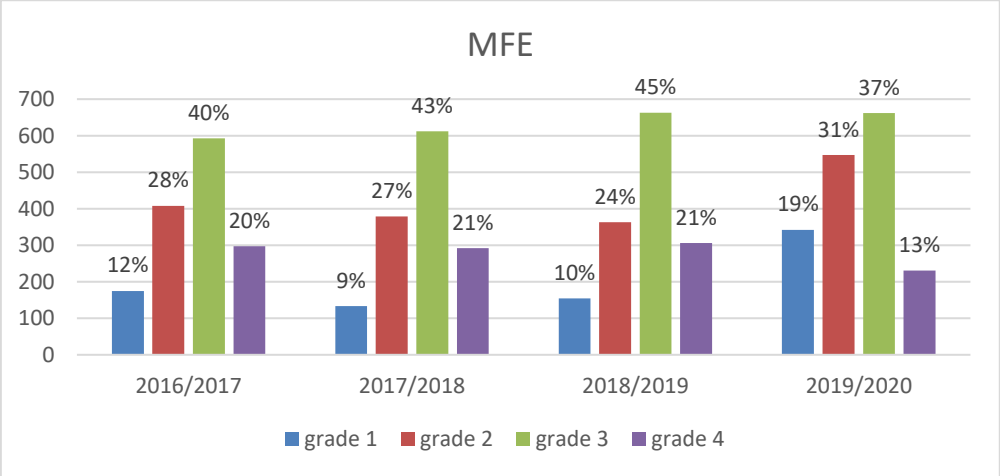
		grade			
year	**subject**	**1**	**2**	**3**	**4**
2016/2017	**MFE**	175	408	593	297
	MFI	22	69	117	41
2017/2018	**MFE**	133	379	612	292
	MFI	41	55	117	58

2018/2019	**MFE**	154	363	663	306
	MFI	33	69	138	60
2019/2020	**MFE**	342	547	662	231
	MFI	59	90	109	63

Source: own construction from data: insis.vse.cz

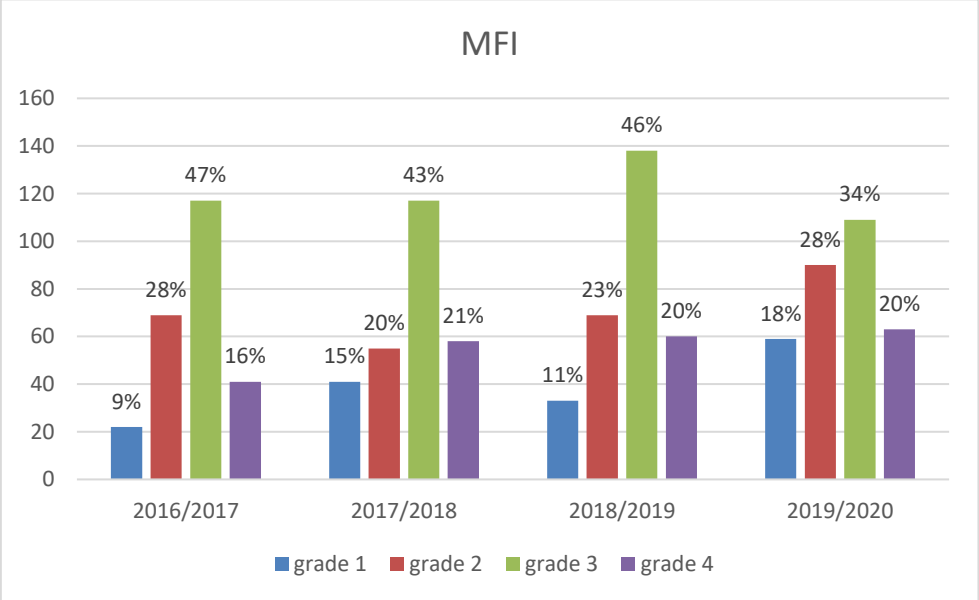
For better clarity, see in Figures 1 and 2 the distributions of grades for every year.

Fig. 1: Evaluation of MFE exams



Source: own construction

Fig. 2: Evaluation of MFI exams



Source: own construction

We wonder if the higher number of lessons of Mathematics has the effect on the grade of the exam. We use a statistical test and we test null hypothesis:

H_0: *There are not any statistical significant differences between grades of students in MFI and MFE.*

The decision reject or not this null hypothesis we can make using two-sample t-tests. See formulas in (Anděl, 2007). We do these tests separately for every year and we compare our calculated t-value against the values in a critical value chart. The two-sample t-test assumes normality of variables in the two groups. Using histograms, we could find out that our data seem to meet this assumption. In addition, as the sample size in the two groups gets large, as in our case, the t-test is valid even when data do not follow a normal distribution (due to the central limit theorem).

In 2016/2017, the value of the statistic is $T = 0.415$, the critical value is $t = 1.961$. The hypothesis H_0 is not rejected at significance level 0.05, i.e.

$$T = 0.415 < t_{0.05}(1720) = 1.961. \qquad (1)$$

Thus, between the marking in MFE and MFI during 2016/2017 are not statistical significant differences.

In 2017/2018, the value of the statistic is $T = -0.783$, the critical value is $t = 1.961$, i.e.

$$|T| = |-0.783| < t_{0.05}(1685) = 1.961. \qquad (2)$$

The hypothesis H_0 is not rejected at significance level 0.05.

In 2018/2019, the value of the statistic is $T = -0.086$, the critical value is $t = 1.961$, i.e.

$$|T| = |-0.086| < t_{0.05}(1784) = 1.961. \qquad (3)$$

The hypothesis H_0 is not rejected at significance level 0.05.

In 2019/2020, the value of statistic $T = 1.987$ exceeds the critical value $t = 1.961$, the hypothesis H_0 is rejected at significance level 0.05, i.e.

$$T = 1.987 > t_{0.05}(2101) = 1.961. \qquad (4)$$

Thus, in 2019/2020 there are statistical significant differences.

If we calculate it for all years 2016 - 2020 together, we obtain the value of statistic $T = 1.038$ and the critical value $t = 1.960$, i.e.

$$T = 1.038 < t_{0.05}(7296) = 1.960. \qquad (5)$$

Thus, the hypothesis H_0 is not rejected at significance level 0.05.

Conclusion

Using t-tests we obtained that there are not statistically significant differences in the grade of the exam of Mathematics between students of economics and informatics. The difference was only during the year 2019/2020, when the statistic was a little bit higher than the critical value. The reason for this change should be the higher success of students of MFE during the summer semester, when the on-line teaching started.

Although, we expected that the higher number of lessons of Mathematics would imply the better results in the exams. The results of paper show that students had in the past four years the similar results. On the other hand, since that the attending seminars of Mathematics is not compulsory for students, we see that often many students skip their classes and this trend is higher between students of informatics.

We can conclude that the success rate in exams of Mathematics is in both courses quite high, about 80 %. The increase of lessons of Mathematics is in any case the way how to increase the level of mathematics knowledge and skills of students. Mathematical background is the basis of a logical thinking, which is a prerequisite for the correct solution of problems of economic practice.

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