4.2 THE CAREER PLANS OF 15 YEAR OLDS: WHO WANTS TO ENTER STEM?[1]

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STEM in this report stands for occupations in the fields of Science, Technology, Engineering and Mathematics that are either at the Professional or the Assistant Professional level, requiring at least higher secondary education. Labour market forecasts predict a continuous increase of demand for STEM skills across the European labour markets (*Cedefop,* 2016). Between 2015 and 2025 it is expected that in Hungary 85,000 new STEM positions will open up.[2] As STEM workers are employed in the technologically most advanced and potentially most productive sectors of the labour market, the prospect of shortages in STEM labour has been named one of the main barriers to economic growth in the first half of the 21st century in Europe (*Caprile et al.,* 2015, *EC,* 2015).

All over the world, males are overrepresented in the STEM workforce. This tendency is particularly strong in Engineering and ICT that were among the twenty most segregated jobs in Europe in 2010 (*Burchell et al.,* 2014). Between 2010 and 2015 in Hungary, four out of five engineers and ICT workers were males.[3] The gender segregation is of course apparent in (higher) education already. In 2015, women accounted for no more than 20% of the ICT students and 23% of the Engineering students in the Hungarian higher education institutions. On the other hand there was no difference in the number of men and women studying Sciences, Maths and Statistics.[4]

Women's underrepresentation in the STEM workforce is associated with several negative consequences. First, women's absence from these areas reduces the pool of potential applicants and can therefore contribute to the labour shortage. Secondly, it can also lead to a loss of talent if capable women choose not to go to STEM for external reasons. Absence of women in the STEM occupations also contributes to the gender wage gap as STEM jobs tend to be among the best paid ones all over Europe (*Goos et al.,* 2013),[5] including Hungary (*Veroszta,* 2015). Gender segregation in the labour market also has a tendency to reproduce itself as observed gender patterns influence young people's career decisions, reinforcing existing gender stereotypes about the masculine or feminine nature of the occupations (*Jarman et al.,* 2012).[6]

In what follows, we analyse the career plans of 15-year old students to better understand their motivations to choose or not to choose a STEM career. Career plans at this age are not only fairly realistic and reflective of students' abilities, school achievements and motivations but they also influence their later educational choices, and this way they also serve as self-fulfilling prophecies (*OECD,* 2015). Even though we are not aware of any longitudinal study

1 This paper is based on a major comparative study on students' STEM career plans, that used PISA data from the 28 EU Member States, prepared for the European Commission Joint Research Centre. (See: *Blasko at al.,* 2018). The views expressed are purely those of the authors and may not in any circumstance be regarded as stating an official position of the European Commission.

2 Cedefop.

3 Own calculations from LFS data.

4 Own calculations from Eurostat data (Eurostat: Students enrolled in tertiary education by education level, programme orientation, sex and field of education [educ_uoe_enrt03])

5 It is important to note that in Goos's study a STEM definition different from ours was applied that included Medical occupations but excluded occupations in Informatics and Computing.

6 For an overview of the Hungarian context see also (*Konczosné–Mészáros,* 2015, *Csőke et al.,* 2013; *Schadt–Péntek,* 2013). Further details can also be found on the following websites:. Vs.hu; Tizperciskola.blog.hu.

that would directly link adolescents' occupational plans to their actual labour market careers many years later, research has shown that these plans are rather good predictors of the occupational prestige achieved (*Ashby–Schoon,* 2010, *Croll,* 2008; *Schoon et al.,* 2007, *Sikora–Saha,* 2011), as well as of the subject-choice in higher education in general (*Tai et al.,* 2006, *Sikora,* 2014) and of choosing a STEM field of study in particular (*Morgan et al.,* 2013). Further, adolescents' occupational plans are already well reflecting the gender-segregation observed in the labour markets (*Sikora–Pokropek,* 2011, *Morgan et al.,* 2013, *Sikora,* 2014).

Thus our study is based on the idea that adolescents' career plans represent a significant stage along the path leading to the labour market. Even though students after age 15 will still face several selections and self-selections, this early choice will no doubt influence the later ones. Career plans of the adolescents and the labour market processes mutually reinforce each other, therefore by analysing young people's gendered career plans we expect also to better understand the gender-segregation apparent in the labour market.[7]

Data

For the purposes of this study, PISA data from 2015 was used. In that year 5,658 students from 245 Hungarian schools participated in PISA, and the sample was representative for the 15 year olds in the country. The measure of student career expectations was constructed from the following single question: "*What kind of job do you expect to have when you are about 30 years old? Write the job title.*" The responses were coded using ISCO08. To identify STEM occupations for the purposes of this study we have chosen the categorisation of occupations previously applied e.g. by *Caprile et al.* (2015) and also in a report published by the EC (*EC,* 2015). Accordingly, the following ISCO08 subgroups were classified as STEM: 21 Science and engineering professionals; 25 Information and communications technology professionals; 31 Science and engineering associate professionals; 35 Information and communication technicians.

Results show that in 2015, 28,3% of boys but only 7,7% of girls were considering entering STEM in Hungary. The majority of these students (25,5 and 7,1% respectively) were planning to become a professional in one of the STEM fields, and only a small minority had an assistant professional occupation in mind. Hungarian girls lag behind the European average, as across Europe, 10,3% of the 15 year old girls were planning to work in STEM. Consequently, the gender gap in Hungary, which is calculated as the difference between the share of boys and girls who want to work in STEM, is slightly bigger than the European average (20,6 versus 18,7 percentage points). The Hungarian value is closest to the Slovakian, the Croatian, and the Portuguese gender gap.

7 A similar approach, but a very different research method was used in a study commissioned by the University of Obuda. The study was looking at female students career plans at the high school and relied on interviews and focus-group methodology (*Krolify*, 2012).

Table 4.2.1: Career plans of the 15 year olds in Hungary, percentages

Career plan	Boys	Girls	Total
STEM			
Science and Engineering Professionals (ISCO 21)	15.5	6.1	10.9
Information and communication technology professionals (ISCO 25)	10.0	1.0	5.5
Science and engineering associate professionals (ISCO 31)	2.4	0.7	1.6
Information and communication technicians (ISCO 35)	0.4	0.0	0.2
Non-STEM	71.7	92.3	81.8
Together	100.0	100.0	100.0
(N)	(2,207)	(2,175)	(4,382)[a]

[a] 20% of the students in Hungary did not provide a valid answer to this question. In this table they are not included. In the multivariate analyses, *Multiple imputation technique by chained equation* (*Royston,* 2004) was applied to replace their missing values.

Source: *PISA* 2015. Own calculations.

Who wants to enter STEM?

The key dependent variable in this report is a student's expectation of working in a STEM occupation at age 30, coded 1 for science occupations and 0 for non-science occupations. To estimate the probability of choosing a STEM occupation, Logit models were estimated. As main independent variables in our models, we included gender, science test scores, science self-efficacy (student's self-confidence in being able to carry out science-related tasks), instrumental motivation (students' beliefs that studying science is useful for their future career), self-assessed ICT competence and whether or not they attend mathematics or science lessons outside the compulsory schooling.[8] In the models, we also controlled for the socio-demographic background of the students as well as some characteristics of the school. Interaction effects between gender and some other independent variables were also considered.

The following variables were added to the models. Social background was assessed by parental socio-economic status (ESCS); a dummy variable indicating if at least one parent is working in a STEM job and ICT equipment available in the parental home. School-level variables: female ratio in the school; science teaching resources in the school; science club available in the school; availability of science competitions in the school; vocational vs. non-vocational school. Continuous variables were standardised to have a mean value of 0 and standard deviation of 1. In this paper only statistically significant ($p \leq 0.05$) associations are discussed. Details of the models and a full discussion of the estimation procedure are available upon request from the authors.

Not surprisingly, science test scores are very strong predictors of STEM career choices: only few students with low achievement consider a STEM career, while among the highest-achievers, the ratio is around 50%.[9] Contrary to the common assumptions, it is also clear that science achievements have nothing to do with the gender gap in STEM career choices as boys and girls achieve very similar scores on this PISA test. However, the extent to which achievement in science is conducive to a plan to work in science in the future is different for

8 Ideally, a more balanced representation of science, mathematics and ICT competencies and attitudes should be used. PISA 2015 however, was focused on sciences and does not provide equal details about other subject areas.

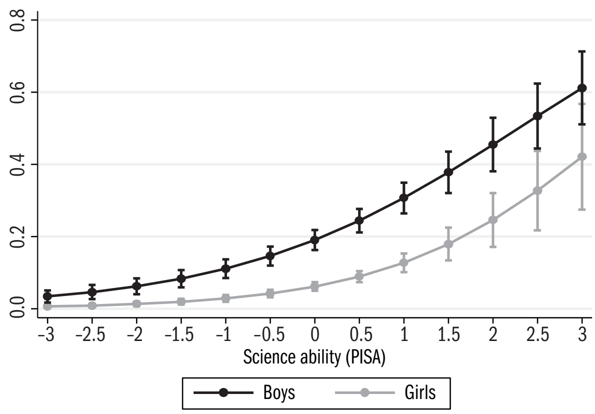
9 The importance of science achievement is also shown by the increase of the explained variance (from 4 to 16%) when this variable is added to the baseline model with gender as the single independent variable.

males and females. *Figure 4.2.1* depicts the estimated probabilities of opting for a STEM career for males and females at different levels of science scores.

Figure 4.2.1 – and the following figures alike – shows how the independent variable in the logit model affects the probabilities predicted with the estimated coefficients. This is represented by the average marginal effect, which is the average of the effect of the given variable with all the other effects being held constant for each individual. In the case of a dummy variable – like gender – this effect is simply the difference of the probabilities predicted for the two possible values. On *Figure 4.2.1,* this effect referring to students with an average science test score can be calculated as the difference between the predicted probabilities at value 0 on the horizontal axis and it equals to 0.128. Interaction effects included in the models take this analysis a step further. They indicate how the average marginal effect of gender varies depending of the level of the other variable – in this case, science score. These different levels of the gender-effect can be depicted at the different values of the horizontal axis, representing PISA science test scores: the effect of gender depends on science-achievement. But the opposite is also true: the average marginal effect of science-achievement varies by sex and thus has an unequal effect on the career choices of boys and girls. Higher test-scores are associated with greater probabilities of choosing a STEM career across both genders, but for boys, this increase in the probabilities is bigger, at least up to an achievement-level 1.5 standard deviations above the average.

Results show that the gender gap in STEM choices not only remains significant when the test scores are held constant, but its size is even increasing somewhat as we move towards the higher achievers. Boys for example, whose test score exceeds the average by 2.5 standard deviations demonstrate 53.4% probability of opting for a STEM career, while across girls with a similar achievement the respective probability is only 32.7%. If girls who do well in science but do not plan to make a STEM career are considered as talent-loss for STEM, then from our results a substantial talent loss can be identified.

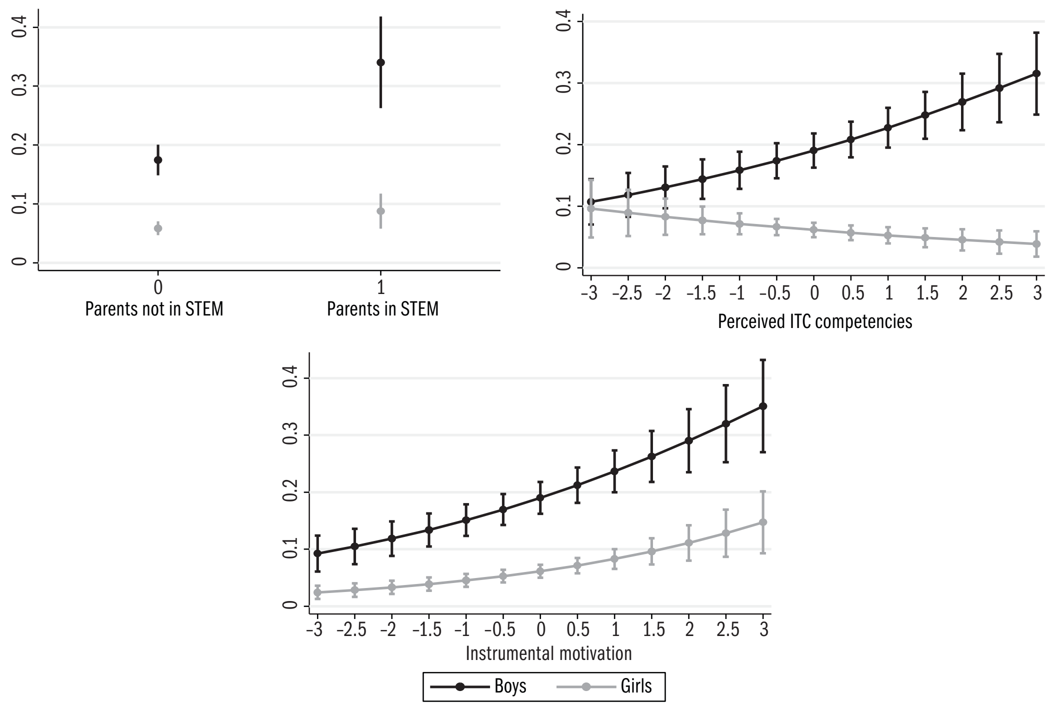
Figure 4.2.1: Predicted probabilities of expecting a STEM career. Logit models. The effect of gender and science achievement



Note: On this figure as well as on the following ones, 95% confidence intervals around the estimated probabilities are shown.
Source: *PISA* 2015. Own calculations.

Science achievement is not the only factor that influences boys' and girls' choices in different ways. First, boys are also further motivated to choose a related career if they have a parent working in a STEM occupation. If this is the case, sons show an increased probability of opting for STEM (34.0% instead of 17.5% – see in *Figure 4.2.2*). For girls however, parents' occupation does not make a difference in this respect. More interestingly from an educational policy point of view, girls are also less responsive than boys to the levels of ICT-competence they develop (self-evaluation), as well as to their levels of instrumental motivation. While boys with higher levels of self-evaluated ICT skills are also more likely than others to plan a STEM career, among girls, no such association can be found. Further, instrumental motivation is also more strongly related to the career choices of boys than of girls – although in this case some positive association even in the case of girls occurs. In this respect however, girls are also at a disadvantage because they are less likely to believe that science subjects will be useful for their future labour market opportunities. Other individual variables assessed in this study were not found to be related to students' career plans.

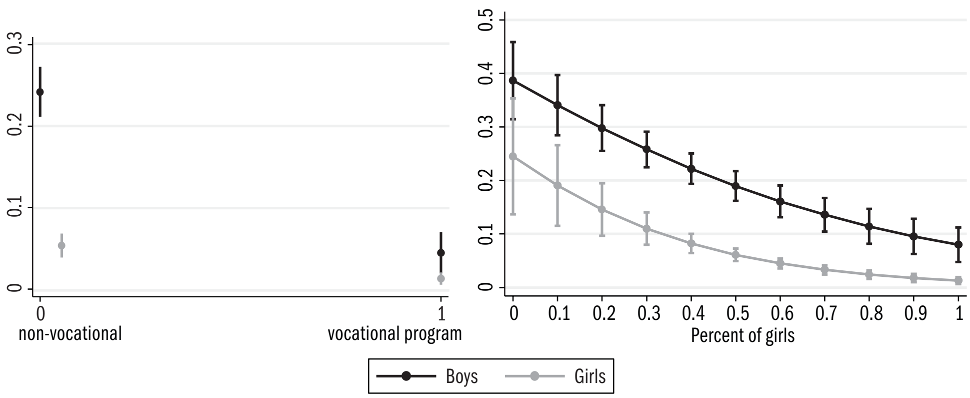
Figure 4.2.2: The effects of parents' occupation, subjective ICT competencies and instrumental motivations on boys' and girls' estimated probabilities of choosing a STEM career



Source: *PISA* 2015. Own calculations.

As one could expect, students in different types of school also tend to have different career plans. First, students in non-vocational schools are significantly more likely to consider a STEM occupation than students in the vocational schools and this holds both for boys and girls. As a high proportion of vocational students in Hungary will not achieve a qualification that would entitle him/her for higher education studies, this is not a very surprising finding (*Figure 4.2.3*). Further, we also find that the share of females in the school is negatively related to the probabilities that a student in that school would be interested in pursuing a career in STEM. This finding seems to contradict the expectations that female-dominance in the school can reduce gender-stereotyping and therefore can make girls more confident to consider gender-atypical careers (*Schneeweis–Zweimüller,* 2012). Instead, we would rather interpret this finding as an indication that by age 15 girls are already more likely to be concentrated in schools without a strong science-profile.

Figure 4.2.3: The effects of programme-orientation and share of girls in the school on boys' and girls' estimated probabilities of choosing a STEM career



Source: *PISA* 2015. Own calculations.

Conclusions

The main drivers of STEM career choices that were identified in this study include science abilities, (self-perceived) ICT skills and the level of understanding of how science knowledge can be useful in the labour market. While boys will certainly gain some additional motivation from an improvement in these areas, for girls, only a limited increase (science abilities and instrumental motivation) or no increase (ICT skills) in the interest for STEM occupations can be expected. From this it follows that the gender gap in students' interest for STEM occupations can not significantly be influenced by the factors assessed here. Altogether our results suggest that strong gender segregation in the career choices develop before age 15 and already by this time girls even tend to be in schools that reduce their probabilities of choosing a STEM career. This is in line with research suggesting that children develop their perceptions of what is compatible with prescribed gender norms from a very early age onwards as part of the gender role socialisation process, and this understanding will continue guiding their interest as well as their career decisions later on. STEM areas remain to be associated with masculine, rather than feminine qualities and these stereotypes are culturally deeply rooted in our societies. Moreover, the same stereotypes also orient girls who are strong in science more towards healthcare and medical jobs (*Charles,* 2003, *Charles–Bradley,* 2002, *Sikora–Pokropek,* 2012). International comparative studies further suggest that this type of gender-segregation is particularly strong in the more affluent, democratic countries where gender-egalitarianism is well developed (*Sikora–Pokropek,* 2012). From these it follows that reducing the gender gap in STEM is not an objective that is easy to achieve and if anything, then early-childhood interventions need to be considered if this goal is to be achieved.

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