CHAPTER 1

Introduction
1.1 Introduction
Female participation in higher education has risen sharply in recent decades. In most EU and OECD countries more than half of all students in higher education are now female (Eurostat, 2012a). Yet, the participation of women in mathematics, science and technology (MST) remains low (Eurostat, 2012b). This lagging female participation in MST is a worldwide phenomenon and of concern to many (Caprile et al. 2012; Marchetti & Raudma 2010; Organisation for Economic Co-operation and Development [OECD] 2006).

At the same time, when one looks at the share of female students in MST across the EU and the OECD, large variations in female participation in MST become evident (Eurostat, 2012b, 2012c, 2012d).

1.2 Existing research
In the past the underrepresentation of female students in MST used to be explained as a result of a lesser aptitude of women for related subjects or as a result of traditional gender roles (Barres, 2006; Ceci, Williams, & Barnett, 2009; Guiso, Monte, Sapienza, & Zingales, 2008; Haworth, Dale, & Plomin, 2008; Hyde, Lindberg, Linn, Ellis, & Williams, 2008; Lynch & Feeley, 2009; Spelke, 2005). It has become clear, however, that these explanations are flawed and cannot account for the huge variation in participation between countries.

As for the assumption of lesser aptitude, comparisons of student results in earlier education provide hardly any empirical support that women perform less well on subjects like mathematics and physics (Ceci, Williams, & Barnett, 2009; Guiso, Monte, Sapienza, & Zingales, 2008). Moreover, this aptitude explanation cannot be used to explain the vast differences in female participation rates that exist between countries.

Similarly, the suggestion that low participation of women in MST is simply a result of traditional gender roles is untenable in view of much contradictory evidence. Female participation in for example science, mathematics and computing – one of the two subdomains of MST – is sometimes remarkably higher in countries with traditional unequal gender roles than in countries
that are more gender equal (World Economic Forum 2014, 2015). The share of female students in science, mathematics and computing fields in countries such as Sweden (42\%\(^2\)), Denmark (34\%), Finland (38\%), Norway (35\%), Germany (35\%), France (35\%) and the Netherlands (23\%)\(^3\) is for instance much lower than in countries such as Turkey (45\%\(^4\)), Algeria (67\%\(^5\)), Tunisia (59\%\(^6\)), Egypt (49\%)\(^7\) and Iran (69\%)\(^8\) (Eurostat, 2012c; UNESCO, 2013, 2014). According to the most recent Global Gender Gap Index, countries in the first group all rank in the top 15 of 145 countries in gender equality, whereas countries in the second group rank all rank in the bottom 18\(^{th}\) equal countries (World Economic Forum, 2015).

The current research literature on gender imbalances in MST provides various explanatory frameworks to explain gender differences in MST participation, at various levels of aggregation (for an extensive overview, see chapter 2).

Explanations at the micro-level refer to individual student characteristics. An example is the finding that girls’ mathematics self-efficacy beliefs – that is, their confidence in their own mathematics abilities and skills – tends to be lower than boys’, which would explain why they opt for MST less often (Bussey & Bandura 1999; Lent et al. 1994).

Explanations at the institutional level relate gender differences in study choice to characteristics of the education system. For example, countries with highly differentiated education systems are found to produce more gender inequality than countries with less differentiated systems (Charles 2011; Van Elk, Van der Steeg & Webbink 2011; Wößmann 2009).

Explanations at the macro-level focus on societal factors, such as gender roles and other cultural values. The relationship between culture, gendered identities and gendered choice patterns presents somewhat of a paradox, with female participation in MST fields actually being higher in societies with more traditional gender roles than in societies with more egalitarian gender roles (Charles & Bradley, 2009).

While it is clear that each of the three analytical frameworks helps us to understand a piece of the puzzle, it is still not understood how they work together to create gendered study
choice patterns in MST. This is then essentially about how the various determinants operating at different levels interact. The study of how individual students’ choice processes towards MST study fields come about allows for a better understanding of these interactions. This implies asking students, for example, about their self-efficacy beliefs, the timing of their choices and their expectations with regard to possible future fields of study and occupations, and – importantly – to relate this to students’ self-identity and values.

Moreover, the observation that low female participation is not simply the result of traditional gender roles, begs for a more thorough study of the relationship between culture and students’ choices towards or away from MST.

Here, Schreiner and Sjøberg (2004; Schreiner, 2006; Sjøberg and Schreiner, 2005), provide an insightful explanation for the paradoxical gender imbalances in study choice in Western countries based on Inglehart’s modernization theory (1997; Inglehart and Norris 2003; Inglehart and Welzel 2005). They argue that economic development and prosperity has led to an increased dominance of postmaterialist values, in these countries. As a result study choices are more based on intrinsic motivation and on the connection of studies to students’ core identities. Following this hypothesis, Schreiner and Sjøberg argue that both men and women in late modern societies, when offered a choice between different alternatives in higher education, will tend to choose studies which are more in line with their gender roles, which leads to a division in male and female fields of study. Conversely, women in less developed societies appear to be less concerned with these identity issues and more often choose to study in non-traditional fields, including MST, because their choices are more driven by modernist values, like a concern for material security and stability, according to Schreiner and Sjøberg. Although the same explanatory mechanism would apply to men and their educational choices, Schreiner and Sjøberg argue that the difference in academic choices in different societies is nonetheless smaller, because men’s core identities and gender roles are much less contested in other academic fields than women’s in MST. Research by Charles and Bradley
(2009) on sex segregation by field of study in higher education across 44 societies, including developed, developing and transitional countries, shows that sex typing of MST is indeed stronger in more economically developed contexts. It may therefore be expected that not only male and female students make different choices, but also that students whose families originate from economically less developed societies, that is, students with an immigrant background from these societies, will choose differently from native students in more developed country contexts.

Based on Schreiner and Sjøberg’s theory, I therefore expect that female students with a native Western background, i.e. Dutch or Swedish background, will be less likely to opt for MST, not only compared to native Western male students, but also compared to both male and female students with a non-Western migrant background. This is because sex typing of MST is stronger in more economically developed countries than in economically less developed countries and because female students’ core identities and gender roles are assumed to be more contested in MST than male students’ core identities in other fields. In order to explore these assumptions, attention is also given therefore to migration background in the comparison between male and female students’ choice processes towards or away from MST.

1.3 Research question
It is obvious from the large body of previous research, that gender differences in MST participation are an international phenomenon and that each of the three analytic frameworks helps to understand a piece of the puzzle of gendered study choice. However, it is also clear that focusing on each of these pieces separately, may obfuscate the puzzle as a whole, which is essentially about how these pieces interlock in practice, since each piece separately fails to provide a sound explanation for the large differences between countries in the share of female students in MST.

Given the vast scientific evidence available, it is now evident that individual, cultural and institutional factors all play a role in explaining gendered patterns of choice in MST, although currently very little is known about the way different factors work
together in students’ actual choices processes towards MST. This dissertation aims to shed more light on these interactions between the different elements of the female study choice puzzle.

It does so by focussing on the choice processes of high school students in two countries: the Netherlands and Sweden. These two countries have been chosen for a comparative study because the difference in the share of female between both countries defies the existing literature. As will discussed in chapter 3 and 4, Sweden and the Netherlands are generally regarded as quite similar in terms of gender equality and socioeconomic development and – at first glance – have education systems that are quite similar with respect to the moment of choice, the number of choices and the types of choices that high school students are required to make in order to be able to enter MST fields in higher education. Yet, Sweden differs significantly from the Netherlands in terms of female participation in MST. 15% of all female students in higher education in Sweden are enrolled in MST fields, as opposed to 6% in the Netherlands (Eurostat, 2012b). As a result the gender imbalance in MST is much lower in Sweden. In the MST subfield of science, mathematics and computing fields, 42% of students are female in Sweden, as opposed to 23% in the Netherlands (Eurostat, 2012c). The other MST subfield – engineering, manufacturing and construction fields – provides a similar picture with 29% of female students in Sweden and 18% female students in the Netherlands.

In view of these remarkable differences in female participation between both countries, my research question is: In what way and to what extent do interactions between micro-, macro- and institutional level factors explain differences in female high school students’ study choices towards MST fields between the Netherlands and Sweden?

From this research question I have derived three sub-questions, which I will try to answer in my thesis:

1) Which types of explanations are currently given for gendered choice patterns in MST and what are their implications for designing further research in this field?
2) In what way do individual male and female high school students in the Netherlands and Sweden explain their own choices in favour of natural science tracks and how does this differ between the Netherlands and Sweden?

3) To what extent do male and female high school students in the Netherlands and Sweden differ in the way they evaluate and weigh different aspects of MST-studies when considering a study in these fields?

1.4 Design and outline of the dissertation

This dissertation is set-up as follows.

Chapter 2 presents the state-of-the-art of the research literature on gendered study choice patterns, thus addressing the first sub-question.

After a comprehensive review of the research literature from 2005 onwards, I distinguish three main strands in the literature, based on micro-level, macro-level, and institutional perspectives. For each perspective, I present a summarized overview of the main theoretical frameworks on which recent studies have been based, as well as the results of these recent studies. Next, I critically discuss the evidence provided from each perspective, but also point out some inconsistencies and lacunae. This discussion then leads to the formulation of recommendations for a more integrative approach.

To understand why relatively more female students in Sweden opt for MST, in the next two chapters I focus on the second sub-question and study individual students’ choice processes towards natural science tracks and MST fields in the case of the Netherlands and Sweden. I thereby take into account the various determinants of gender differences in MST, as put forward in the existing literature. The study also takes advantages of substantial migration from non-Western countries to both the Netherlands and Sweden (for a definition of this category, see chapters 3 and 4). Following Schreiner and Sjøberg, it can be assumed that students with a non-Western migrant background differ in cultural values and gender role expectations, as compared to native Western students. Attention is therefore given to possible differences in study choice behaviour between students of these different ethnic backgrounds.
Chapter 3 first presents the results of the Dutch case study, using a mixed-methods research approach. In the Netherlands, I explore students' choice for the so-called Nature and Technology (NT)-profile. The quantitative part of the Dutch case study focuses on exploring the statistical relationships between profile choice (dependent variable) and gender and migrant background (independent variables). I try to establish not only the quantitative statistical relationship between gender, migrant background and the choice for a NT-profile, but also the study choice processes themselves and the rationales the students themselves gave for their choices.

This is followed in chapter 4 by the results of the Swedish case study and the comparison between the Dutch and Swedish case, using a qualitative research approach. In Sweden, I focus on the choice for the so-called Natural Sciences (NS)-program and compare that with how students talk about the choice for the NT-profile in the Netherlands.

The mainly qualitative study of students’ choice processes – and the identification of the factors that students in the Netherlands and Sweden consider to be important – is then followed in chapter 5 by a quantitative study of the influence of these factors on male and female students’ intentions to choose MST in higher education in the Netherlands and Sweden.

In chapter 5, I focus on the third sub-question and study differences in Dutch and Swedish high school students’ perceptions of MST fields on six key factors that are expected to affect the choice for MST. Based on the results of the literature study and the two case studies, I expect students’ intentions to choose MST fields to be explained by six key factors. The first factor relates to students’ perceptions of MST fields as fun and interesting, i.e. intrinsic motivation. The second factor relates to students’ perception of MST fields as an important tool for students’ self-realisation. The third factor relates to students’ perceptions of the job prospects of MST fields. The fourth factor relates to students’ perceptions of the amount of hard work that is required for MST fields. The fifth factor relates to how much pressure students feel from significant others to choose MST fields. The sixth factor relates to students’ self-efficacy beliefs in relation to MST fields.
This dissertation is concluded in chapter 6. There I give a summary of the main findings and present my conclusions. I also provide a brief discussion on the limitations of the results and the implications thereof for future research.
Endnotes

1. Participation in ‘MST fields’ and ‘MST’ refers to the share of female students at ISCED levels 5-6 enrolled in the fields of science, mathematics, computing, engineering, manufacturing and construction as a percentage of all female students (Eurostat, 2012b). The levels and fields of education and training used, follow the 1997 version of the International Standard Classification of Education (UNESCO, 2006 [1997]) and the Eurostat manual of fields of education and training (Andersson & Olsson, 1999). We sometimes only refer to the share of female students in the subdomain of science, mathematics and computing as a percentage of male and female students at ISCED levels 5-6 when data on female participation in MST missing, e.g. in comparison to countries outside the EU and OECD context.

2. Female students (ISCED 5-6) enrolled in science, mathematics and computing fields as a percentage of male and female students in these fields (Eurostat, 2012b). Similarly, recent figures by UNESCO from 2014 show that 41% of students enrolled in Science programmes in Sweden are female (2014).

3. Eurostat, 2012b. Recent data on the percentage of students enrolled in Science programmes who are female is missing in the UNESCO database for the Netherlands.


6. Id.

7. Id.

8. Id.

9. Schreiner and Sjøberg (2004; Schreiner 2006; Sjøberg and Schreiner, 2005) use the terms ‘Western’, ‘developed’, ‘modern’, ‘modernized’ and ‘late-modern’ as synonyms in reference to cultural, economic and political development in Western societies.
References


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