The End of a Gender Quota in Elite Higher Education*

Léa Dousset† Georgia Thebault‡

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Abstract

We show that a gender quota system in competitive higher education institutions could be an efficient solution to address the issue of women under-representation in math-intensive fields and elite environments. We use original hand-collected historical data from the entrance exam for one of the most competitive graduate schools in France to evaluate the effect of a change in admission policy that removed a hard gender-based quota system. We document that the end of the quota led to a sharp decline in the percentage of admitted female candidates, but only in math-intensive fields. We then focus on the mathematics entrance exam to delve into the mechanisms. We show that roughly half of this fall can be mechanically explained by a gender performance gap. However, we also uncover an endogenous response by female candidates: there are fewer female candidates at the entrance exam once it became mixed-gender, and this *turning-away* mechanism is mostly driven by potentially high-achieving female candidates. This detrimental endogenous response of women in a real-life context is important. As this elite institution leads to high-level academic careers in France, we show that the removal of the gender quota increased the gender gap in academic careers for affected students.

JEL Codes: I23, I24, J16, J24, J78

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†Paris School of Economics, Université Paris 1 Panthéon-Sorbonne. Contact: lea.dousset@psemail.eu

‡Université Paris Dauphine-PSL. Contact: georgia.thebault@sciencespo.fr

Introduction

In many higher education systems, recruitment into elite schools is based on competitive exams, which are the cornerstones of meritocratic admissions policies. Selective education is by definition facing a capacity constraint due to a limited number of seats. Competitive exams are often considered as a fair and equitable solution to assess and select students based on their ability.[1] However, recent experimental literature has shown the extent of gender differences in attitudes towards competition. Women's performances and their willingness to compete have been shown to be lower in mixed-gender rather than single-gender settings (Gneezy et al., 2003; Niederle and Vesterlund, 2007), especially while performing stereotypically male associated tasks (Niederle and Vesterlund, 2010). Gender differences in aptitude during high stake exams, which has already been documented among high-school students (Azmat et al., 2016), can have detrimental effects on women's outcome in higher education (Arenas and Calsamiglia, 2022). Gender quotas have been shown in experimental design to be an effective tool to level the playing field between male and female students, especially in STEM (Niederle et al., 2013). However, little is known still about the real-world effect of such a policy, as there have been limited sources of exogenous variations in the implementation or the end of gender quotas in the educational context.

In this paper, we aim to empirically address this question by studying the removal of a gender quota implemented in the entrance examination for one of France's most prestigious elite graduate schools, the *École normale supérieure de Paris* (ENS Paris). Before 1986, there were two single-gender entrance examinations for admission to the ENS Paris, equivalent to a hard gender-based quota system. In order to prepare for the entrance examination, students must undergo two to three years of intense preparation into preparatory programs.[2] Since the mid 1970s, both female and male candidates studied together in mixed-gender preparatory programs. They were both given the same ENS entrance exam topics, but were graded and ranked separately, with a fixed number of seats for male and female students.[3] Once they were admitted to the school, and

[1] In addition to the French "grandes écoles", competitive exams (or multiple examinations) are common practice in several countries (OECD, 2019). Other countries rely on entrance examination (e.g. India or Turkey), or standardized aptitude tests (e.g. SAT in the United States, SweSAT in Sweden).

[2] In France, students prepare for the competitive exams to enter elite graduate schools in preparatory programs, which are hosted in high schools.

[3] Except in humanities, until 1984.

though there were still two single-gender schools, male and female students followed the majority of their classes in mixed-gender public universities, and ultimately had the same type of career in research and teaching.

Though the ENS Paris was one of the last schools to comply with the law on compulsory co-education in 1975 (*loi Haby*), the merger of the two schools happened at an unpredicted time. Our study leverages this unexpected event to evaluate the impact of the introduction of mixed competition on female and male performance. We investigate this question using original hand-collected and digitized information about the entrance examination at the ENS Paris between 1969 and 2007. We gathered individual-level data for the mathematics track, and aggregate-level data for the biology, humanities and physics tracks. We complete this dataset with information about candidates' outcomes on the labor market, but also with hand-collected and digitized information about students' grades report from the best mathematics preparatory program between 1978 and 1988.

We document that the introduction of the mixed competition led to a dramatic fall in the share of female candidates admitted to the mathematics and the physics-chemistry tracks, while it remained unchanged in the biology and humanities tracks.[4] However, in all four tracks, the end of the gender quota led women to be under-represented among admitted candidates with respect to their enrollment in preparatory programs. For instance, in the mathematics track, the share of women among the admitted candidates fell from 39 % on average over the ten years before the merger to 9 % on average over the twenty years that followed it, while they represented 16.5% of students in mathematics preparatory programs in France.

We then focus on the mathematics entrance examination to better understand the underlying mechanisms. Using relative odds ratios to take into account the gender composition of candidates and students in preparatory classes, we show that female students were actually more likely to be admitted to the ENS before the introduction of the mixed competition. This pattern is then entirely reversed after 1986. Male students then have a substantial advantage in qualification at the written exam and in final admission. Using our detailed information about students' scores at the entrance examination, we show that female students perform worse than male students at the

[4]Before the merger, the quota was set to be around 40-35 % of female students in mathematics, 45-50 % in physics-chemistry, and around 50 % in biology and humanities.

written exam over the entire study period, but perform as well as them at the oral exam, with and without controlling for their grades at the written exam. We then perform a pre-merger counterfactual simulation by ranking both male and female candidates together on their final grade. We find that about half of the fall in the share of admitted female candidates can be explained by this gender performance gap at the entrance exam. However, a large share remains unexplained by it. We investigate the causes of this unexplained part of the fall in admitted female students, and we show that women tend to *turn away* from the ENS Paris examination after the implementation of the mixed competition. as the end of the gender quota is followed by a decrease in the number of female candidates. This endogenous response is concentrated among candidates who are likely to be high performers: the ones from best preparatory programs in France.

We take advantage of the students' grades report from the best mathematics preparatory program between 1978 and 1988 to study the extensive and intensive margins of this endogenous response. Although the students of this prep program only represent a subsample of the ENS candidates (roughly 13%), they make up for a third of all the admitted students. At the extensive margin, we show that after the end of the gender quota, there was a general decrease in the probability to apply to the ENS for female students. Indeed, we observe fewer female candidates throughout the academic achievement distribution, meaning that the decrease in the share of female candidates is not explained only by the lowest-achieving female students turning away from the heightened and mixed-gender composition, which would be rational for them given the low admission rate. On the intensive margin, we looked at whether, conditional on applying, female candidates performed less well at the exam once it became mixed-sex. We find no evidence of women underperforming at the entrance exam with respect to their male counterparts once we control for their grades at the end of the preparatory program, and no increasing nor appearing gender gap in performance at the exam once it became mixed-sex.

Finally, we investigate the long-run impact of ending gender quotas on the French academia. Indeed, studying the ENS Paris is especially relevant to assess the consequences of this reform on the French academic landscape, as between 1984 and 2010, 28 % of all the mathematics professors in French Universities are former students of the school.[5] We define a group of both male and female candidates who are likely to have

[5]ENS alumni represented 40 % of the mathematics professors in French Universities in the 1980s, and 13 % of all professors in French Universities between 1984 and 2010.

been impacted by the quota system, or by its ending in 1986. Our results suggest that the end of the quota system led to an increase in the gender gap in the probability to pursue a teaching or a research career in mathematics-related fields.

Related Literature This paper makes several contributions to the literature. Firstly, our paper investigates the impact of gender quotas in education on academic achievement and later labour market outcomes. If one believes that we should try to increase women representation in STEM fields, the long-term solution could be to tackle gender stereotypes. Some interventions have been shown to be effective in reducing this gender gap, such as information provision (Li, 2018), (same-gender) mentoring (Lim and Meer, 2017), or (same-gender) role models (Carrell et al., 2010; Kofoed and McGovney, 2019; Porter and Serra, 2020; Riise et al., 2022; Breda et al., 2023; de Gendre et al., 2023). However, these interventions must happen early enough in students' life to affect their school choices. A more short-term solution in higher education could be to implement gender quotas. This tool has been, until now, more extensively used and studied in the context of the workplace (Bertrand et al., 2019), in hiring committees (Deschamps, 2023), or in politics (Besley et al., 2017; O'brien and Rickne, 2016), including in France (Lippmann, 2021, 2022).A paper of interest is Schaede and Mankki (2024) who study the end of a gender quota in favor of men in Finland for primary school teachers on their pupils' long-run outcomes. While the use of gender-based affirmative action may seem unusual in an educational context, such policies are already in place in countries like Finland, where points are awarded to underrepresented genders in a field (Silliman and Virtanen, 2022).

Although our natural experiment is not the end of an affirmative action policy *per se*, we believe that our results can shed light on the symmetric context of an implementation of a gender quota. Our paper can inform us on the mechanisms at play in the long-lasting debate on the efficiency-equity trade-off of affirmative action policies in education. In line with Bleemer (2022), we show that the implementation of quotas counteract some endogenous responses by the targeted candidates: in the absence of quota, they reduce their application behavior. This brings us to our second contribution. Our paper provides new real-world evidence on the detrimental effects of mixed competition for women performance in stereotypically masculine task, notably by showing the existence of a

turning away effect exhibited in the experimental literature (Niederle and Vesterlund, 2010), driven mostly by potentially high-achieving candidates.

Our third contribution is to offer a potential solution to the persistent problem of women under-representation in math-intensive fields and elite institutions. While they outnumber men in higher education, women account for less than 20 % of new entrants in computer science and approximately 18 % in engineering on average among member countries of the Organization for Economic Co-operation and Development (OECD, 2017). This unbalance raises concern for three main reasons. First, the lack of women in STEM generates a potential loss of talents that could help meet the growing demand for these types of skills (Hoogendoorn et al., 2013; Hunt, 2016; Hsieh et al., 2019). Second, it contributes to gender inequality on the labor market, as STEM occupations lead to higher income on average (Brown and Corcoran, 1997; Black et al., 2008; Blau and Kahn, 2017). Finally, the under-representation of women challenges the production of ethical and fair knowledge(Truffa and Wong, 2024), which has notably been shown to be a concern for the development of artificial intelligence (UNESCO, 2020).[6] We show that affirmative action in favor of women in STEM could foster their participation in competitive exam, eventually benefiting high-achieving women that would not have applied in the absence of the policy.

Our study also speaks to the social science literature on the effect of the internalization of gender stereotypes on women's performance and school choices (Breda et al., 2020; Charles and Bradley, 2002; Charles and Grusky, 2005; Charles and Bradley, 2009; Huguet and Régner, 2007; Sikora and Pokropek, 2012; Spencer et al., 1999). Recent literature, finding its theoretical basis in evolutionary psychology, posits that in more equal countries, men and women would have more freedom to express their inner preferences (Lippa et al., 2010; Stoet and Geary, 2018; Falk and Hermle, 2018), resulting in more horizontal differentiation. In the schooling context, this would imply that women would outperform men in humanities, and men, women in science, maintaining a status quo in the end. However, we do not observe this phenomenon in our historical experiment; the introduction of the mixed competition eventually led to an absolute decrease in the number of women admitted to the ENS Paris, as there were fewer women admitted in the mathematics and physics track, but not more admitted in the biology

[6] A similar phenomena has been shown with respect to racial minorities (Dossi, 2024).

and humanities tracks. Our paper then contributes to the recent literature on the effect of co-education. It notably speaks to the paper by Calkins et al. (2021), which shows that women's colleges' transitions to co-education in the United States led to a 3.0 percentage-point (30 %) decline in the share of women majoring in STEM.

Finally, our paper also confirms previous results regarding the impact of the merger of the ENS de Fontenay-aux-Roses and Saint-Cloud (Bataille, 2011), and extend the results by analysing the effects of ending gender quotas on candidates profiles, candidates performances at the exam and on long-run labor market outcomes (Blanchard et al., 2014).

The rest of the paper is organized as follows. Section 1 describes the institutional background, and Section 2 presents the data used for this study. Section 3 presents the results on admission, and Section 4 delves into the mechanisms, disentangling the part due to a gender gap in performance and an additional endogenous response from female candidates. Section 5 discusses the long-run consequences of the end of the gender quota on the mathematics academic landscape in France. The last section concludes and discusses our findings.

1 Institutional Background

1.1 The École Normale Supérieure: a School for Research and Teaching

The School The *École Normale Supérieure de Paris* (ENS Paris) is an elite graduate school (*grande école*), located in the French capital, which was created after the French Revolution. Its purpose was initially to give homogeneous training to high school teachers across France, and now mostly leads to high-level teaching and academic careers. There are three other ENS aside from the one in Paris, located in Lyon, Saclay and Rennes.

The school has different tracks (humanities and sciences) for the entrance examination. However, students are free to study what they want once they enter the school. Though some classes can be taken on site, a large part of the ENS students' training takes place at public universities. At the time of the merger of the two schools, almost

all classes were taken outside of the ENS Paris. The ENS Paris has barely no tuition fees (only a couple hundreds of euros per year), and students who enter the school through the main entrance examination are paid to study for four years.[7] It is a particularly relevant context to study inequalities in access to top positions in mathematics. The ENS Paris is considered as one of the top schools in research in the world.[8] Out of 13 French Fields medals, 10 were former students from the ENS Paris. It is also one of the main pathways to an academic career in France; on average, between 1984 and 2010, 28 % of all the mathematics professors in French Universities are former students of the school.

Recruitment Recruitment at the ENS Paris mainly relies on a highly competitive entrance examination.[9] After high school, students willing to enter the ENS Paris in mathematics first have to go through a two-year mathematics preparatory program where they can prepare for the entrance examinations for the ENS and other elite graduate schools.[10] Preparatory programs are located in high schools, and students are taught by the highest qualified secondary teachers.[11] Tuition fees are very low for public preparatory programs, and more than 80 % of students are enrolled in a public one (MENESR, 2022).

At the end of their training, students can apply to the ENS Paris mathematics entrance examination. Application to the entrance examination is free. The examination is staged in two steps: a written examination, and then for qualified candidates, an oral examination. The number of seats offered in each track is defined by law at the beginning of the school year by the Ministry of Higher Education. Exams take place at the end of the school year, between April and June. Since the merger of the two single-gender schools in 1986, more than 800 candidates are registered at the mathematics written exam on average each year, for approximately 40 seats available.

All candidates are ranked according to a weighted average of all written test scores

[7] Students are then formally in contract with the state as civil servant trainees for 10 years, including their four years of studies.

[8] The ENS has the largest ratio of Nobel Prize winners per capita in the world according to Clynes (2016).

[9] A small number of students are also recruited based on their academic records. Over the past decade, the number of students admitted through this admission procedure has fairly increased; it has been used by the administration has a way to increase diversity in the school, though students at the ENS Paris are still largely coming from very high socioeconomic status background (Bonneau et al., 2021).

[10] Details about the French higher education system can be found in Figure A1.

[11] Only teachers who obtained the *agrégation* can teach in preparatory programs.

and the highest ranked students are declared qualified for the oral examination. The qualification threshold is track and year specific, and the number of qualified students is a little more than twice the final number of seats available. The mathematics-track written examination consists of three main written exams, two of mathematics and one in physics. French and languages are also evaluated at the written exam, but are only counted as part of the oral examination since 1994. In particular, the largest weight is given to the first mathematics exam, which lasts 6 hours. It has a reputation to be particularly difficult and hard to complete in time.

The oral examination takes place in June, two weeks after the results of the written exam have been disclosed to the candidates. Candidates are unaware of their grades and rank at the written exams, so that low and high-performers in the first stage prepare the final examination in the same way. Except some slight variations over time, subjects at the written and oral exams are essentially the same. Finally, qualified candidates are ranked according to a weighted average of all written and oral test scores and the highest-ranking students are admitted to the school. Oral examination typically accounts for more than 85 % of the final average. Admission to the ENS Paris in mathematics is highly selective: the final acceptance rate is only 5 % (compared, for instance, to 7 % for the Massachusetts Institute of Technology). Students have the possibility to do a third year of preparatory program to retake the exam.

With the exception of the 1986 merger, the preparation conditions and the recruitment procedures for the entrance examination to the ENS Paris in mathematics have remained stable over time. The other major change took place in 1994 with the creation of a common written exam for all the ENS. Prior to this change, each ENS conducted its own separate entrance exam, which made it difficult for students to apply to multiple schools.[12] The creation of a common written exam made it easier for students to apply to multiple ENS and helped to standardize the admission procedure across the different institutions. It mainly resulted in a change of the weights applied to each subject for the ENS Paris.

Juries ans Exam Topics Before 1985, the juries and exam topics differ depending on the entrance track (mathematics, physics-chemistry, biology, humanities). In 1985, in

[12]Although not impossible, since the calendar was such that students could take all the different exams if they wanted to.

order to anticipate for the end of the gender quota the following year, the four tracks provided the same exam topics for both male and female students, and the same jury graded (anonymously for the written part of the exam) both male and female students together.

Prior to 1985 and at least since the 1970s, for the mathematics entrance examination at least, the exam topics were the same for male and female students, but their exam papers were graded by different juries.[13] In scientific subjects, there were hardly any female jury members at the women-only school, and a men-only jury at the men-only school. Variation in the gender balance of the jury is thus not a dimension we are able to study. [14] For the physics-chemistry and the biology tracks, the exam topics and the juries where the same for both male and female students. However, their exam papers where graded separately, meaning that the jury members knew whether they where grading a woman or a man's work. For the humanities track, both the juries and the exam topics where different for male and female students.

1.2 Two Single-Gender Schools until 1986: A Gender Quota?

History of the Schools The *École normale supérieure de jeunes filles*, later known as ENS de Sèvres due to its location, was created in 1881 as an equivalent of the *École normale supérieure de la rue d'Ulm* (hereafter ENS d'Ulm) for women. Except from the interwar period when some female candidates could take part in the male examination (mainly for tracks that were not available in their school), admission to the ENS de Sèvres and to the ENS d'Ulm was done through two separate entrance examinations.

Before 1986, the existence of these two single-gender entrance exams was equivalent to a gender-based hard quota system.[15] Since at least the mid 1970s, preparatory programs were mixed-gender, even though the share of women in mathematics classes was fairly small (about 17 % in second year of mathematics preparatory classes around the time of the merger). The same exam topic were given to male and female students in

[13]The 1970s is the earliest period we could find in the archives for entrance examination topics and related information.

[14]You can find more details about the mathematics entrance exam juries in Appendix section E.

[15]As described by the Prime Minister Laurent Fabius in his January 1985 speech announcing the merger of the two schools: "The two schools have long been closely linked. In fact, their merger is already a reality in several disciplines. Students share many activities, and not just academic ones. They come from the same mixed preparatory classes. So do the competitive examinations they take.

each subject in the scientific tracks. Male and female students were graded and ranked separately. Once they entered the school, most of ENS students' classes were taken at the university (mixed-gender institution) and male and female students interned in the same research laboratories. They took the same examination to become a teacher after their studies (the *agrégation*), which both female and male ENS students were strongly encouraged to take. Nonetheless, some differences remained between the two institutions: specific classes - namely the preparation to the *agrégation*, the examination to become a secondary school teacher - and the dormitories were still separate for men and women until the merger of the two schools in 1986.

The Women-Only ENS: A Second Class School? One might be concerned that the ENS de Sèvres, being a school for female students only, would not lead to the same type of career opportunities as the ENS d'Ulm. Several documents from the archives of the ENS tend to invalidate this hypothesis. In 1966, a report by mathematician Pierre Samuel about the mathematics track at the ENS de Sèvres reported that about 80 % of the ENS de Sèvres students chose to pursue a research career (either at the university or the *Centre National de la Recherche Scientifique* (CNRS)). The author deplored that only 20 % of them chose to teach in secondary schooling, as there was a need for highly qualified teachers. The report also highlights that France was among the countries with the largest share of female mathematicians in the world, and that the ENS de Sèvres largely contributed to that phenomenon.[16] In 1964, there were 200 professors and assistant professors in pure mathematics in France; about 25 of them were women, among which 15 were former students of the ENS de Sèvres. Former students of the ENS de Sèvres were not concentrated in specific sub-fields of the mathematics, and some female mathematicians were prominent researchers in such domains as arithmetic, geometry or algebra.

Documentation from the ENS archives suggests that female and male students had

[16] In a report written jointly in 1982, the directors of the ENS d'Ulm Georges Poitou and of the ENS de Sèvres Josiane Serre stated " The opinion is quite widespread in France that we are behind in terms of the feminization of higher education and scientific research. However, this is completely false, and it becomes evident as soon as we cross our borders. On the contrary, France is probably the most advanced country in this field. Therefore, we must be careful not to squander this lead through hasty measures. In France's currently favorable situation, it doesn't seem exaggerated to attribute a significant part of this success to the existence of the ENS de Sèvres. As we consider extending coeducation to the ENS of Ulm and Sèvres, it is important to keep these facts in mind. It can be argued that many potential approaches to coeducation would actually harm the feminist cause."

the same type of career after their studies. Our own computations made with the ENS Alumni database and the administrative data from the human resources of the Ministry of Higher Education in France tell us that 8.8 % of the male students who entered the ENS between 1969 and 1985 ended up having an (assistant) professor position in a French public University, while the share was 9.6 % for female students.

Table 1: Outcomes of Students Enrolled in ENS Mathematics Track Before the Merger, ENS de Sèvres and ENS d'Ulm, 1975-1982

	ENS d'Ulm (men only)	**ENS de Sèvres (women only)**	
Entrance Class	1975-1977	1960-1962	1981-1982
Number of Students	91	68	39
Measured in	1984	1966	1990
Secondary Education	14%	15%	13%
(Mostly in preparatory programs)			
Higher Education & Research	55%	79%	40%
Other	11%	6%	37%
Unknown	20 %	0 %	0 %

Source: Documentation sourced from the ENS archives.
Notes: the category "Other" refers to different types of careers than research or teaching. It mainly encompasses different types of job in the French administration, namely high officials in ministry and statistical institutions. *Lecture:* Among male students who entered the ENS mathematics track between 1975 and 1977, 14 % chose to become teachers in secondary education, while 55 % of them chose to pursue a career in higher education and research, and 11 % chose other types of careers. 20 % of the students did not respond to the survey.

Table 1 displays statistics drawn from different waves of survey carried out by the administration of the school regarding students' outcomes after their studies. Among male students who entered the school between 1975 and 1977 in mathematics, 14 % had chosen to become teachers in secondary schooling about 10 years after their entry, mostly in preparatory classes; 55 % of them decided to pursue a career in research, while 11 % of them chose to pursue different types of career, mainly by becoming high officials of the French administration.[17] Figures are comparable for the promotions of female

[17]This include any position as an (assistant) professor in France or abroad, in a public university or a private college, or as a researcher in a public or private institution.

students who entered the school between 1981 and 1982: only 13 % of them chose to become teachers in secondary education, while 40 % pursued career in higher education and research; a slightly higher share of female students turned to other types of careers.

Further evidence that the ENS de Sèvres did not admit students with lower abilities than the ENS d'Ulm is demonstrated by their performance on the Mathematics examination to become a secondary teacher, the *agrégation*. In France, most prospective high secondary education teachers and researchers take the *agrégation* exam. It is a competitive exam, which grants passing students a higher wage, fewer teaching hours, the possibility to teach in higher grades (high schools and preparatory programs), and can be a pre-requisite to pursue a PhD in some fields.[18] Since the ENS d'Ulm and the ENS de Sèvres were both intended to train future researchers and teachers, it was strongly encouraged for students to take the *agrégation* exam after their second or third year of schooling.

Table 2: Success Rate at the Mathematics *Agrégation* in 1984, 1985 and 1986

	ENS de Sèvres (women only)			**ENS d'Ulm (men only)**		
	1984	1985	1986	1984	1985	1986
Number of candidates	14	10	7	13	10	20
Share of qualified candidates	93%	80%	100%	85%	90%	85%
Share of admitted candidates	93%	80%	100%	85%	90%	77%
Average final rank	43.1	45.6	33.4	45.5	32.7	32.4

Source: Documentation sourced from the ENS and French National Archives.
Notes: The first part of the Mathematics agrégation is composed of three written exams: one of Algebra, one of Analysis, and one option (Probability and Statistics, Numerical Analysis, Mechanics). If the candidate is qualified for the second part of the *agrégation*, they take the two oral exams: one of Algebra and one of Analysis. There were 128 seats available in the 1984 Mathematics *agrégation*, 180 in 1985 and 180 in 1986. The lower the rank, the better. The final rank is only available for qualified candidates.
Lecture: In 1985, 80% of the 10 ENS de Sèvres female students who registered at the Mathematics *agrégation* were qualified for the oral part of the exam and all of them passed the *agrégation.* Their average final rank was 45.6.

Table 2, which displays the success rates of ENS students at the Mathematics *agrégation* in years 1984-1986, shows that male students from the ENS d'Ulm and female

[18]This is mostly the case in humanities.

students from the ENS de Sèvres performed equally well on the test.[19]

The Merger of the Two Schools in 1986 The ENS d'Ulm and ENS de Sèvres were among the last schools to comply to the 1975 Haby law which sanctioned compulsory co-education in France. Other elite graduate schools had opened their recruitment to female students in the 1970s, and the other ENS single-gender schools - *Ecole Normale Supérieures de Fontenay-aux-Roses* and *Saint-Cloud* - had merged in 1981. Though the conditions of the merger of the two schools were largely discussed - as it is documented in different reports found in the archives of the ENS - the exact year of its implementation was not anticipated: it was announced in January 1985 by the Prime Minister Laurent Fabius, a former student of the school, in a funeral oration for a former researcher of the school, Alfred Kastler.[20] This means that students who enrolled in preparatory program in 1984 were not aware of the merger of the two entrance examinations until the middle of their first year of training. The documentation we found in the archives of the school clearly stresses the inconvenience of the short timing of the merger. It was then decided to proceed in two steps: in 1985, female and male students had the same topics, the same juries, were graded together but were still ranked separately. The real merger of the two entrance examinations occurred in 1986, when male and female students were ranked together for the first time. This last step validated the merger of the two schools.

There is an extensive body of administrative archives which documents the reflections on the roots and the potential consequences of the merger of the two schools. It appears that, beyond social justice consideration, the merger was also motivated by economic reasons: having two different schools became too costly in terms of teaching and administrative staffs. The different reports and letters from former students and contemporary professors also report the difficulties that the school was facing, coined by many as "the crisis of the ENS". The merger of the two schools was seen as a way to

[19]There is some selection bias, because students can choose in which subject they take the *agrégation*. About a third of the admitted students through the Mathematics entrance exam to the ENS in the 1980s decided to take the Physics *agrégation*, and a handful took it in another subject (e.g. Economics). Some other do not take any *agrégation* exam at all.

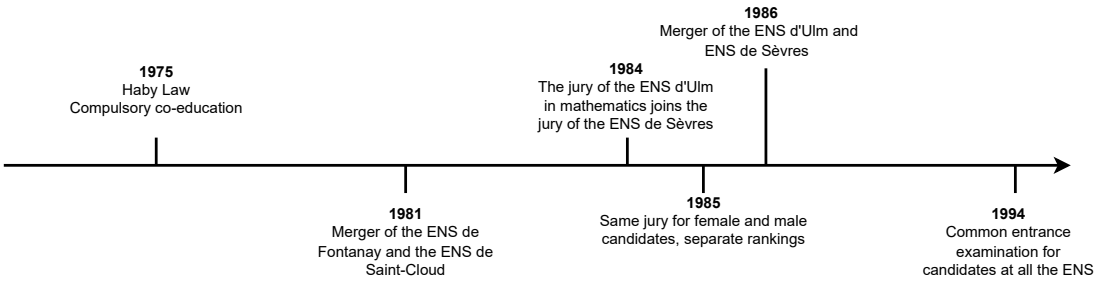
[20]This speech can be found on the Online Appendix.

solve these issues.[21]

It has to be noted that, rather than a merger, the ENS de Sèvres was eventually absorbed by the ENS d'Ulm. ù[22] It is documented in the ENS archives that the merger was challenged both by students and professors of the school (petitions, letters etc.). It was then seen as a way to instrumentalize gender equality to increase budget cuts, and some concerns were raised regarding the impact it might have on female recruitment in the science departments. A comity for co-education was thus created to oversee the merger. An interesting take in these reports is the view that the merger would result in two main phenomena: less women admitted in the science track, but more women admitted in the humanities track. This hypothesis, which conveys the idea that mixed competition would lead men and women to outperform the other in their supposed preferred field, was a common view at the time of the merger.[23]

For the rest of the paper, we refer to the two single-gender schools as the ENS d'Ulm and ENS de Sèvres. We refer to the merged school as the ENS Paris. A summary of the keys dates is presented in Figure 1.

Figure 1: Timeline of the Merger of the ENS d'Ulm and ENS de Sèvres



[21] In his January 1985 speech announcing the merger of the two schools, the Prime Minister Laurent Fabius also mentioned the upcoming budgetary reforms of the schools: "The schools' reform process will affect other fields [than just the implementation of co-education], under the responsibility of the departments themselves and under the authority of the Director General of Higher Education and Research, who will chair an administrative and budgetary reform structure for a few months." but also that one of the goal of this reform was to make sure that " the School will gain in diversity and be able to redeploy its resources more effectively."

[22] This is particularly evident in the management of juries after the merger as presented in Appendix section E.

[23] In an article published on January 15th 1985 in the newspaper *Le Monde* announcing the merger of the two schools, the journalist states this widespread hypothesis: "This merger had been considered for a long time and was generally desired, although it could lead to some imbalances: given the recent competitive exams results, there is a concern that boys might leave little room for girls in the science sections, and that the girls might return the favor in the humanities."

2 Data

Our analyses rely on many historical data sources, several of which we have hand-collected and digitized.[24]

ENS Paris Entrance Examination We collected information about the ENS Paris entrance examination in the archive rooms of the ENS Paris and in the French National Archives. Documents stem from the archives of the entrance examination administration service. All the data sources were digitized by hand, then transformed from image to text either with an Optical Character Recognition (OCR) software or by a typist for the oldest data sources (mainly entrance examinations from the 1970s and 1980s), as the OCR performances were too poor on these materials.

We brought together a individual-level dataset about the mathematics entrance examination at the ENS d'Ulm (men-only), the ENS de Sèvres (women-only) and the ENS Paris (mixed-gender) from 1969 to 2007. However, the data from the ENS de Sèvres was better preserved than the one from the ENS d'Ulm. We only managed to recover individual data about the male mathematics entrance examination for years 1978, 1979, 1982, 1984 and 1985, which are of crucial importance for the analysis of the effect of the merger. [25] For years with complete archives, we have, for each candidate, information about the grades they obtained in every subject of the written examination, their ranking, and whether they were qualified for the oral examination. We also have grades obtained in each subject at the oral examination (for qualified candidates), their final ranking, and whether they were admitted to the ENS or on the wait-list. We also retrieved the list of candidates who actually enrolled in the school at the beginning of the following school year. Finally, we have some socio-demographic information about the candidates (gender, birth date, the preparatory program they attended and where they took the entrance examination). When not available in the administrative sources, the gender of the candidate was guessed based on their first names.[26]

We also retrieved aggregated information about the number of candidates, qualified candidates and admitted candidates at the ENS d'Ulm, the ENS de Sèvres and the ENS

[24]This work has been possible thanks to the financial support of the CEPREMAP, the *Chaire Politiques éducatives et mobilité sociale* (Ardian-DEPP-PSE), the Women and Science Chair (Dauphine-PSL Foundation Chair).

[25]Details about the data collection can be found in the Appendix section B.

[26]This concerns 12 years of our sample after the merger.

Paris for all the tracks of the entrance examination (mathematics, physics-chemistry, biology and humanities).[27]

Finally, we collected information about the juries of the ENS d'Ulm and ENS de Sèvres, and after the merger of the ENS Paris. Unfortunately, there is not enough variation in the gender composition of the juries to do an additional analysis on this topic.[28]

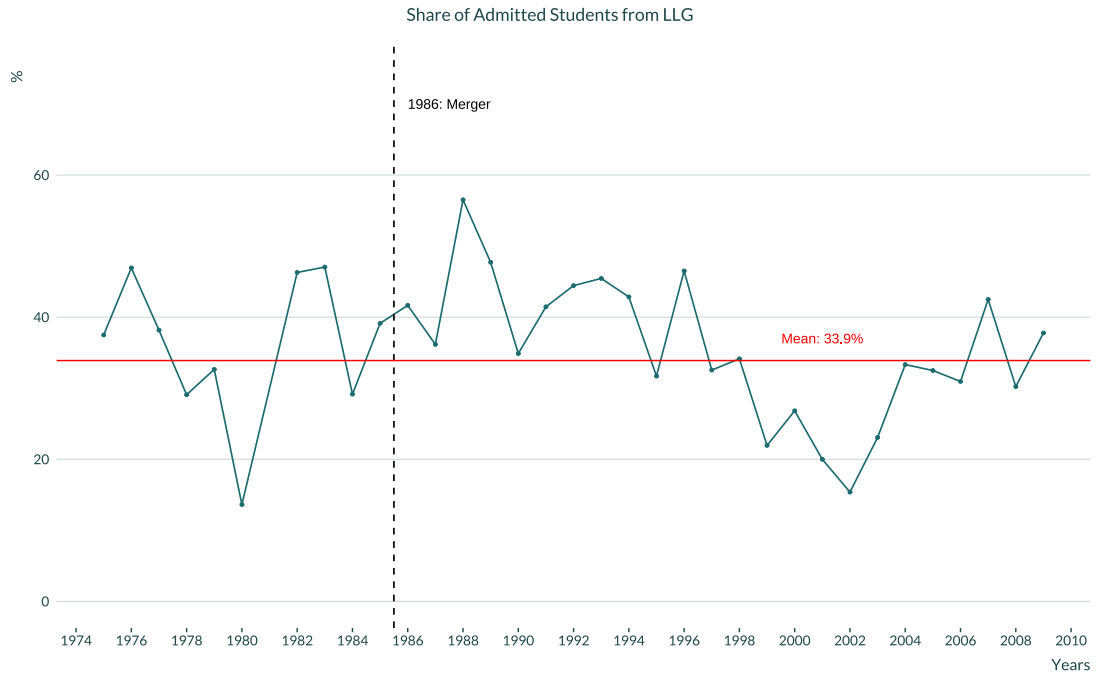
Preparatory Programs We gathered aggregated data about the gender balance of mathematics preparatory programs in France between 1978 and 2000 [29]. This information is available on the digitized archives of the French Ministry of Higher Education. We also collected individual students' grades report from the best mathematics preparatory program in France between 1978 and 1988. We hand collected this information in the archive rooms of *Louis le Grand* high school. It was transformed from image to text by a typist as the OCR performances were too poor on these materials. This detailed information about a subsample of students (roughly 13 % of ENS candidates) allows us to study in depth candidacy behavior from high-achieving students, since we know the exhaustive list of students enrolled in the second year of the best mathematics preparatory programs. Moreover, we are able study precisely ENS entrance examination performance, controlling for these students' academic ability right before taking the exam. It is worth noting that these students make up for a third of all the admitted students to the ENS, as shown in Figure 2.

[27]We have started to collect individual-level data for the other tracks in Spring 2024. We are in the process of converting them into data, to compare our current results in the mathematics track to the other ones, in a companion paper.

[28]Details about the juries are presented in Appendix Section E.

[29]This classification encompasses former classes M and M', which are the equivalent of MP and MP* today.

Figure 2: Evolution of the Share of ENS Admitted Students Who Come from the Best Mathematics Preparatory Program



Source: Documentation sourced from the ENS archives.
Notes: Between 1974 and 2010, on average, 33.9% of the students on the main admission list to the ENS mathematics track did their preparatory program in *Louis le Grand*.
Reading: In 1988, 56.5% of the students on the main admission list to the ENS mathematics track did their preparatory program in *Louis le Grand*, while they were only 13% in 1980.

Long-run Outcomes Finally, we assemble a large dataset about long-run outcomes of students affected by the (end of) the gender quota. Some information was available in the ENS archives but we also added information on results obtained at the high secondary teaching examination (*aggrégation*), collected in the French National archives, as well as individual information on mathematics doctorate completion in France (1985-2021) from *theses.fr* and worldwide (1930s-2021) from the *Mathematics Genealogy Project*. Other public information about the labor outcomes of former students of the school were retrieved online (e.g. the *Journal Officiel*).

We were also granted access to the administrative data of the human resources of the Ministry of Higher Education about the stock of (assistant) professors in French public universities between 1984 and 2010.

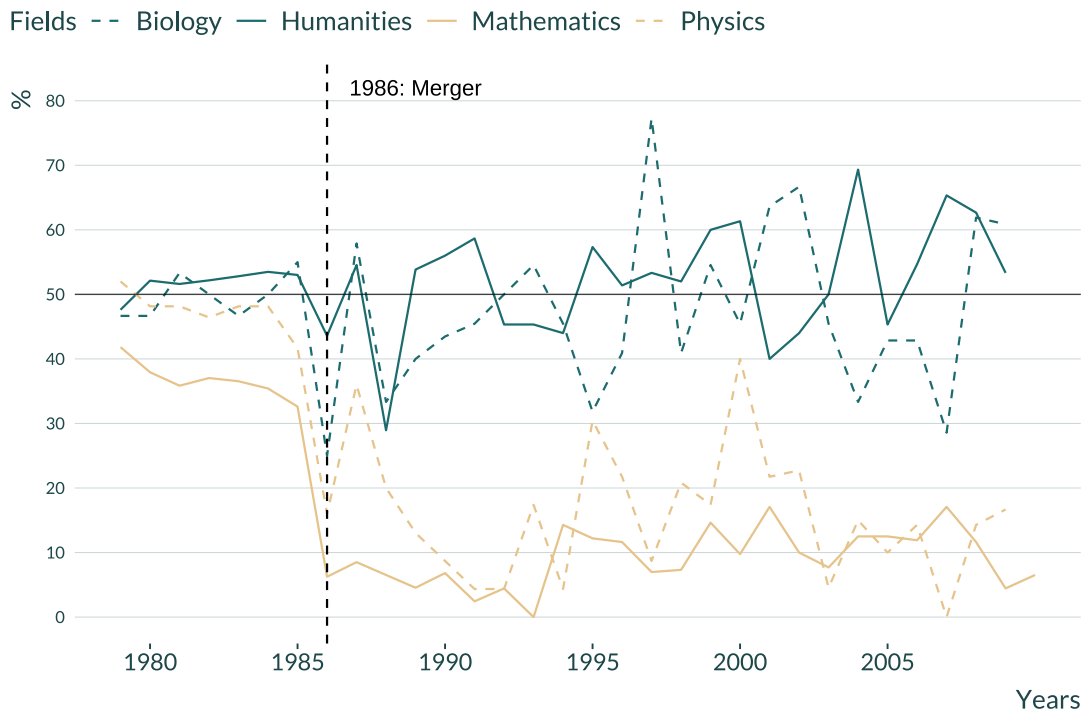
3 Results on Admission

Our analyses focus on the effect of the end of the gender quota on the gender balance of admitted candidates at the ENS Paris.

3.1 Comparison between Tracks

Figure 3 displays the percentage of admitted female candidates in each track between 1979 and 2009, namely mathematics, physics-chemistry, biology, and humanities. The first notable point to highlight is that the proportion of admitted female candidates to the mathematics and the physics-chemistry tracks decreased after the introduction of the mixed-gender competition, while it remained at the level of the gender quota in biology and humanities.

Figure 3: Percentage of Female Students Admitted to the ENS Paris (Ulm & Sèvres)
All fields, 1979 - 2009



Source: Documentation from the ENS archives.
Lecture: In 1987, there were 8,7 % of female students admitted to the ENS in the mathematics track; 36,0 % in the physics track; 54,5 % in the humanities track; and 57,9 % in the biology track.

Prior to the merger (1979 - 1985), the average admission rate for female candidates in the physics-chemistry was 47.5 %, but it dropped to 15.9 % following the merger (1986 -

2009), which is slightly below their representation in physics-chemistry in preparatory programs. In the mathematics track, the share of female candidates among admitted candidates dropped from 40 % before the merge to 9 % after on average, which is far less than their share in mathematics preparatory programs. It si also interesting to note that the decline in the number of female candidates admitted to the physics-chemistry track was more volatile than in mathematics, with the proportion of admitted female candidates even reaching 40 % in 2000, though it never returned to its pre-merger level.

In the biology track, while there was a significant drop in 1986, the proportion of female students among admitted candidates remained around 47.2 % on average after the merger (compared to 49.8 % before the merger). However, it has not followed in increasing feminization of biology preparatory programs in France. The humanities track followed the same trend, achieving parity on average after the merger (52.1 % of female students among admitted candidates, compared to 51.8 % before the merger).[30] But, it remained far below the share of female students in humanities preparatory programs in France over the same period. This apparently *null* effect of the end of the gender quota on the share of female students among admitted candidates in the biology and the humanities tracks actually hide a negative effect for women, since they ended up under-represented with regard to their representation in the corresponding preparatory programs.

These results can be interpreted as evidence that mixed competition can have a detrimental impact on women's performance in stereotypically male-associated tasks, which are represented here by mathematics intensive tracks (mathematics and physics-chemistry). On the other hand, the introduction of mixed competition did not foster women's performance in humanities, which are stereotypically female-associated. Rather than keeping a status quo through increased horizontal differentiation, the introduction of the mixed competition led to an absolute decrease in the number of female candidates admitted to the ENS.

A widely shared idea at the time of the merger was that the introduction of the mixed competition would lead to two phenomena: a decrease in the number of female candidates admitted to the mathematics and physics tracks, and a simultaneous increase in

[30]It has to be noted that the share of admitted female candidates is rather volatile; in humanities for instance, the share of admitted female candidates ranges from 30 % to 70 %. This volatility is partly due to the small size of the ENS cohort (75 admitted candidates per year on average in humanities, which is the largest track in the ENS).

the number of female candidates admitted to the humanities track (see section **??** for more details on this). This idea conveyed the message that the mixed entrance examination would still be a fair competition. In this setting, horizontal differentiation results from a fair game, where men and women would outperform each other in their supposed preferred subject. Between 1980 and 1991, the share of female students enrolled in the second year of a physics-chemistry preparatory program in France remained fairly constant and was 17 %. The trend also remained fairly constant in mathematics at 16.5 % and at 63.9 % in humanities. However, in biology, the share of female students increased over this period from 31.9 % to 47.9 %. Therefore, if one expected the share of female students among ENS admitted candidates to mirror their share in preparatory programs, one would expect the end of the gender quota to decrease the share of female students from 47.5 % (enforced by the gender quota) to 17 % in the physics-chemistry track and from 40 % to 16.4 % in the mathematics one. On the other hand, it should increase the share of female students among ENS admitted candidates in humanities from 52% (enforced by the gender quota) to 63.9 %.

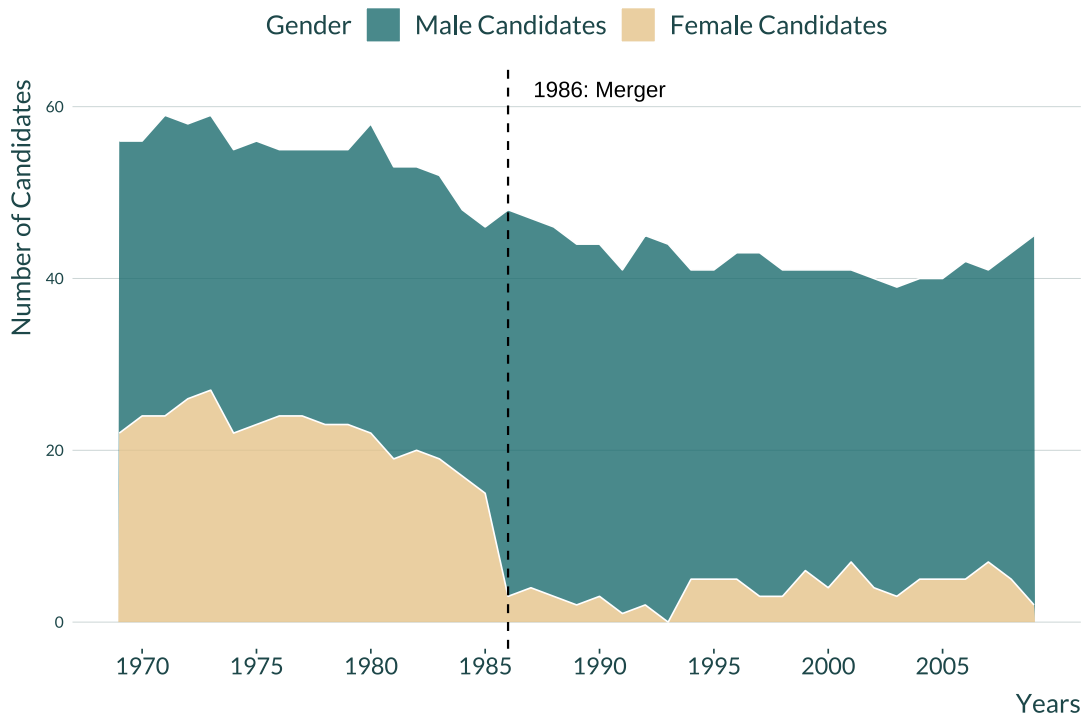
3.2 Focus on the Mathematics Track

We then focus on the mathematics entrance examination, as it the one with the largest and most persistent effect of the end of the gender quota on female representation among admitted candidates.

Admission Figure 4 displays the number of male candidates (green area) and female candidates (yellow area) admitted to the ENS Paris through the mathematics entrance examination. For each year, the sum of the two areas represents the total number of students admitted to the mathematics track. The black line denotes the year of the merger of the two schools, 1986.

There is a decreasing trend in the total number of admitted candidates to the ENS throughout the period: there were on average 55 candidates admitted to the mathematics track before the merger, and only 43 after the merger. This is in line with the information retrieved from administrative documentation announcing the need for budget cuts in the school. Nonetheless, the total number of admitted candidates remained stable around the period of the merger (ranging from 46 to 48 candidates between 1984 and 1988). Before

Figure 4: Candidates Admitted to the ENS Paris (Ulm & Sèvres) in the Mathematics Track, by Gender
(1969 - 2009)



Source: Documentation sourced from the ENS archives.
Lecture: In 1986, 48 candidates were admitted to the ENS through the mathematics entrance examination; 3 were female candidates, and 45 male candidates.

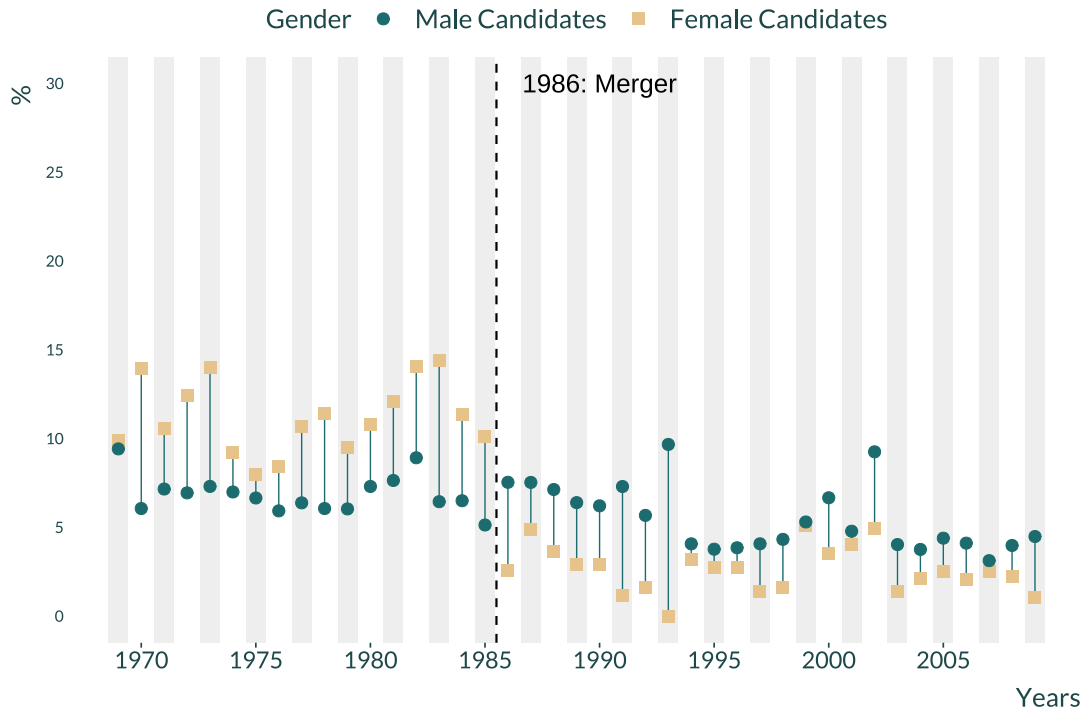
the merger, the number of female and male students followed the same trend; there were, on average, 22 female students admitted to the ENS de Sèvres over the period, and 33 male students. Though the cohorts of the ENS d'Ulm were on average larger than the ones of the ENS de Sèvres, female students still represented on average 40 % of admissions, which was fairly larger than the share of female students in second year of mathematics preparatory classes (16.5 % on average between 1980 and 1991). The entrance examination of the ENS de Sèvres could thus be considered as a generous quota system towards female students.

The implementation of the mixed competition led to a dramatic fall in the number of female candidates admitted to the mathematics track. In 1985, there were 15 female candidates admitted to the mathematics track; there were only three the year of the merger in 1986. The number of admitted female candidates then sharply declined, until reaching its lowest point in 1993 (zero). It then slowly rose again from the second half of the 1990s, which coincides with the implementation of the common written examination

for the three ENS schools (Paris, Lyon and Saclay) (see section 4.3 for more details about this event and its consequences). This fall is all the more striking since the number of admitted female candidates never reached its pre-merger level, even 25 years later. On average, there were only 4 female candidates out of 43 admitted students to the ENS Paris in mathematics between 1986 and 2009.

Success Rates by Gender The gender composition of admitted candidates to the mathematics track does not provide information on how chances of being admitted have evolved over time for both male and female candidates, before and after the merger. Figure 5 displays the success rate (i.e., the number of admitted candidates on the initial number of candidates) for female and male candidates separately. The first thing to note is that success rates at the ENS tend to decline over time for both male and female candidates. This is due to a decrease in the number of seats offered in the mathematics track (Figure 4) and an increase in the number of candidates throughout the years. The success rates of female candidates began to slightly decrease prior to the merger, which can be explained by a reduction in the number of seats offered at ENS de Sèvres from 20 to 15. However, the number of candidates taking the written exam remained roughly the same, with between 131 and 150 candidates. After the introduction of the mixed competition, we observe a sharp decline in the success rate of female candidates, dropping from 10.1 % in 1985 to 2.6 % in 1986. Two main features are worth highlighting. First, before the merger, the success rate of female candidates was substantially higher than that of male candidates, mostly due to a relative larger number of seats offered to female students compared to male students. Second, over the twenty years following the merger, the success rate of female candidates remained consistently lower than that of male candidates. This represents a complete reversal of the admissions pattern: prior to the merger, female candidates were more likely to be admitted to the mathematics track (11.2 % versus 6.9 %), while after the merger, male candidates were twice as likely to succeed as their female counterparts (5.6 % versus 2.7 %).

Figure 5: Success Rates in Admission to the ENS Paris (Ulm & Sèvres) Mathematics Track, by Gender
(1969 - 2009)



Source: Documentation sourced from the ENS archives.
Lecture: In 1986, the success rate (number of admitted students over the number of candidates at the written exam) was 2.6 % for female candidates and 7.6 % for male candidates.

Odds Ratios To measure the evolution of gender disparities in access to the mathematics track, it is necessary to compare the evolution of the recruitment to the underlying deformation of the gender composition of the pool of candidates. To take potential structural changes into account, we use *odds ratios*, which account for changes in the ratio of the relative chances of admission of female candidates with respect to male candidates.

We first consider the universe of candidates at the ENS entrance examination as the reference group. The value of the odds ratio ranges from 0 to plus infinity. A value of the relative odds ratio greater than 1 denotes an advantage for female candidates, whereas values comprised between 0 and 1 (excluded) denote an advantage for male candidates. Zero denotes perfect inequality and one perfect equality. The methodology for the computation of the odds ratios and their confidence intervals is given in Appendix D.

We want to assess whether the odds ratio is significantly different from 1, i.e. whether

the situation is different from perfect equality between the two genders.[31] It appears that the odds ratio value, computed year by year, is rarely statistically significant at conventional levels in the case of admission. This can be explained by the fact that female admission to the ENS is a relatively rare event after the merger; there are less than 10 admitted female candidates per year, and the initial pool of candidates is not large to begin with. As a result, this increases the variance of the logarithm of the odds ratio used to compute confidence intervals. However, this issue does not apply to the qualification stage, as there are more female candidates at this stage.

To gain a clearer understanding of the evolution in admission chances, we have grouped the years two by two in the rest of the analysis. Year-by-year results are presented in the Appendix D. The pattern exhibited in the yearly or grouped graphical representation are similar.

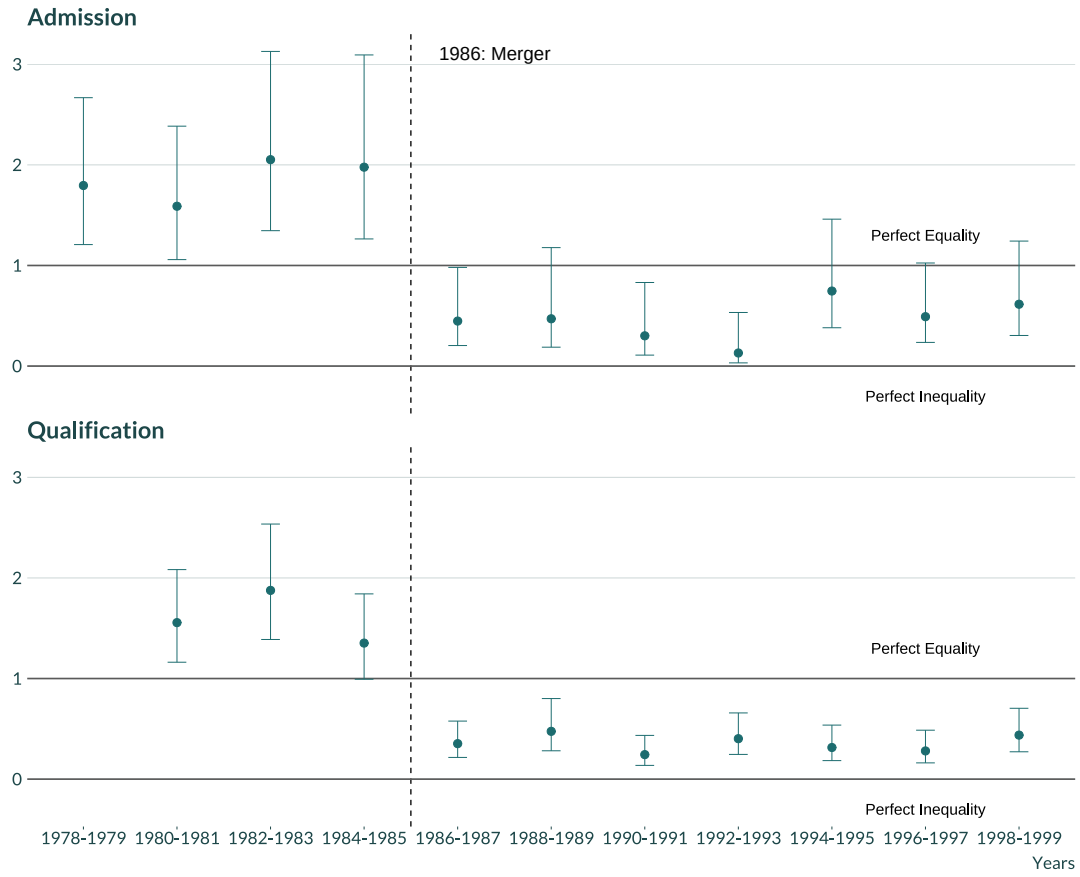
Figure 6 presents the relative odds ratio (later referred to as odds ratio) of female candidates with respect to male candidates at the admission and qualification stages. Error bars denote the 95 % confidence interval. The two horizontal black lines denote the cases of perfect equality and perfect inequality, while the vertical line denotes the time of the merger. We take the pool of candidates at the written exam for each year as the population of reference.

The results can be interpreted as follows: in 1984-1985, a female candidate at the written exam was twice more likely than a male candidate at the written exam in this period to be admitted to the mathematics track rather than not being admitted. This ratio went down to 0.4 for candidates who took the exam the following years. This means that in 1986-1987, a female candidate was less likely than a male candidate to be admitted to the mathematics track rather than not being admitted. The values of the odds ratios between 0 and 1 are not directly understandable; by inverting the ratio (i.e., computing the odds ratio with male candidates as the interest group), we find that in 1986-1987, the years just following the merger, a male candidate at the written exam was 2.2 more likely than a female candidate at the written exam to be admitted to the mathematics track rather than not being admitted. In 1993, as there were no female admitted to the ENS Paris in mathematics, the odds ratio reaches zero (Figure D1).[32]

[31] One must note that odds ratios are not distributed symmetrically; confidence intervals are not necessarily centered on the sample value.

[32] In this peculiar case, the variance of the logarithm of the odds ratio is not defined. See Appendix D for more details.

Figure 6: Odds Ratios, Admission and Qualification, 1978 - 1999



Source: Documentation sourced from the ENS archives.
Notes: Reference population is the ENS candidates at the written exam.
Lecture: In 1984-1985, a female candidate at the written exam was twice more likely than a male candidate at the written exam in this period to be admitted to the ENS mathematics track rather than not being admitted.

There are three main takeaways from these results. First, female candidates had a clear advantage in admission to the mathematics track before the merger. This is a direct result of the hard quota system: there were more available seats for female students at the ENS de Sèvres compared to the initial number of candidates, whereas there were fewer seats available for male students at the ENS d'Ulm. This trend is then entirely reversed after the merger: on average, male candidates were 2.1 more likely than female candidates to be admitted to the mathematics track rather than not being admitted. The year of the implementation of the ENS common written exam (1994) also marks a slight shift in the trend; male candidates' advantage is at its peak between 1986 and 1993 (the odds ratio is on average 3.1 over this period), and decreases to some extent afterwards (1.8 on average over the rest of the period). We observe a similar trend in qualification

as we did in admission. However, at this stage, male candidates' advantage is greater after the merger compared to the advantage female candidates had prior to the merger. On average, male candidates were 3.2 times more likely to be qualified for the oral exam than not be qualified, while female candidates before the merger had only 1.6 times higher chances of qualification. We observe no major changes in relative chances of qualification after 1994 and the implementation of the ENS common written exam.

In addition to this analysis, Figure D2 displays odds ratios computed on the pool of candidates who actually took the exam (no blank copies). The order of magnitude and the pattern are similar, suggesting that our results are not driven by a larger share of female candidates registered at the exam without trying to take it.

Now that we have a clear understanding of how the end of the gender quota has impacted the proportion of women among ENS qualified and admitted students, we can focus on examining the underlying mechanisms behind this fall.

4 Mechanisms

We documented that the introduction of the mixed competition led to a dramatic decrease in the share of women admitted to the ENS Paris in the physics-chemistry and mathematics tracks. This could be due to several factors. Women might perform worse than men on average, which would result in fewer admissions once the quota system is removed. Experimental studies have also demonstrated that, conditional on ability, women's performance and their willingness to compete are lower than men's in mixed-gender settings compared to single-gender settings (Gneezy et al., 2003; Niederle and Vesterlund, 2007, 2010), and especially while performing stereotypically male tasks.

This section tries to disentangle the following mechanisms for the ENS mathematics entrance exam: (i) the presence of a gender performance gap, (ii), the detrimental impact of the mixed-gender competition on performance, (iii) the format of the exam that could favor men's performance, and (iv) an endogenous response from female candidates who would *turn away* from the heightened and mixed-gender competition.

4.1 Gender Gap in Peformance

It has been shown in several context that, on average, women underperform in mathematics with respect to men, and this divergence starts as early as in 1st grade in France (Breda et al., 2024). In our case, our studied population consists of a very selected sample of higher education students who decided to pursue competitive mathematics studies. This is thus not obvious that women in this selected sample would underperform with respect to men. However, if women were to perform worse than men at the ENS mathematics entrance exam, this could explain the sudden fall in the share of female students in admitted candidates. The quota was forcing in lower-achieving female candidates, who would not have made it in the absence of the gender quota.

We investigate this hypothesis by looking at the average difference in performances between male and female candidates, at the written and oral examination.

Percentile Ranks For each subject and each year, we compute percentile ranks of scores obtained by female and male candidates at the written and oral exams. This transformation is done for two main reasons. First, as explained by Breda and Ly (2015), we focus on a competitive exam, where candidates are not expected to achieve a given score, but to be ranked according to the number of predefined available seats for qualification and admission. Second, the distribution of scores for the written and oral exam are also very different, as the purpose of the oral examination is to differentiate and identified the better candidates. Using percentile ranks makes it possible to keep only the ordinal information we are interested in.

Subject and Evaluation We focus on the set of subjects that were passed every year by candidates at the written exam and at the oral exam. For the written exam, this includes two subjects in mathematics, denoted as Maths 1 and Maths 2, and one subject in physics. The first mathematics exam (Maths 1) is the flagship exam of the ENS mathematics track. It lasts six hours and is widely recognized as the most challenging subject among the entrance examinations for STEM elite graduate schools. Physics and Maths 1 have the same weight in the total written score (6), and the second maths subject a smaller weight (4). We only consider two subjects at the oral examination: mathematics and physics. The total written and oral scores represent the weighted average obtained at

the written and oral examinations, including other subjects which are year specific (e.g. French, foreign languages, or computer sciences).

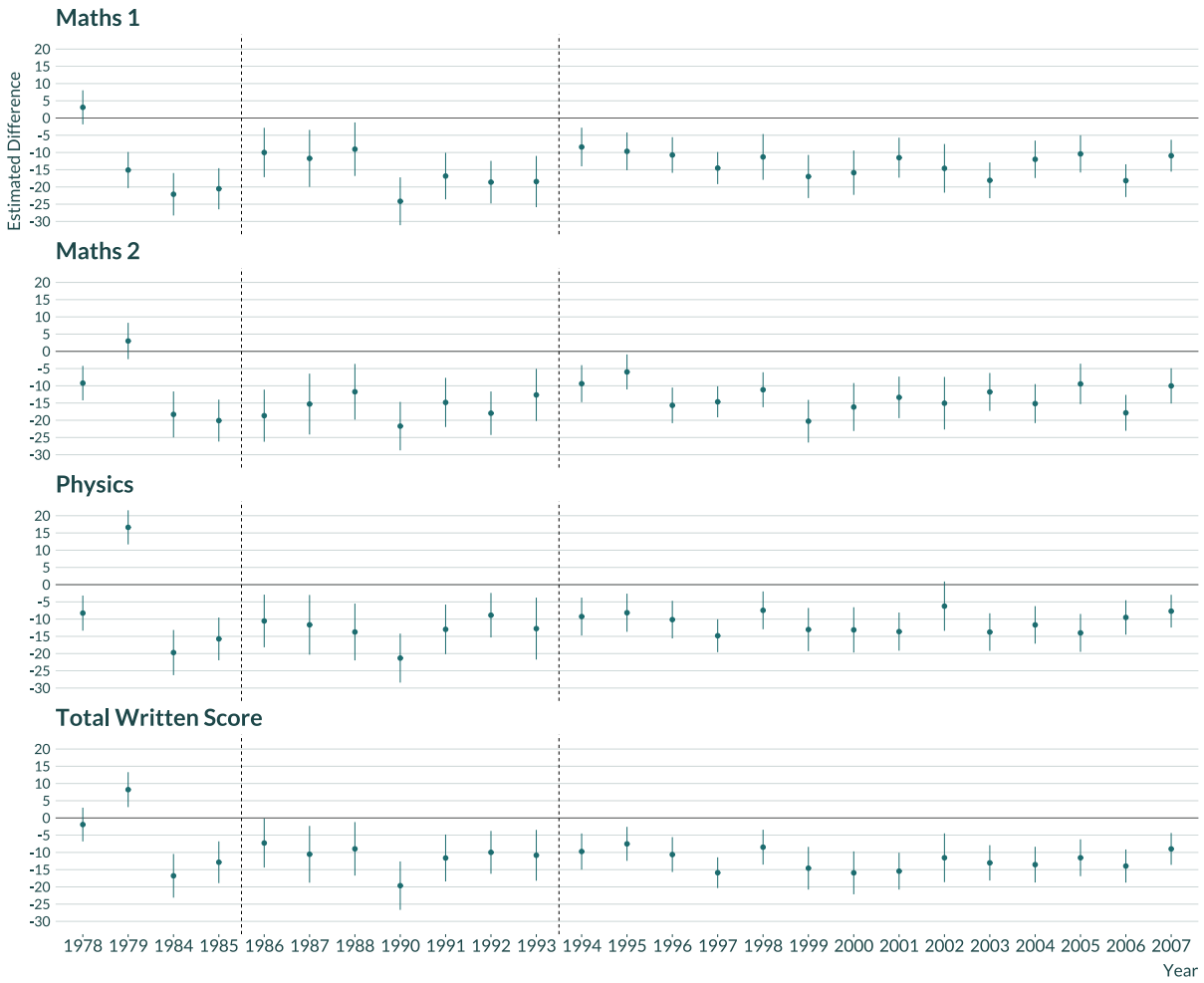
Before the merger of the two schools, though the exam topics given to female and male candidates were the same in every subject, the juries were different for the two entrance examinations (see Section E). A common jury was established in 1985 to evaluate female and male candidates together, both at the written and oral stages. Female and male candidates were then ranked separately, and a certain number of seats were still reserved for female candidates. Additionally, in 1984, part of the jury from the ENS d'Ulm was assigned to the ENS de Sèvres, particularly for the mathematics main examination (Math 1). In subsequent sections, we discuss whether female and male candidates were evaluated in the same way before 1985 at the written exam, and its implications for our results.

Differences at the Written Exam Figure 7 shows the results of a regression of candidates' percentile rank in each subject on a binary variable equal to one if the candidate is a female. Error bars displays the 95 % confidence intervals. The figure basically shows the evolution of the difference in the average percentile rank between female candidates and male candidates in each subject. A positive difference indicates that female candidates performed better than male candidates on average. The total score is a weighted average of scores obtained in Math 1 and 2, Physics, and other year-specific subjects.

Female candidates consistently perform worse than male candidates on the written exam across all subjects and time periods, except for the late 1970s. The difference in performance between male and female candidates was particularly noticeable in mathematics exams, with the largest difference observed in 1984 and 1990, where male candidates scored over twenty percentile ranks higher than female candidates in Maths 1. There is, however, no discontinuity in performance between male and female students observed around the time of the merger. The gender gap in performance is even at its smallest in 1986, the year of the merger.

We were not able to retrieve individual data for the ENS d'Ulm between 1980 and 1983. However, we retreive information on female candidates' performances on the entrance examination for the ENS de Sèvres in the longer run. Figures D8 and D9 show

Figure 7: Differences in Mean Percentile Rank, by Gender, Subject and Year
ENS Paris (Ulm & Sèvres) Entrance Written Exam, 1978-2007



Source: Documentation from the ENS archives.
Note: Error bars represent the 95 % confidence interval.
Lecture: In 1985, the average percentile rank of female candidates at the total written score was 39, whereas it was 52 for male candidates. The difference between the two is -13, which is reported in the graph.

the average score obtained by female candidates on the written exam, and in Math 1 separately. While this measure of performance is imperfect, it does reveal a discontinuity in the trend around 1984, where the average grade for both the entire exam and Math 1 declined. [33] One possible explanation for the decline in performance among female candidates after 1984 is that female candidates' examination papers might have been overrated with respect to male candidates before the implementation of the common marking. Alternatively, disclosing the information about common grading might have

[33]For instance, it does not take into account differences in the difficulty of the exam each year or the different jury from one year to the other

affected female student performances in itself.

Differences at the Oral Exam Differences between male and female candidates are not as strongly pronounced at the oral examination. Figure 8 displays the differences in performance for qualified candidates, controlling for their initial performance at the written exam. Figure F1 displays the raw difference in performance at the written exam, without controlling for their initial performance at the written exam, and the results are fairly similar.[34] The total oral score is once again an average of Maths 1 and Physics 1, plus other subjects that were year specific (e.g. computer science, chemistry, or languages).

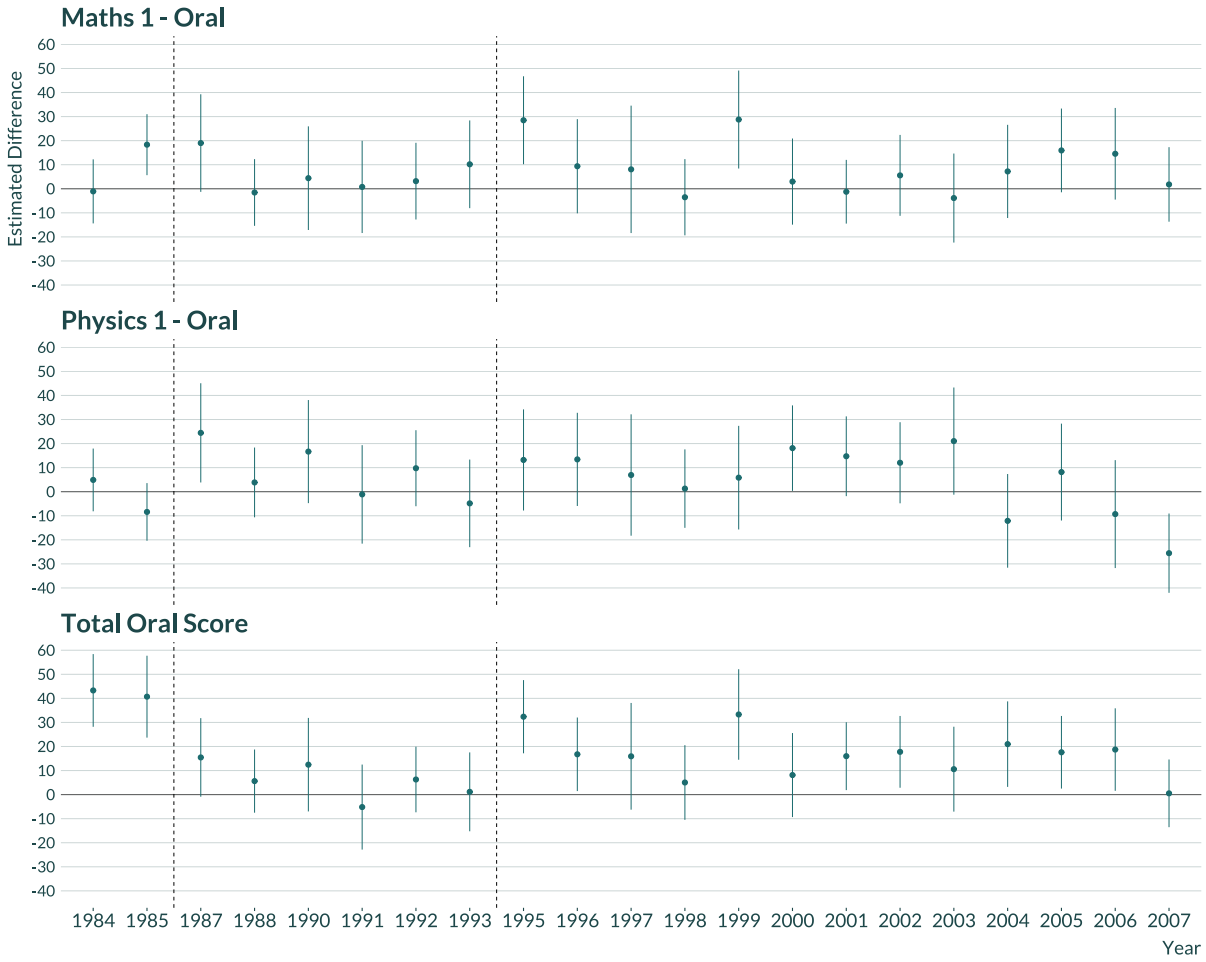
For most years, we do not observe significant differences in performances between male and female qualified candidates. If anything, it seems that female students slight outperform men. Once again, we do no observe a clear discontinuity in the gender gap in performances around the time of the merger.

Test Scores Transformation As previously mentioned, the distribution of scores is quite different for years 1978-1979 and years 1984-1985. Since the distribution of scores for men is almost stationary over these years, we mean-shift the distribution of scores at the written exams for female candidates in 1978, 1979, and 1984 to match mean difference between male and female distribution of scores in 1985, when there was a unique jury for the two schools. These transformed mean-shifted scores are used in the subsequent sections of the paper, as a way to rank male and female candidates together.

Quantifying the Effect of the Gender Performance Gap While we did not observe any discontinuity in scores around the time of the merger, it remains unclear whether the sharp fall in the number of female candidates admitted to the mathematics track is solely due to the gender gap in exam performance, or whether there is an additional detrimental effect of the mixed-gender setting. To quantify the extent of the effect of the gender performance gap, we simulated the share of female candidates who would have been admitted to the mathematics track if there were no gender quota prior to the merger. To do so, we ranked female and male candidates together based on their

[34] As we do not retrieve complete archives for the oral examination in 1986 and 1994, these data points are missing from the figures.

Figure 8: Differences in Mean Percentile Rank Controlling for Written Exam Performances, by Gender, Subject and Year
ENS Paris (Ulm & Sèvres) Entrance Oral Exam, 1978-2007



Source: Documentation from the ENS archives.
Note: Error bars represent the 95 % confidence interval.

written and oral exam scores. In this counterfactual simulation, it is as if male and female candidates competed in a single-gender setting, but ultimately, they would have been ranked together. Figure D6 in appendix presents a visualisation of the intuition behind this exercise. Table 3 presents the results of our simulation. For each year prior to the merger for which we have all candidates' exam scores (1978, 1979, 1984, and 1985), we defined n_{year} as the number of open seats (Panel A). We then ranked male and female candidates together based on either their raw score or their transformed score, matching the score distribution of the one of 1985. For years 1978 and 1979, for which we do not have oral exam scores, candidates were ranked based on their total written score. The share displayed in Panel B was computed by considering the first n_{year} candidates

and looking at the gender composition. If the decline in the number of admitted female candidates after the merger was solely due to the gender gap in performance, we would expect the simulated share of admitted candidates prior to the merger to be equivalent to the one observed after the merger (between 6 to 9 %).

Table 3: Share of Female Admitted Students

	1978	**1979**	**1984**	**1985**
Panel A. Number of Seats Opened				
ENS d'Ulm	32	32	31	31
ENS de Sèvres	23	23	17	15
Total (n_{year})	55	55	48	46
Panel B. Share of Female Candidates				
Actual Share		*with gender quota*		
	42%	42%	35%	33%
Simulated Share		*without gender quota*		
Raw Scores	35%	36%	8%	20%
Transformed Scores	22%	15%	21%	20%

Source: Documentation sourced from the ENS and French National Archives.
Notes: Candidates are ranked according to their total final score, except for years 1978 and 1979 for which oral score are not available, and candidates are ranked on their total written score. Transformed scores are average scores modified so that the gender difference in average score at the oral and written exams remains at the level of 1985 in 1978, 1979 and 1984.
Lecture: In 1985, there was 46 offered seats in the mathematics track. The actual share of female among admitted students was 33 %, which was determined by the quota system. If we would have ranked male and female together based on their average total score, this share would have reached 20 %.

Our results do not support this hypothesis. In 1985, there was 46 offered seats in the mathematics track. The actual share of female students among admitted candidates was 33 %, which was determined by the quota system. If we would have ranked male and female together based on their total final score, this share would have reached 20 %. There are substantial difference between raw and transformed scores depending on the year considered; in 1984 for instance, the share of female students among admitted candidates would have been 8 % based on their raw score, but 21 % with transformed score. Between 1985 and 1986, there was a 27 percentage point fall in the share of

admitted female candidates (from 33 % to 6 %), but this fall would have been only 33 - 20 = 13 percentage point if we only took into account the gender performance gap. We can extrapolate that $\frac{13}{27} = 48\%$ of the fall can be explained by the average difference in performance between male and female candidates at the exam. Table D1 in appendix displays the results of a similar simulation that takes not only the number of admitted candidates but also the number of candidates on the waiting list, which draw to the similar conclusion.

Taken together, our findings indicate that female candidates perform less well on the exam compared to male candidates. However, our simulation exercise shows that this disparity alone cannot fully account for the change in the proportion of female students among admitted candidates following the implementation of the mixed competition.

4.2 High-Stake Exams and Mixed-Gender Competition

We have shown that the average gender performance gap only partially explains the sudden drop in the share of admitted female candidates. Building on the experimental literature, we posit the hypothesis that, even conditional on ability, the introduction of mixed competition could have exacerbated this discrepancies. The fact we do not see a discontinuity around the time of the cutoff in Figure 7 can be the results of two scenarios:

1. The introduction of mixed competition did not exacerbate the gender gap in performance;

2. The introduction of mixed competition did exacerbate the gender gap in performance but came hand in hand with a change in the composition of candidates: a higher share of high-achieving female candidates, but whose performance worsen because of the behavioral response to mixed-gender composition.

To test this hypothesis, we use the students' grade reports from the best mathematics preparatory program to study potential gender difference in performance at the ENS entrance exam, controlling for students' performance before the exam. Table 4 displays our results. Column (1) show a naive double difference on the performance at the written exam between male and female students, before and after the end of the gender quota, without controlling for any academic ability measure. If we do not take into account students' grades at the end of their mathematics preparatory program, we observe

significant gender gap in performance at the ENS written exam, and this gap actually reduces after the end of the gender quota. However, columns (2) and (3) show that once we control for students' academic achievement just prior the ENS entrance exam, there is no significant gender gap, neither before nor after the end of the gender quota.

Table 4: LLG Candidates Performance at the ENS Entrance Exam (1978-1988)

	Percentile Rank at the Written Exam		
Female	-.216***	-.053	-.059
	(.046)	(.041)	(.041)
After the End of Gender Quota	-.063***	-.050**	-.048**
	(.024)	(.021)	(.021)
Female × After	.135*	.004	.015
	(.079)	(.069)	(.069)
Star Class		✓	✓
Quintile of Math GPA		✓	✓
Star Class × Quintile Math GPA			✓
N	654	654	654

Source: Document sourced from the Louis le Grand *archives*
Note: Standard errors in parentheses. Significance levels: *** p < 0.01, ** p < 0.05, * p < 0.1
In the second year of maths prep program, students are placed either in star or standard class, depending on their achievement at the end of their first year. Star classes concentrate the best students. Therefore, one can consider that students in a star class has higher academic ability than a student in a standard class.

Therefore, the hypothesis that the introduction of mixed-gender competition at the ENS entrance exam exacerbated the gender performance gap is invalidated by our data from the best preparatory programs. A word of cautious: this hypothesis might not apply to this subsample of students, since they are very particular. They are among the highest-achieving students in mathematics from their birth cohort. Bonneau and Dousset (2024) study contemporaneous STEM preparatory programs in France and do find a gender gap in performance at competitive entrance exam, even after controlling for academic achievement just before the exams.

4.3 Format of the Exam and Weighting Scheme

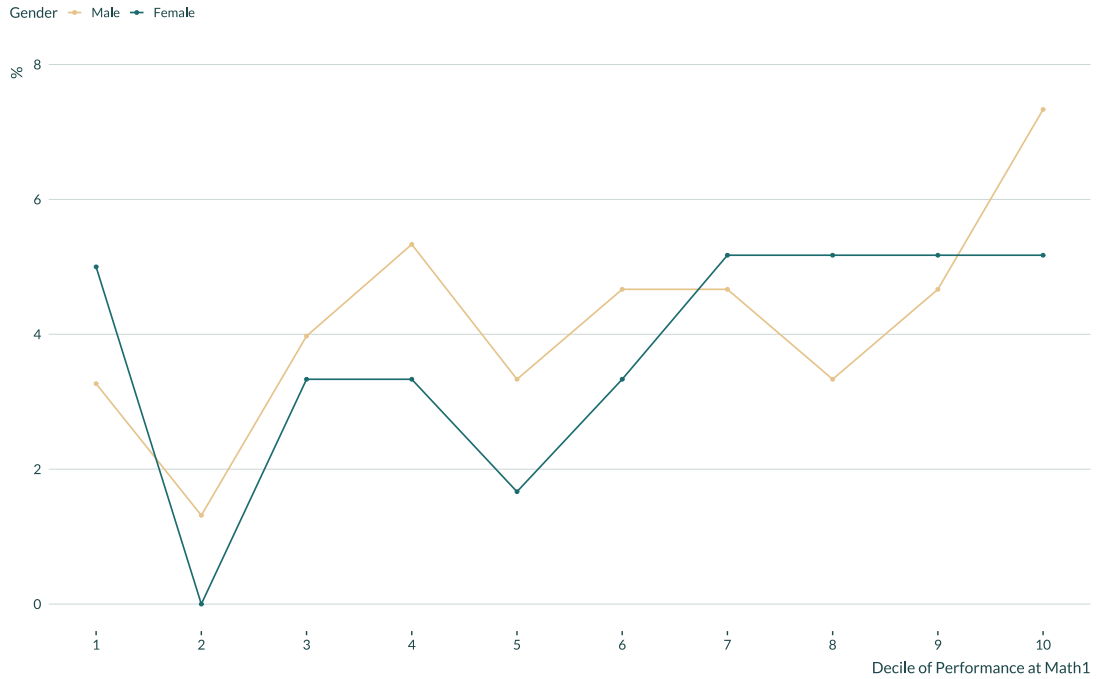
One potential explanation for the gender gap in performance at the entrance examination is the format of the exam. Recent literature in economics has raised significant concern on whether differences in performance by socioeconomic status or gender reflect inequities in the testing process itself, rather than differences in underlying skills (Miller and Stassun, 2014; Dobrescu et al., 2021; Duquennois, 2022). It has been notably shown that gender gaps in mathematics performance can be strongly influenced by the format of exams that students take (Griselda, 2022).

Combined with the weighting scheme applied to each subject, these factors could potentially affect the gender composition of qualified and admitted students. To explore this question, we simulate different weighting schemes and focus on two main aspects: the weights assigned to each mathematics subject (Maths 1 and Maths 2), and an analysis of the impact of the introduction of the common written examination for all ENS in 1994.

The Two Mathematics Subjects As mentioned above, the Maths 1 subject is considered to be one of the most challenging examinations in mathematics. It lasts 6 hours, which is an unusual format for this type of examination. Indeed, most mathematics written exam for entrance to STEM elite graduate school last 4 hours; students in preparatory programs are thus less trained for this exam. On the other hand, the Maths 2 subject is a more classical mathematics examination: it lasts 4 hours, and is closer in its difficulty and format to other examinations for entry into STEM elite graduate schools. We cannot argue that this specific subject in mathematics is irrelevant to select potential good researchers, which is one the core missions of the ENS Paris. However, we find almost no correlation between Math 1 test score and the probability to pursue an academic career in a French public university, as display in Figure 9.

Figure 10 presents a comparison of the performances of male and female students at the two mathematics written exams. The left panel shows the density of normalised scores obtained in Math 1 and Math 2 by gender, while the right panel presents the share of female candidates by quartile of performance (including the share of female candidates who hand in a blank exam), for years 1986-2000. The first quantile represents the worst performers, while the fourth quantile represents the best performers.

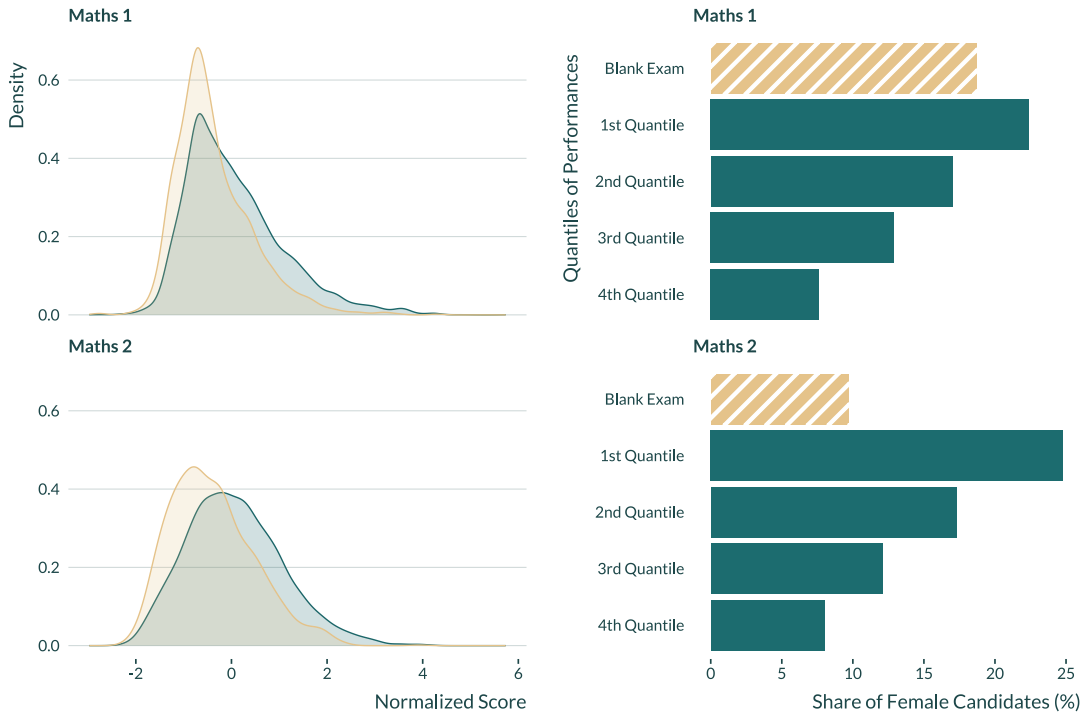
Figure 9: Share of Candidates Who Had an Academic Career in France in France by their Performance at the Maths 1 Written Exam, by Gender (1978-1985)



Source: Documentation sourced from the ENS archives and administrative data from the human resources of the Ministry of Higher Education.
Notes: The x-axis represents students' decile of performance at the Maths 1 written exam (1 being the lowest decile and 10 the highest). These deciles are computed by gender, for each year for which we have all candidates written exam grades (1978, 1979, 1984, 1985).
Reading: Female students who ranked in the 6th decile at Math1 have on average a probability of 3.3% of pursuing an academic career in France, while male students who ranked in the 6th decile have a probability of 4.7%.

First, it does not seem that the two mathematics exams assess the same skills, as the distribution of scores are very different between Maths 1 and Maths 2. Both male and female candidates perform worse on average in Maths 1 than in Maths 2, with a higher kurtosis for the distribution of scores for female candidates. The two subjects are however very similar in the representation of female candidates in each quantile of performances, including at the highest level of performance (4th quantile). Interestingly, the proportion of female candidates who hand in a blank exam is almost twice as high in Maths 1 compared to Maths 2, which automatically prevent these candidates to get qualified. It seems that women get discouraged at a higher rate than male candidates by this specific exam. It has also been shown in other contexts that female students' written average tend to be dragged down by specific subjects, where male students clearly outperform them. For instance, in the case of competitive exams to administrative civil

Figure 10: Performance in Mathematics at the Written Exam, by Gender
1986-2000

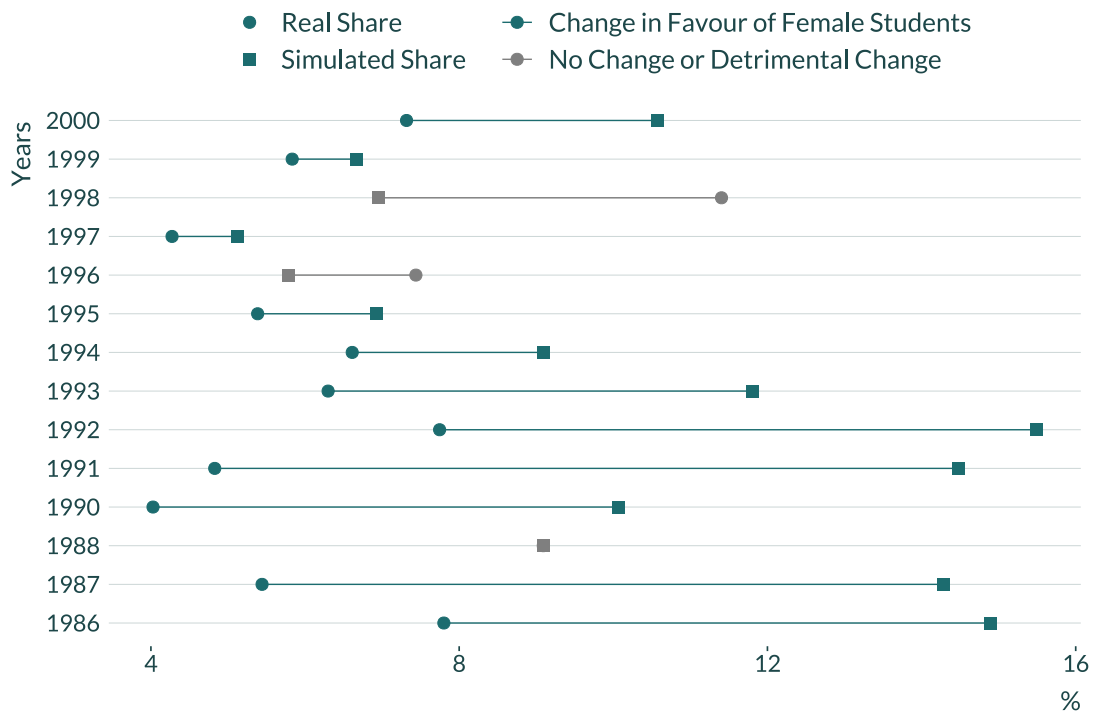


Source: Documentation sourced from the ENS archives.
Reading: In Maths 1, female students represent 19% of handed blank copies, while they represents only 10% of them in the Maths 2 written exam.

servant school, Meurs and Puhani (2019) show that women are disadvantaged by the "essay on general knowledge" at the written exam, though they are outperforming men on both "on the job" anonymous written and non-anonymous oral evaluations.

To see how much Math 1 matters in female candidates' chances to be qualified at the oral exam, we compute what would have been the total written score of every student without Math 1, from 1986 to 2000. To do so, we have to make the assumption that the elimination of Math 1 would not have changed the pool of candidates. Using this simulated total written score, we define a new pool of qualified students at the oral exam.

Figure 11: Real and Simulated Share of Female Candidates, Qualification Stage, 1986-2000



Source: Documentation sourced from the ENS archives.
Lecture: In 1986, the share of female qualified candidates was 7.8 %. It would have been 14.9 % if students would have been ranked without taken the Math 1 examination into account.

Figure 11 displays the real share (circle) and simulated share (square) of female candidates at the qualification stage. Years for which the simulated share of female candidates is higher than the real share are highlighted in green. On average, the simulated share is 3.4 percentage points higher than the real share of female candidates qualified at the oral exam (10.1 % against 6.7 %). There are 11 years out of 14 where the simulated share is actually higher than the real share. Eliminating Maths 1 could have a substantial impact on the share of women qualified to the exam; for 6 out of 14 years, it roughly doubles - even triples - the share of qualified female candidates.

Effect of the ENS Common Exam The introduction of a common ENS examination in 1994 represents another natural experiment we can exploit in our setting. Since 1994, the three ENS (Paris, Lyon and Saclay) have shared a common written examination. The majority of subjects are shared among all ENS; however, there are still some school-specific subjects, and each ENS is free to apply their own weights to compute the final average. Students only have one application to fulfill, and take all exams in the same

week. Modalities of the written and oral exams also changed that year: the French and languages written exams are no longer part of the average written score, and are only accounted for in the average oral score for qualified students. A larger weight has also been given to these subjects.

The implementation of a joint exam led to a substantial increase in the number of candidates, almost doubling in 1994. However, this did not seem to impact the composition of the pool of candidates, as we do not observe any discontinuity in the share of female candidates (Figure 12) or in distribution of preparatory programs after 1994 (Figure 14).

The first striking effect of the common exam is the jump in the number of female candidates admitted to the ENS (Figure 4). To investigate whether this change is due to the new coefficients, we simulate an alternative ranking for qualified candidates from 1987 to 1993, applying the weights of 1994. Table D2 (right panel) in appendix displays both the actual number and the simulated number of admitted female candidates each year. A change in the coefficients applied at the oral examination would have barely changed the number of admitted female candidates to the ENS before 1994. This suggests either a change in the ability of qualified candidates in the subsequent years, or that female candidates were favoured at the oral examination. The latter would not be surprising, as we found in the administration archives letters and exchanges expressing worries about the all-time low number of admitted female candidates in 1993, zero. This could also confirm to some extent the results found by Breda and Ly (2015) for latter periods, which shows that female candidates are favoured at the oral examination in field where they are under-represented.

The second fact is that the share of qualified female candidates did not increase after 1994 (Figure 12). Table D2 (left panel) displays the real and simulated percentages of qualified female candidates from 1986 to 1993, when we only consider the subjects taken into account since 1994 (namely mathematics and physics). Overall, humanities helped boosting the share of qualified female candidates. However, as illustrated by the low number of admitted female candidates over this period, this was not enough to increase the proportion of qualified female candidates up to their share in the initial pool of candidates at the written exam.

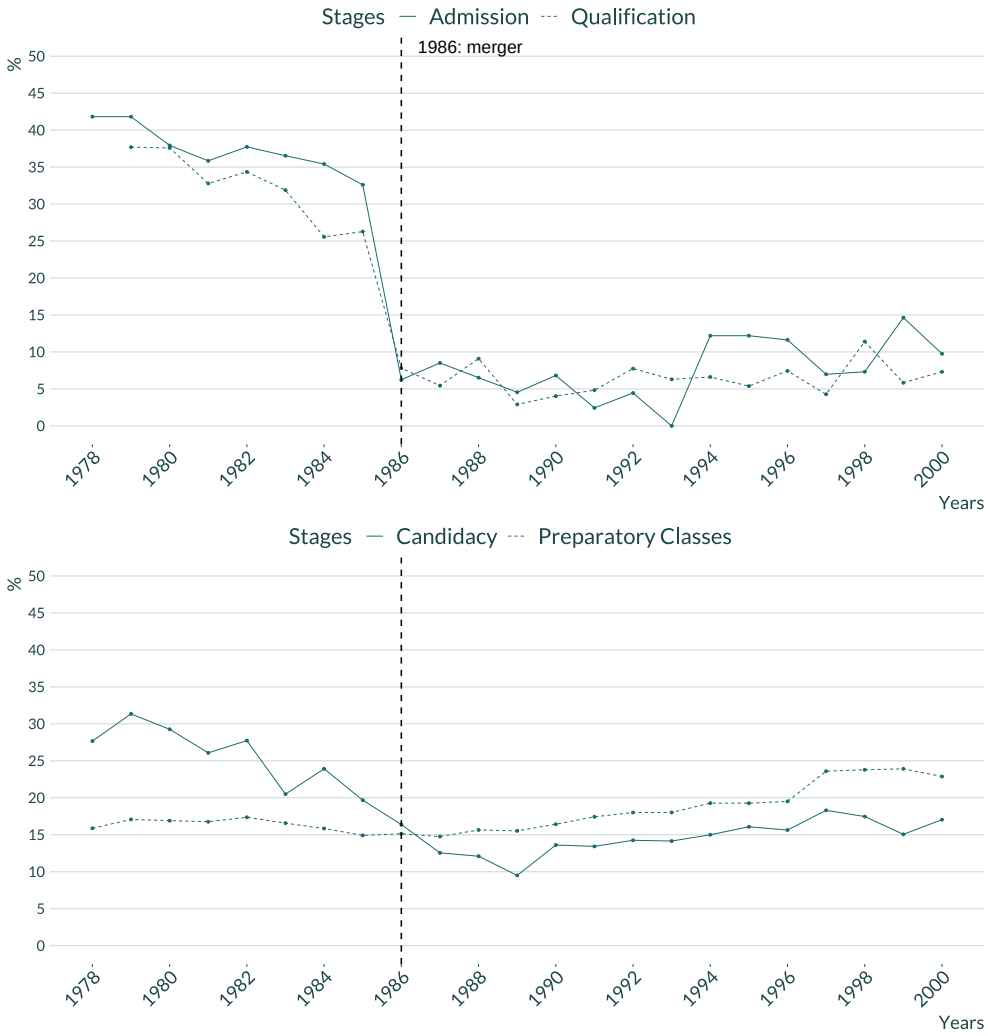
Hence, the next section investigates whether female students were less inclined to

take the exam after 1986, and whether female students turned away from this heightened mixed-gender competition.

4.4 Endogenous Response: Female Students Turning Away from the Heightened Mixed-Gender Competition

The end of the gender quota and the introduction of the mixed-gender competition not only impacted the gender composition of admitted candidates, but also led to changes in the gender distribution of the candidate pools at earlier stages of the admission process. Figure 12 displays the share of female students among mathematics preparatory classes, candidates at the written exam, qualified candidates and admitted candidates, from 1978 to 2000. The introduction of the mixed competition led to a similar substantial fall in the share of female students among the qualified candidates, from 32 % on average before the merger to 6 % after. After 1993, the share of admitted female candidates becomes larger than the share of female students among qualified candidates. This can be identified as a catch-up effect of female candidates at the oral examination. This jump coincides with institutional changes in the entrance examination (notably common examination for all ENS, and changes in weighting of the oral examination, see Section 1.)

Figure 12: Percentage of Female Candidates in Admission, Qualification, Candidacy and Preparatory Classes, 1978 - 2000



Source: Documentation sourced from the ENS archives.
Lecture: First panel: In 1986, there were 6.2 % of female students admitted to the ENS in the mathematics track; the share of female candidates among the qualified candidates (passed the written exam) was 7.8 %. Second panel: In 1986, the share of female students among the candidates at the written exam was 16.3 % and the share of female students in mathematics preparatory classes was 15.1 %.

We also observe that the proportion of female candidates taking the written examination gradually decreased around the time of the merger of the two schools, and reached its lowest point in 1989. This means that the share of female candidates for the mathematics track used to be higher than the share of female students in preparatory classes, indicating that the ENS de Sèvres was a particularly attractive school for female students. The proportion of female candidates then stabilized at roughly 15 % on average during the post-merger period, matching the level of the share of female students in mathematics preparatory classes in 1986 (16 %). However, due to yearly variations and the small

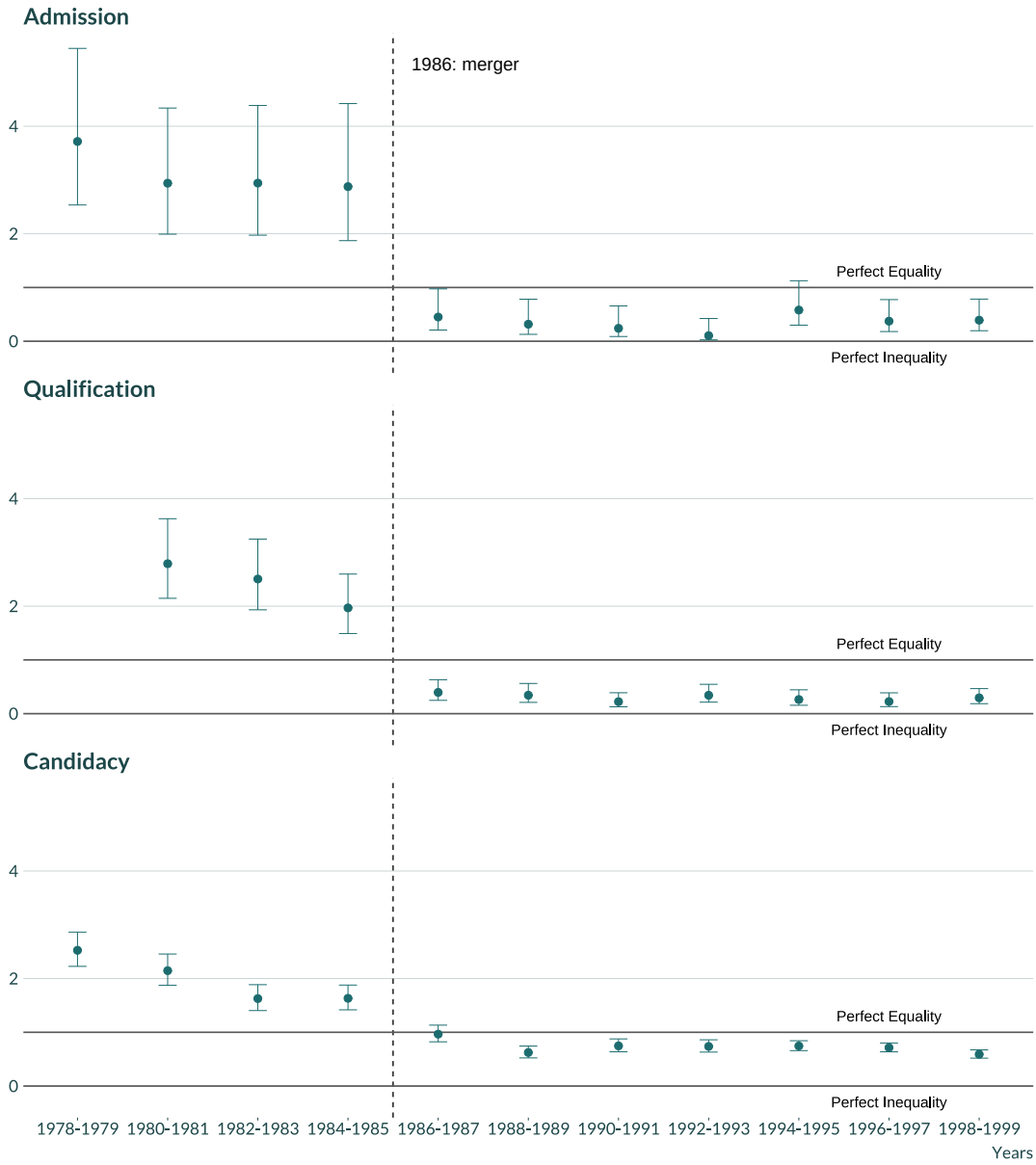
number of observations, the timing of this decline is hard to interpret.[35] Finally, although the shares of female candidates and female students in preparatory classes followed a similar pattern of slight increase since the 1990s, the proportion of female candidates never again reached the level of female students in mathematics preparatory classes after the merger. This result can be considered as the first indication that women tended to avoid the mixed competition after the merger.

Odds Ratios Computed on the Pool of Students in Preparatory Classes Figure 13 shows the odds ratios computed on the pool of students enrolled in second year of mathematics preparatory classes between 1978 and 1999. This comparison makes it possible to assess the effect of the merger on students' probability to be candidate to the written exam in the first place.

We observe a discontinuity regarding candidacy at the time of the merger, although the value of the odds ratio gradually decreases over the pre-merger period. Prior to the merger, female students were more likely to apply for the written exam, with a value of the odds ratio of 2.5. After the merger, the value of the odds ratio is close to one on average, suggesting that female and male students are then almost equal in terms of their probability of being a candidate for the entrance examination. This effect is not driven by the number of female students in preparatory classes, which remains stable over that period (Figure 12). These findings also confirm our previous results about admission and qualification, which were computed on the pool of candidates at the written exam.

[35] For instance, the proportion of female students among admitted candidates are equal in 1983 and 1985.

Figure 13: Odds Ratios, Admission, Qualification and Candidacy, 1978 - 1999



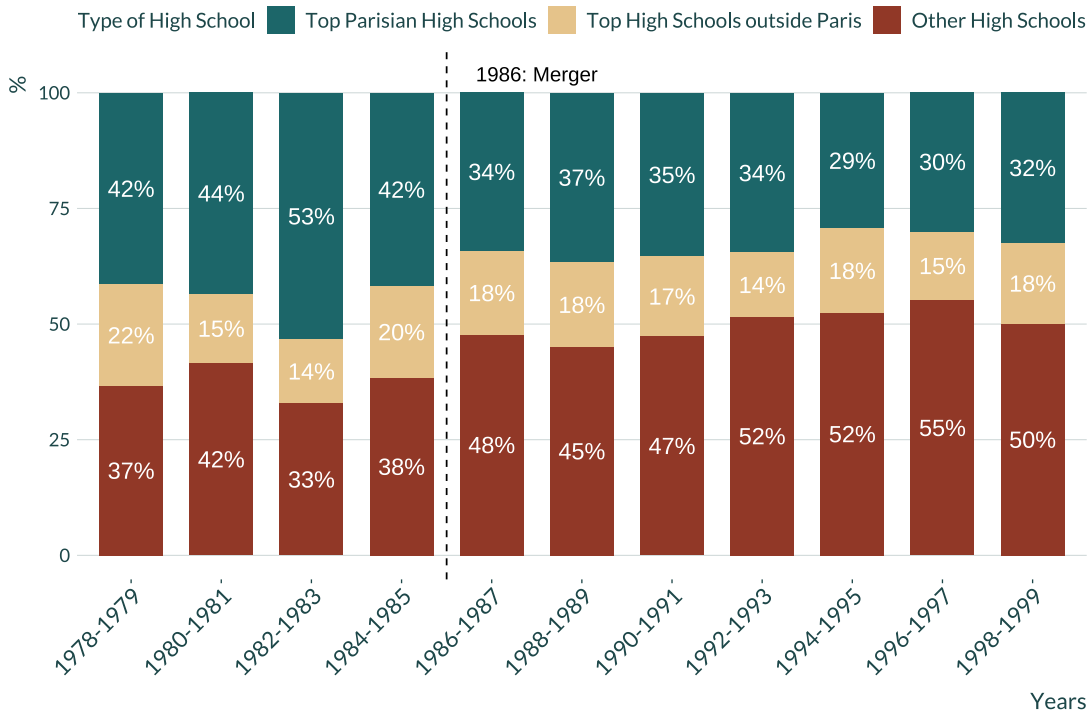
Source: Documentation from the ENS archives and the archives of French Statistical Services (DEPP).
Notes: Qualification information is missing for the ENS d'Ulm in 1978.
Sample: Students in second year of mathematics preparatory classes.
Lecture: In 1984-1985, a female student in preparatory classes was 1.6 more likely than a male student to be candidate to the written exam rather than not to be.

Characterizing Missing Candidates Figure 13 provides evidence that female students were less likely to take the written exam after the implementation of the mixed competition. It is possible that a specific group of female candidates chose to opt-out of the competition. However, without detailed information on students' prior academic achievement, it is difficult to determine the direction of this selection effect. Nevertheless,

the data comprises information on the preparatory program students attended, which is highly informative about their academic level.

Preparatory Program Typology We divide preparatory programs into three groups according to the number of female candidates which were admitted to the ENS de Sèvres before the merger. Top high schools gather high schools with more than 5 students admitted to the ENS de Sèvres from 1978 to 1985. Top Parisian ones are mainly composed of Louis le Grand and Saint-Louis, which account for roughly 50 % of admissions before the merger, and other high schools from the Paris region.[36] Top high schools outside of Paris are mainly located in large urban centers and account for 26 % of admission at the ENS de Sèvres.[37] The remaining high schools (both located in and outside the Paris region) are grouped together.

Figure 14: Percentage of Female Candidates, by Preparatory Programs Type



Source: Documentation sourced from the ENS archives.
Lecture: In 1984-1985, 42 % of female candidates at the written exam came from top Parisian high school, 20 % from top high schools outside Paris and 38 % from other high schools.

[36]Top Parisian high schools include Louis le Grand, Saint-Louis, Hoche, Condorcet, Fénelon, Janson de Sailly, Sainte Geneviève, and Henri IV

[37]This group includes Thiers (Marseille), lycée du Parc (Lyon), Pierre de Fermat (Lille), Montaigne (Bordeaux), and Clemenceau (Nantes).

Evolution of the Composition of Candidates Figure 14 displays the proportion of female candidates who took the written exam (i.e., at least one exam completed) by type of preparatory class and two-year intervals from 1978 to 1999. Prior to the merger of the two schools, the composition of the candidate pool remained stable with the majority of candidates coming from top Parisian high schools, comprising between 41 to 53 % of the pool depending on the time period. However, after the merger, there was a noticeable shift in the candidates' composition with a decline in the share of candidates from top Parisian high schools and an increase in candidates from high schools outside of Paris. This change was not solely due to an increase in the number of candidates from high schools outside of Paris, but also to a significant decrease in the number of candidates from top Parisian high schools, despite the total number of students at these schools remaining relatively stable over the same period (see Figure 15 for the case of *Louis le Grand*, the best mathematics preparatory program). Notably, we did not observe the same trend among male candidates around the time of the merger (see Figure D7).

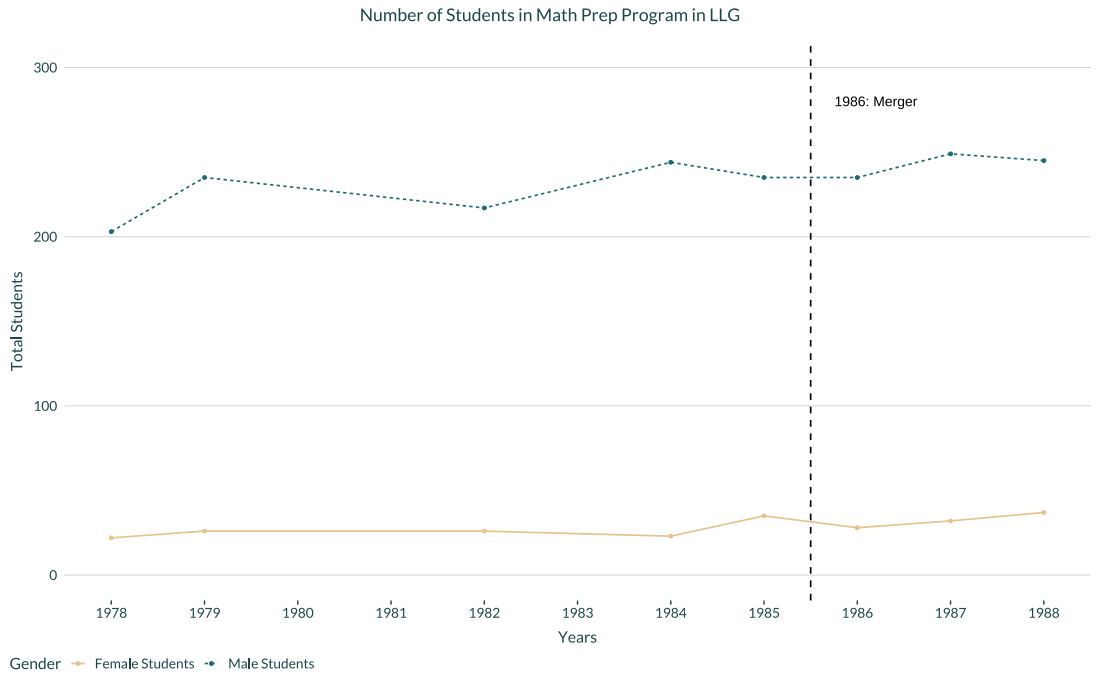
Although several explanations could be put forward to explain this phenomenon, these results are consistent with the framework of the stereotype threat (Spencer et al., 1999), which suggests that candidates who identify the most with the performed task (e.g. high-ability candidates) are more likely to be the most affected by the activation of stereotype threats. Indeed, as explained by Huguet and Régner (2007) in their experiment about the effect of the internalisation of gender stereotypes on mathematics performances in French middle schools, "susceptibility to stereotype threat derives not from internal doubts about one's ability based on one's history of failure [...] but from one's identification with the critical domain and the resulting concern about being stereotyped in that domain." Provided that high performing candidates identify strongly with mathematics, the stereotype threat is expected to be especially prominent among candidates in top Parisian high schools.

Focus on the top mathematics preparatory program We take advantage of our detailed data about *Louis le Grand* students to better understand who are these missing female candidates, i.e., female candidates that would have had applied to the ENS entrance examination if the gender quota was still in place. It could be understandable if the missing female candidates are all the lowest-achieving students. As the ENS entrance

examination is highly competitive, they know that their admission chances are very low, and would rather focus their time and energy on other graduate schools exams. Being surrounded by some of the highest achievers in France, their personal view about their own performance could be biased.

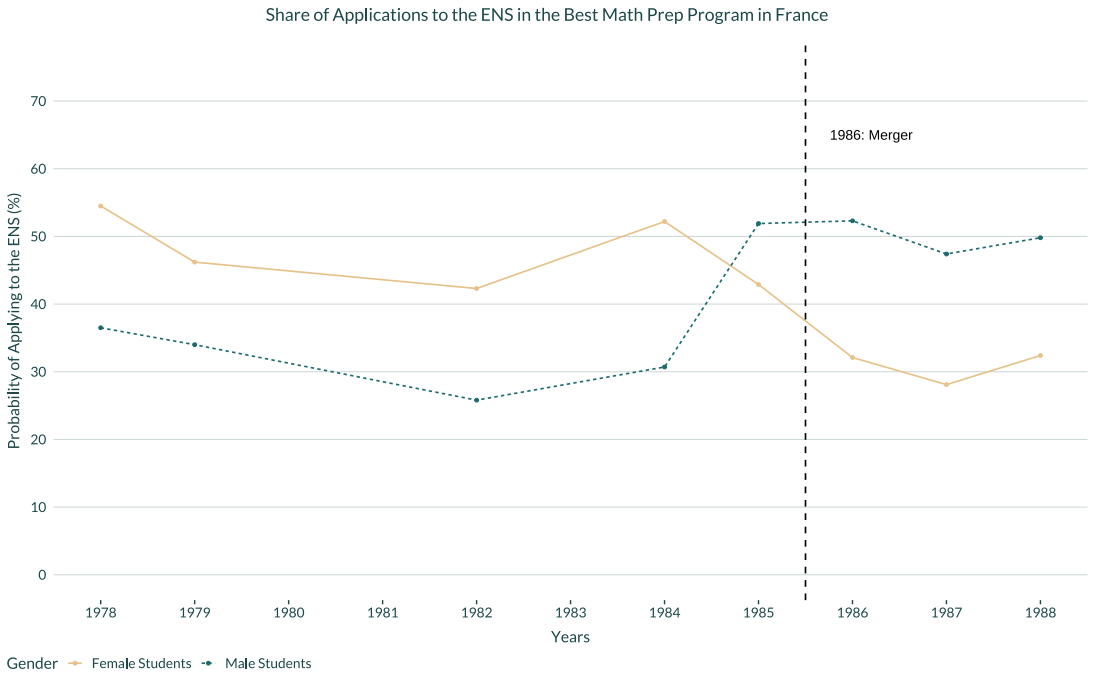
Firstly, we can say that the reduction in the number of female candidates to the ENS from *Louis le Grand* (as displayed in Figure 16) is not explained by a reduction in the number of female candidates in Louis le Grand. As shown in Figure 15, the number of female students in Louis le Grand remained stable over our studied period.

Figure 15: Evolution of the Number of Students in the Best Mathematics Preparatory Program, by Gender



Source: Documentation sourced from the *Louis le Grand* archives.
Notes: The sample consists of male students who are enrolled in second year in the best mathematics preparatory program in France, *Louis le Grand* in 1978, 1979, 1982, and 1984-1988.
Reading: In 1982, there were 217 male students enrolled in the best mathematics prep program in France, and there were 26 female students.

Figure 16: Female Students Application Behavior, by Math Performance at the End of Prep Program



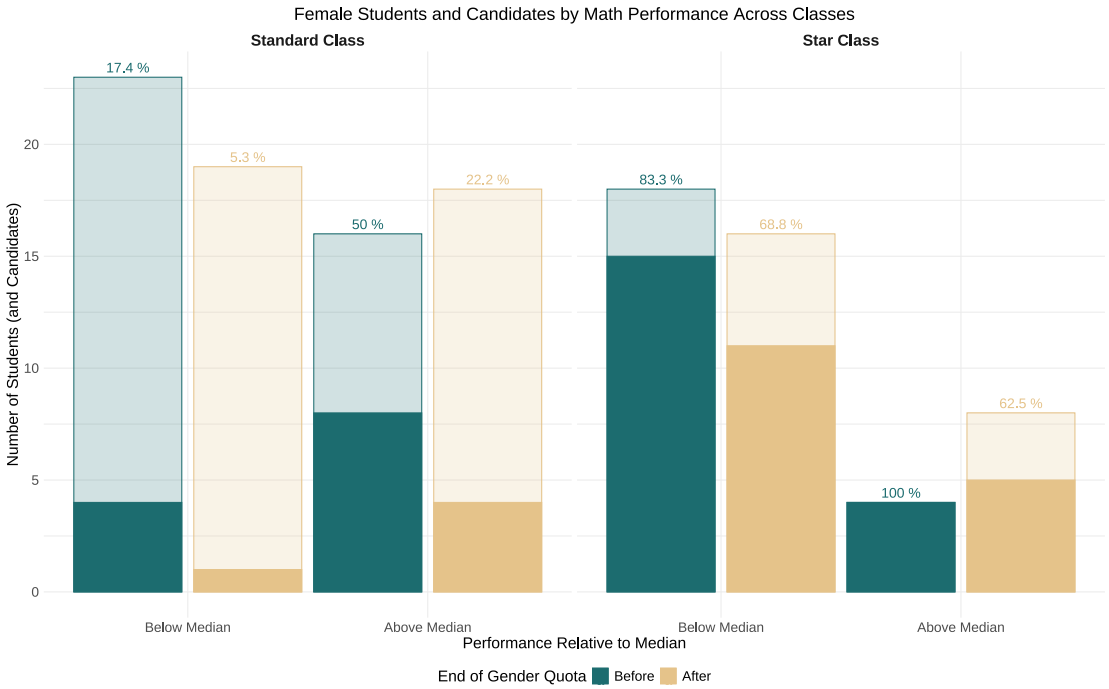
Source: Documentation sourced from the *Louis le Grand* and ENS archives.
Notes: The sample consists of students who are enrolled in second year in the best mathematics preparatory program in France, *Louis le Grand* in 1978, 1978, 1982, 1984-1988.
Reading: In 1982, 42.3% of the female students enrolled in Louis le Grand in second year of mathematics prep program took the ENS entrance exam, while 25.8% of the male students took it.

Then, we study who are these Louis le Grand female students who do not apply to the ENS after 1986. Figure 17 show us that they are actually evenly distributed according to their academic achievement. In all our academic achievement groups, we observe a reduction in the share of candidates after the ENS entrance exam became mixed-sex. On the contrary, Figure G2 show the opposite results for men. Surprisingly, some very high-achieving female students decided not to take the ENS entrance exam once the gender quota ended, while almost all of them were taking before 1986. This fact points toward an absolute loss of talented female candidates, and thus potential female students at the ENS.

What do these female students do instead? They took other elite STEM graduate schools entrance exams and got in. We do not observe a total shift of these missing female candidates and missing admitted students to the ENS to only one other school, but rather that they spread out among different ones, as shown in Figure 18. In particular, we do not observe a sharp increase in the share of female students admitted to the *Ecole*

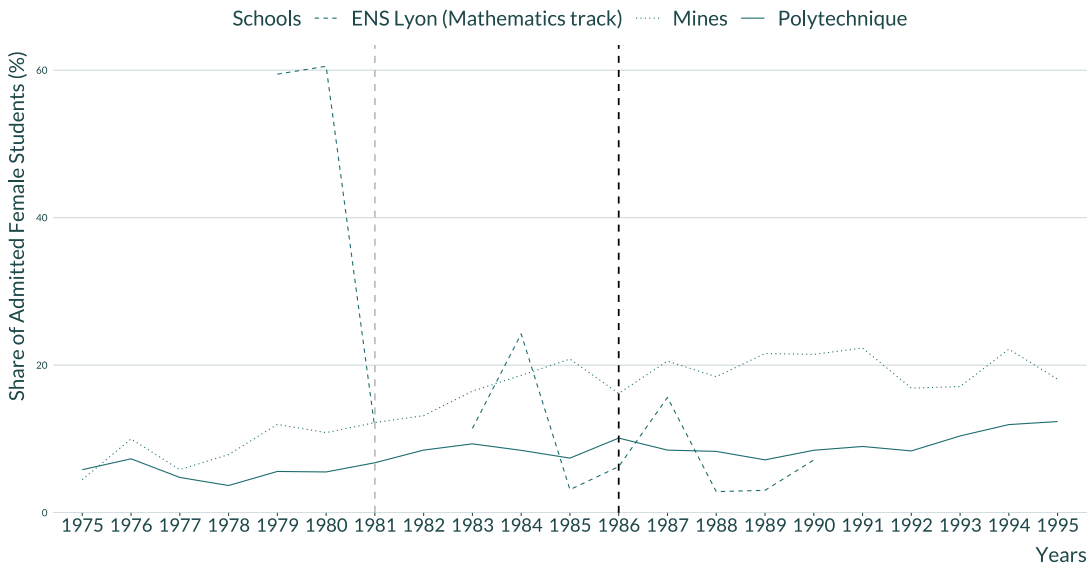
Polytechnique, which is the main competitor of the ENS Paris.

Figure 17: Female Students Application Behavior, by Math Performance at the End of Prep Program



Source: Documentation sourced from the *Louis le Grand* and ENS archives.
Notes: The sample consists of female students who are in second year in the best mathematics preparatory program in France, *Louis le Grand* in 1982, 1984 and 1985 (Before) and in 1986-1988 (After). They are ranked by their mathematics GPA at the end of the school year, just prior taking the ENS entrance exam. In the second year of maths prep program, students are placed either in star or standard class, depending on their achievement at the end of their first year. Star classes concentrate the best students. Therefore, one can consider that a student below the median in a star class has higher academic ability that another student who is above the median in a standard class.
Reading: There were 16 female students who were above the median in standard class in our cohorts before the end of the gender quota (1982, 1984, 1985), and 50% of them applied to the ENS, while there were 18 after (1986-1988), and 22.2% of them took the ENS entrance exam.

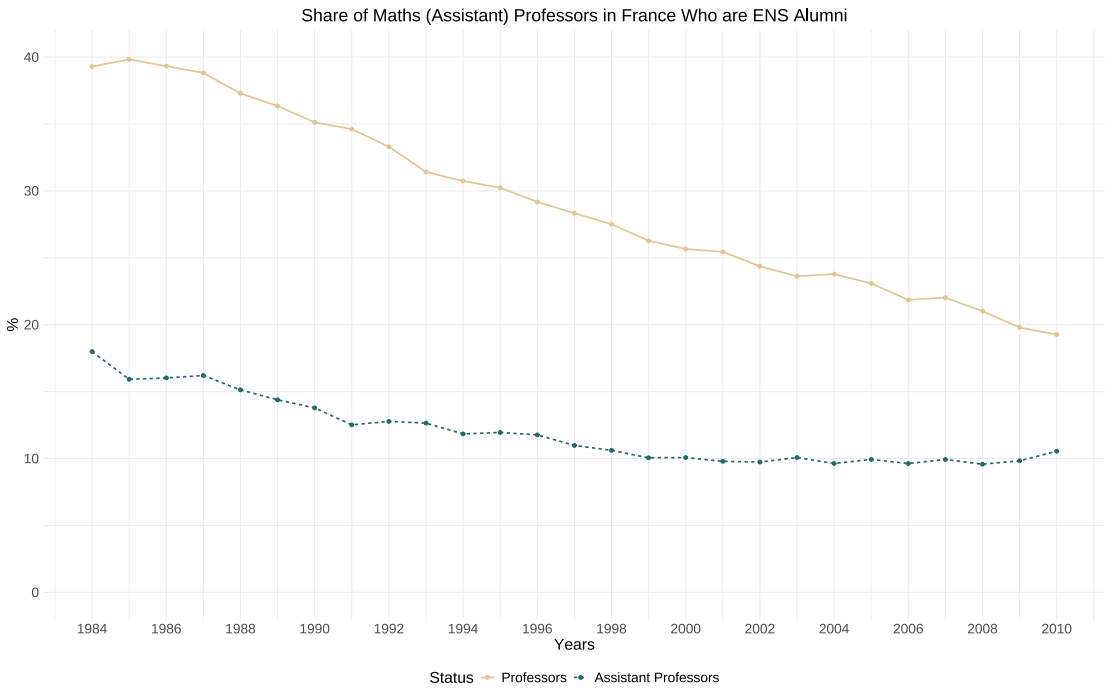
Figure 18: Percentage of Female Students in Other Sciences Schools, 1975-1995



Source: Bataille (2011) and Stéphane Benveniste's database on elite graduate school in France.
Note: the grey dashed line displays the merger of the ENS de Fontenay-aux-Roses (female only) and the ENS de Saint-Cloud (male only) into the the ENS de Lyon in 1981.

5 Long-Run Consequences

Figure 19: Evolution of the Share of Mathematics (Assistant) Professors in France Who are ENS Alumni



Source:
Notes:
Reading:

The sharp fall in the number of female candidates admitted to the ENS Paris after the merger of the two schools is likely to have had an impact on the French academic landscape. Indeed, as a third of (assistant) professors in mathematics over 1984 to 2010 are former students of the school, the implementation of the mixed competition might have resulted in fewer women pursuing academic careers in scientific fields.

To investigate this question, we study gender differences in labor market outcomes of candidates potentially affected by the quota, before and after the merger. We identify this group by simulating counterfactual lists of admitted candidates. Figure D6 present a visual representation of our simulations. This section is still preliminary, as we are currently collecting information on the latest cohorts in our sample.

Identifying Candidates Affected by the Merger We identify two groups of candidates affected by the implementation, and then the abrogation, of quota system:

Before the merger: For the years for which we have information on both scores at the written and the oral exams, we rank male and female candidates together[38] to simulate the pool of accepted candidates in the absence of the gender quota. We identify our group of female and male always-takers as the male and female candidates who would have been accepted with or without the gender quota, given the capacity fixed for a given year. We identify our group of male compliers as the male candidates who were not accepted because of the gender quota but who would have been accepted without the gender quota. Reversely, we identify our group of female compliers as the female candidates who were accepted thanks to the gender quota but who would not have been accepted without the gender quota. We use the years 1978, 1979, 1984 and 1985, because we only have the test scores of all students for these pre-merger years.

After the merger: We fix the quota at the gender ratio of 1985 - roughly one third of female candidates and two thirds of male candidates - and simulate its implementation, given the capacity fixed for each year. We identify our group of female and male always-takers as the male and female candidates who would have been accepted with or without the quota. We identify our group of male compliers as the male candidates who were accepted without gender quota but who would not have been accepted with the gender quota. Reversely, we identify our group of female compliers as the female candidates who were not accepted because of the abrogation of the gender quota but who would have been accepted with the gender quota. We use the years 1986, 1987, 1988 and 1990, because we have the test scores of all students for these first four post-merger years.

Around the time of the merger, there was roughly 40 % of the male candidates and 15% of female candidates listed on the main admission list and the waiting list who rejected their admission to the ENS, mostly because they preferred to go to another graduate school (mostly to the *École Polytechnique*). It was thus not unusual to be among the last candidates on the waiting list but still be offered a seat at the ENS Paris in the end. To account for this, we use the number of available seats from the main admission list and

[38]When score at the oral exam are not available, students are ranked based on their score at the written exam.

the waiting list to define our sample of analysis. Our calibration for the simulations is presented in Table 5. Table 6 presents our sample size by years.

Table 5: Actual and Simulated Number of Seats Opened for Female and Male Candidates (Admission and Waiting-List)

	1978	**1979**	**1984**	**1985**	**1986**	**1987**	**1988**	**1990**
Panel A. Actual Number of Seats Opened for...								
	Gender Quota				*No Gender Quota*			
Male Candidates	46	46	61	61	0	0	0	0
Female Candidates	26	26	22	23	0	0	0	0
Any Candidates	0	0	0	0	83	83	82	85
Panel B. Simulated Number of Seats Opened for...								
	No Gender Quota				*Gender Quota*			
Male Candidates	0	0	0	0	22	22	22	23
Female Candidates	0	0	0	0	61	61	60	62
Any Candidates	72	72	83	84	0	0	0	0
Total (n_{year})	72	72	83	84	83	83	82	85

Source: Documentation sourced from the ENS and French National Archives.
Notes: To simulate the gender quota after 1985, we used the gender implemented in 1985 (27% of female students and 73% of male students.). We take n_{year} as given.

Table 6: Number of Candidates Affected by the Gender Quota, by Years

	1978	**1979**	**1984**	**1985**	**1986**	**1987**	**1988**	**1990**
Male Always Takers	38	41	61	61	55	61	60	62
Female Always Takers	15	8	22	21	4	6	7	4
Male Compliers	18	21	0	2	24	16	15	19
Female Compliers	11	18	0	2	18	16	15	19
Total	82	88	83	86	101	99	97	104

Source: Documentation sourced from the ENS and French National Archives.

Challenges in the Identification We showed in section 4 that the abrogation of the gender quota lead to a change in the composition of female candidates to the mathematics entrance examination. This implies that the always-takers could also be considered as being affected by the abrogation of the gender quota system. Indeed, we may believe that these individuals might not have been admitted before the merger, the pool of candidates being different. After the merger, they are also likely to have been treated differently once they got into the ENS Paris. For instance, we can assume that the very few post-merger admitted female candidates could have been more followed-up by the ENS Paris department. For these reasons, we cannot consider that female and male always-takers are comparable over time. As a consequence, we cannot study the difference in outcomes between the always-takers and the compliers. However, we can study the gender difference in labor outcomes for both always-takers and compliers candidates, taken together. This group represents the broad sample of students who are "affected" by the gender quota. Finally, as students listed on the admission and waiting list can resign, we only identify an intent-to-treat, i.e., having a non-null probability of actually enrolling in the ENS Paris. Candidates in our group of interest have a positive probability of actually entering the ENS while candidates whose rank is below the last candidate on the waiting list have zero chances of entering the school (see Figures D10 and D11 in appendix).

Outcomes of Interest We construct four outcomes to qualify candidates' labour market outcomes, distinguishing teaching and research careers. First, we define a dummy variable equal to one if the candidate obtained a PhD in a scientific field. While we restrict our sample to mathematics-intensive fields, our definition of scientific fields is rather broad. It includes domains such as Mathematics, Physics, Computer Sciences, (Applied, Earth) Sciences, Astronomy, Biology, Chemistry, Engineering Sciences, or Economics.

We define having a teaching career as a dummy variable equal to one if the candidate obtained a position as a teacher in a high school, a preparatory class or as a (assistant) professor at a university. We define having a research career as a dummy variable equal to one if the candidate holds or held a position as a (assistant) professor at a university,

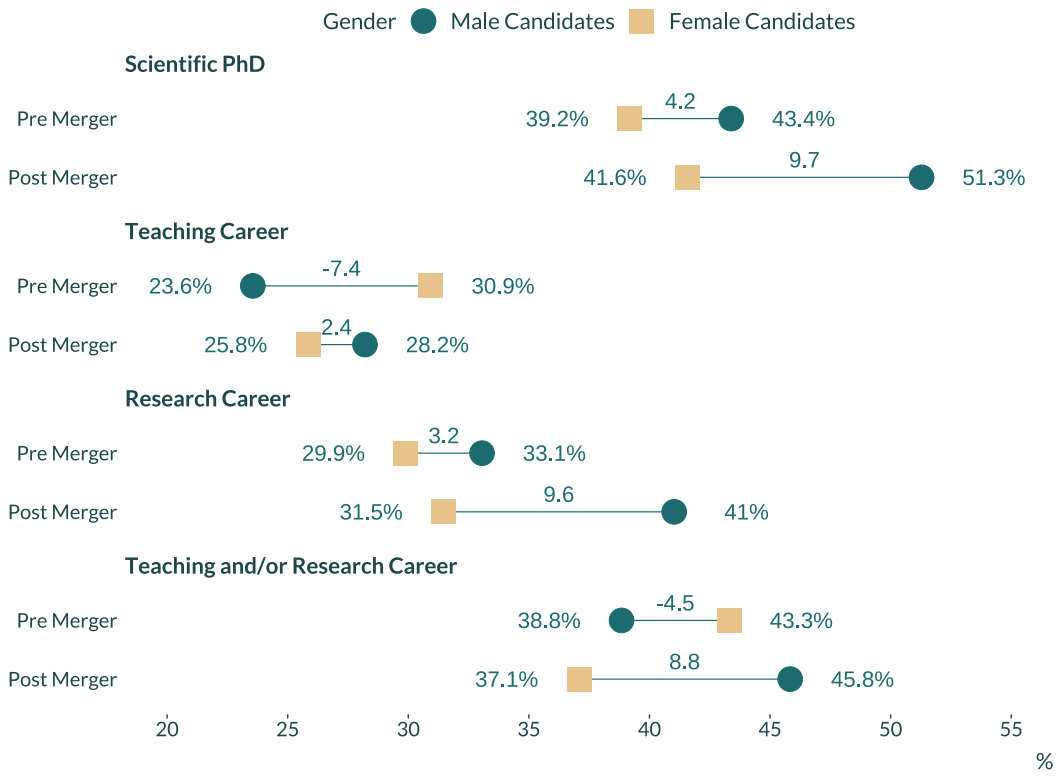
as a researcher in a public institute [39], or as a researcher in the private sector. Finally, we define having a teaching and/or a research career as the union of the two latter categories.

Results Our results suggest that the abrogation of the gender quota have increased the gender gap in teaching and research careers. Figure 20 presents the gender gap (male - female) for our four outcomes of interest. Before the merger, 43.4 % of male candidates in our group obtained a scientific PhD, compared to 39.2 % for female candidates, representing a gap of 4.2 percentage points. After the merger, the share of candidates who obtained scientific PhDs increased for both male and female students. However, the gap increased as well; 51.3 % of male candidates obtained a scientific PhD, compared to 41.6 % for female candidates, representing a gap of 9.7 percentage points. We observe a similar pattern for the probability to pursue a research career. While male candidates were already more likely pursue this type of profession before the merger (33.1 % compared to 29.9 % for female candidates), the gender gap increased after abrogation of the quota system, from 3.2 to 9.2 percentage points.

The findings related to teaching are particularly noteworthy. Prior to the merger, female candidates were more inclined than male candidates to pursue a career in teaching, with 30.9 % of them opting for this profession, compared to 23.6 % for male candidates. However, after the merger, this trend was entirely reversed, resulting in a gap of 2.4 percentage points in favor of male candidates. While this result is still exploratory, it may be worth exploring its potential link to the impact of role models on students' enrolment in scientific fields. Recent research has emphasized the importance of female role models, including both professors and researchers, for female students' engagement in STEM subjects (Porter and Serra, 2020; Breda et al., 2023). A decrease in the proportion of female teachers coming from ENS Paris may have had an adverse effect on female students' aspirations toward the school and STEM studies.

[39] This includes the CNRS, the CEA, and the INRIA, which are French public research institutions

Figure 20: Effect of the End of the Gender Quota on Affected Male and Female Candidates



Source: Documentation sourced from the ENS archives, *theses.fr*, *The Mathematics Genealogy Project*, *LinkedIn* and the French *Journal Officiel*.
Notes: The numbers display the mean difference of the share of male candidates minus the share of female students in different outcomes. Scientific PhD is composed of the following subjects: Mathematics, Physics, Computer Sciences, (Applied, Earth) Sciences, Astronomy, Biology, Chemistry, Engineering Sciences, Economics. A teaching career is defined as holding a position as a teacher in a high school, a preparatory class or as an (assistant) professor at a university. A research career is defined as holding a position as an (assistant) professor at a university, as a researcher in a public institute (e.g. CNRS, CEA, INRIA), or as a researcher in the private sector.
Lecture: Before the merger, 30.9 % of affected female candidates and 23.5 % of affected male candidates had a teaching career. The mean difference between male and female candidates was -7.4 percentage points. After the merger, 25.8 % of affected female candidates and 28.2 % of affected male candidates had a teaching career. The mean difference between male and female candidates was 2.4 percentage points.

6 Discussion and Conclusion

This paper investigates the effect of the end of a gender quota in admission to one of the most prestigious elite graduate school in 1986 in France, the *École Normale Supérieure de Paris*. This school is of particular interest since its purpose is to prepare students for high-level teaching and academic careers. Between 1984 and 2001, it provided more than 30% of the French public universities professors in ancient languages, mathematics, philosophy, literature, archaeology and astronomy and astrophysics.

We document that the end of this gender quota had a detrimental long-lasting effect on the percentage of admitted female candidates in the mathematics and physics tracks. The implementation of the mixed competition did not foster the number of women admitted in humanities or in biology, and eventually led to an absolute decline in the number of women admitted to the school.

Further analyses on the mathematics entrance exam show that women had a significant advantage in qualification and admission before the merger of the two schools, which was later entirely reversed in favour of men. Moreover, our pre-merger counterfactual simulation show that gender performance gap only explains half of the fall in the number of admitted women. The remaining half is explained by an absolute decrease in the number and the share of female candidates, mostly coming from the best preparatory programs in Paris. This illustrates that women tend to *turn away* from mixed competition, especially in performing stereotypically male associated task. In line with the stereotype threats framework (Spencer et al., 1999), high performing students, and students who identify the most to the task, are more likely to be affected by activated stereotype threats, in this case mixed competition in mathematics. This could also be explained by the fact that female Parisian students have more information about competitive exams and act more strategically. The mathematics subject with the largest weight at the ENS written examination is particularly demanding; it requires a special training, and skills that are not directly transferable to the preparation of other competitive exams for engineering graduate schools. Hence, women studying in top Parisian high schools could have chosen to focus on the other exams rather than losing time on this particular subject. We cannot argue that this maths examination is irrelevant to select potential good researchers, but it is worth noting that we find not correlation between Math 1 test

score and the probability to obtain a scientific PhD or the probability to have a research career in our sample of affected candidates by the gender quota. Nonetheless, we show that the gender differences in scores obtained in this subject are especially pronounced, and that suppressing it could lead to substantial increase in the share of women qualified at the oral examination. Evidence on the good performances of women candidates at the oral examination - including in 1985, when the pool of female qualified candidates was less self-selected - suggest that this could be an efficient policy to increase the share of women among admitted candidates.

Lastly, we document that the long-run consequences of the implementation of the mixed competition might have increased gender differences in the probability to obtain a doctorate degree in a scientific field and to pursue a teaching and research career for the affected students.

If one believe that our results can be symmetrically extrapolated to the implementation a gender quota, we bring up some new empirical evidence on that a gender quota could be an efficient solution to reduce gender inequality in access to competitive higher education institutions. It can create a reassuring environment for all women to apply, which allows some high-achieving candidates to get in, who would have not applied in the absence of this gender quota, but did not need it to get in. Recent evidence on the entrance examination to the most prestigious civil servant school in France (*l'École Nationale d'Administration*, ENA) show that women with lower socio-economic status tend to spread themselves between too many competitive exams, reducing their chances in entering the school in the end (Parodi et al., 2022). This is in line with the literature on gender difference in risk-aversion. This points towards an absolute loss of talented female candidates, and thus female students at the ENS.

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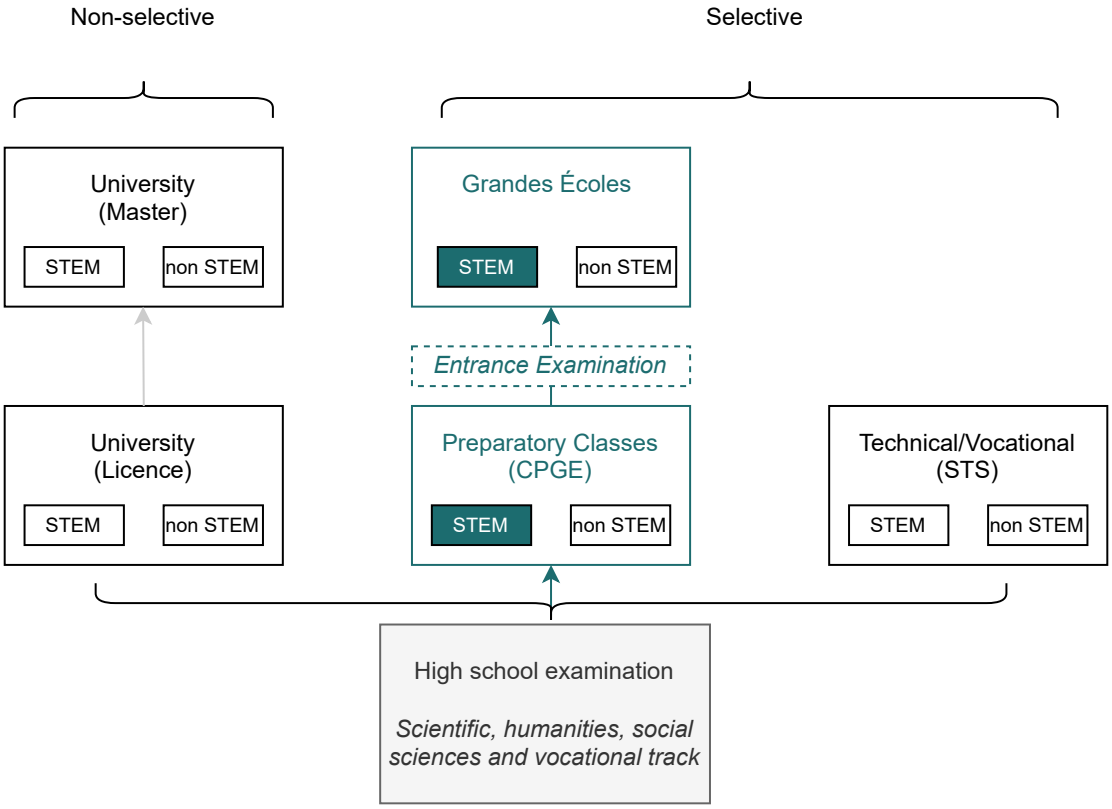
Appendix

A Institutional Background

Figure A1: Tracks in Secondary and Post-Secondary Education in France



Note: Squares highlighted in green show the main educational pathway considered in this article.

Co-education and Underrepresentation of Women in STEM in France

Mixed-Gender Schooling in France Mixed-gender schooling was introduced in the French educational system in the beginning of the 20th century. It started with a long process of harmonization of educational programs for female and male students, which was finally ratified in 1924 by the Bérard Decree. Mixed-schooling was then gradually promoted by several laws after World War II: first in 1959 and 1963 for secondary schooling, then in 1965 for elementary schools. Finally, in 1975, the Haby Law sanctioned co-education (or mixed-gender schooling) in all educational institutions in France. Part of the motivation for co-education was economic and material circumstances. For instance, until the beginning of the 20th century, mixed-gender schools were only allowed in case of material constraints, in remote and rural areas, where the number of children in the municipality was too small to divide classes in two. In 1915, because of a shortage of teachers due to the conscription, a decree was passed to allow boys and girls to attend the same elementary classes.

Higher education in France was never formally close to women, although the number of female students only rose in the second half of the 20th century. In 1971, women represented 50 % of students at the university (Ferrand, 2004). Mixed-gender schooling was then gradually introduced among elite graduate schools: in 1945, the Ecole Nationale d'Administration (ENA), was open to both female and male students in order to train the future high officials of the country. Engineering and business schools opened their recruitment to women during the 1970s and, by the end of the 1980s, the entire system was formally mixed. Finally, mixed-gender competition was also introduced to recruit teachers (especially the *agrégation*, which is the examination required to teach in secondary schooling) between 1974 and 1976.

Under-representation of Women in STEM Co-education historically went hand-in-hand with gender differentiation in choices of fields of study. Though women now represent 55 % of students in higher education in France, they are still largely under-represented among STEM graduates: in 2020, women outnumbered men in medicine, health program and biology (accounting for respectively 65,6 % and 63,5 % of students in these fields), but only represented 28,9 % of students enrolled in engineering programs. This unbalance is even more striking among the most selective schools: in 2016, women represented only 31 % of students enrolled in science preparatory classes, less than 30 % of students enrolled in engineering schools, and only 21 % of students among the top 10 % most selective engineering schools (Bonneau et al., 2021). These gender differences in choices of fields of study, and more generally in attitudes towards math-intensive sciences, are present early on in students' trajectory (Perronnet, 2021). Nonetheless, they cannot be entirely explained by differences in academic performance.

Women outperform their male counterpart at every step of the educational system: they obtain better grades at school, are far more likely to obtain their high school examination (*baccalauréat*), and are more likely to graduate from higher education (DEPP, 2022). For instance, Bonneau et al. (2021) show, using Blinder-Oaxaca decomposition, that given their academic performances, women should have higher enrolment rates to engineering schools than men. A large literature in economics and sociology has tried to explain these difference by the role of gender stereotypes. Recent studies have shown that stereotypes associating mathematics with masculinity is stronger in more egalitarian and developed countries, suggesting that, rather than being suppressed, gender stereotypes are reshaped, leading to more horizontal forms of social differentiation (Charles and Bradley, 2002; Charles and Grusky, 2005; Charles and Bradley, 2009; Sikora and Pokropek, 2012; Breda et al., 2020).

B Data

Table B1: Data Collection for the ENS d'Ulm Mathematics Entrance Examination

Years	Jury Composition	List of Candidates	List of Qualified	List of Wait-listed	List of Admitted	List of Enrolled	Written Grades of Candidates	Written Grades of Qualified	Oral Grades of Qualified
1985 - 1984	✓	✓	✓	✓	✓	✓	✓	✓	✓
1983	✓		✓	✓	✓	✓			
1982	✓	✓	✓	✓	✓	✓			
1981			✓	✓		✓			
1980				✓	✓	✓			
1979	✓	✓	✓	✓		✓	✓	✓	
1978		✓	✓	✓	✓	✓	✓	✓	
1977 - 1976			✓	✓	✓	✓			
1975	✓		✓	✓	✓	✓			
1974			✓	✓	✓	✓			
1973				✓	✓	✓			
1972			✓						
1969 - 1971			✓	✓	✓	✓			

Table B2: Data Collection for the ENS de Sèvres Mathematics Entrance Examination

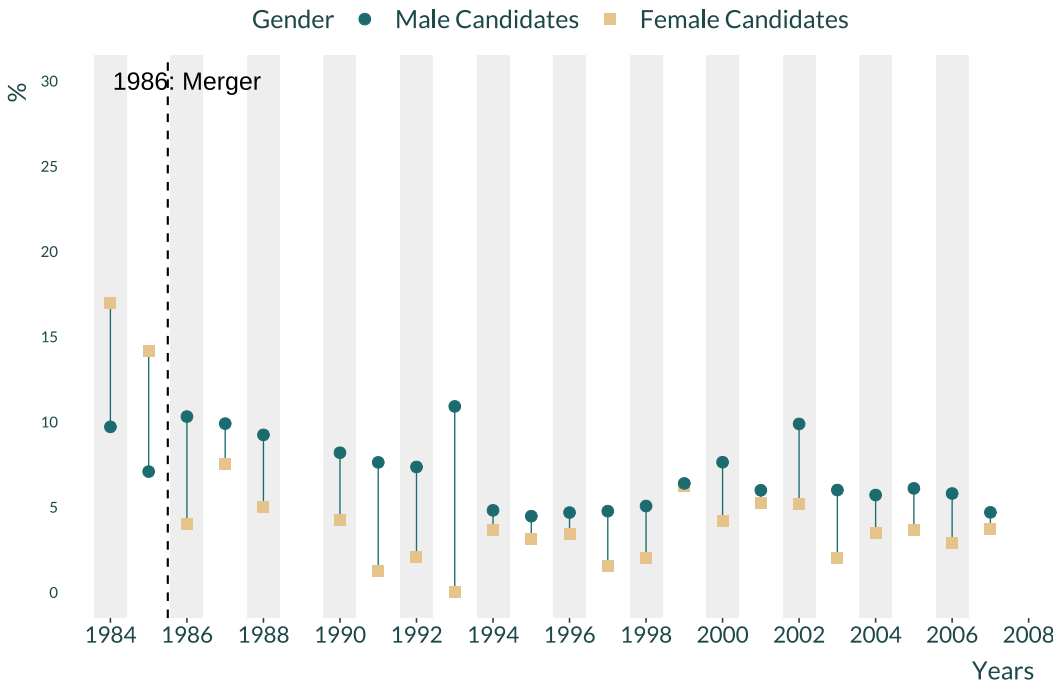
Years	Jury Composition	List of Candidates	List of Qualified	List of Wait-listed	List of Admitted	List of Enrolled	Written Grades of Candidates	Written Grades of Qualified	Oral Grades of Qualified
1985 - 1969	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table B3: Data Collection for the ENS de Paris Mathematics Entrance Examination

Years	Jury Composition	List of Candidates	Qualified	Wait-listed	Admitted	Enrolled	Written Grades of Candidates	Qualified	Oral Grades of Qualified
2009		✓	✓	✓	✓	✓	✓	✓	✓
2005 - 2008	✓	✓	✓	✓	✓	✓	✓	✓	✓
2005 - 2007		✓	✓	✓	✓	✓	✓	✓	✓
2003 - 2004	✓	✓	✓	✓	✓	✓	✓	✓	✓
2002	✓	✓ (partial)	✓	✓	✓ (partial)	✓	✓	✓	✓
2001		✓	✓	✓	✓	✓	✓	✓	✓
1995 - 2000	✓	✓	✓	✓	✓	✓	✓	✓	✓
1994	✓	✓	✓	✓	✓	✓	✓	✓	✓ (partial)
1993	✓	✓	✓	✓	✓	✓	✓	✓	✓
1992		✓	✓	✓	✓	✓	✓	✓	✓
1991	✓	✓	✓	✓	✓	✓	✓	✓	✓
1990		✓	✓	✓	✓	✓	✓	✓	✓
1989	✓		✓	✓	✓	✓		✓	✓
1987 - 1988		✓	✓	✓	✓	✓	✓	✓	✓
1986			✓	✓	✓	✓	✓	✓	

C Summary Statistics

Figure C1: Success Rates in Admission to the ENS Mathematics Track, by Gender, Pool of Candidates which Took the exam, 1984 - 2007



Source: Documentation sourced from the ENS archives.

D Odds Ratios : Methodology

Odds ratio For a given group of individuals G (e.g.: female candidates), the odds ratio is the ratio between the probability to succeed (e.g.: admission to the ENS), and the probability of not succeeding :

$$\text{Odds ratio} = \frac{\tau_G}{(1-\tau_G)}, \tag{1}$$

where τ_G is the proportion of individuals from group G qui who succeeds (e.g. the proportion of female candidates admitted to the ENS).

Relative odds ratio The relative odds ratios between group A and B, is the ratio of the odds ratio of group A and the odds ratio of group B

$$\text{ODDS}_{A/B} = \frac{\tau_A/(1-\tau_A)}{\tau_B/(1-\tau_B)}, \tag{2}$$

where τ_A is the proportion of individuals from group A who succeeds and τ_B is the same proportion for group B.

The odds ratios can also be rewritten as:

$$\text{ODDS}_{A/B} = \frac{ad}{bc}, \tag{3}$$

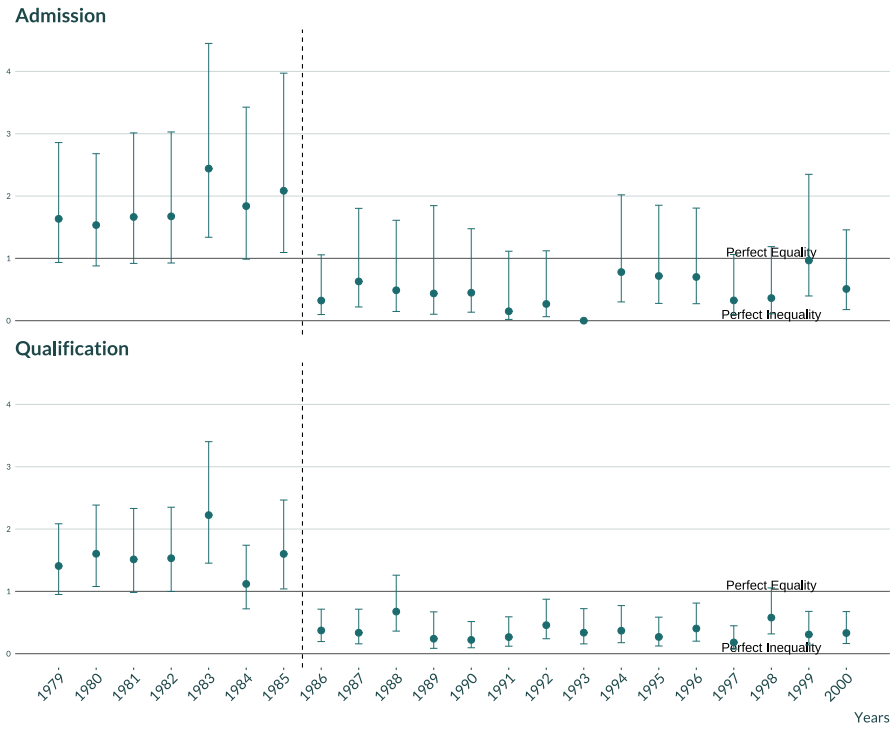
Where: a is the number of female candidates who succeed, b is the number of female candidates did not, c is the number of male candidates who succeed and d the number of male candidates who did not.

Confidence Intervals The aim is to assess whether the value of the odds ratio is statistically different from 1, which is the case of perfect equality between male and female candidates. The distribution of odds ratio is skewed, so it is not possible to directly calculate confidence interval for the statistics. However, the log of the odds ratio is symmetrically distributed, and the standard error of the this statistics is given by

$$se(log(ODDS_{A/B}) = \sqrt{\frac{1}{a}+\frac{1}{b}+\frac{1}{c}+\frac{1}{d}}, \tag{4}$$

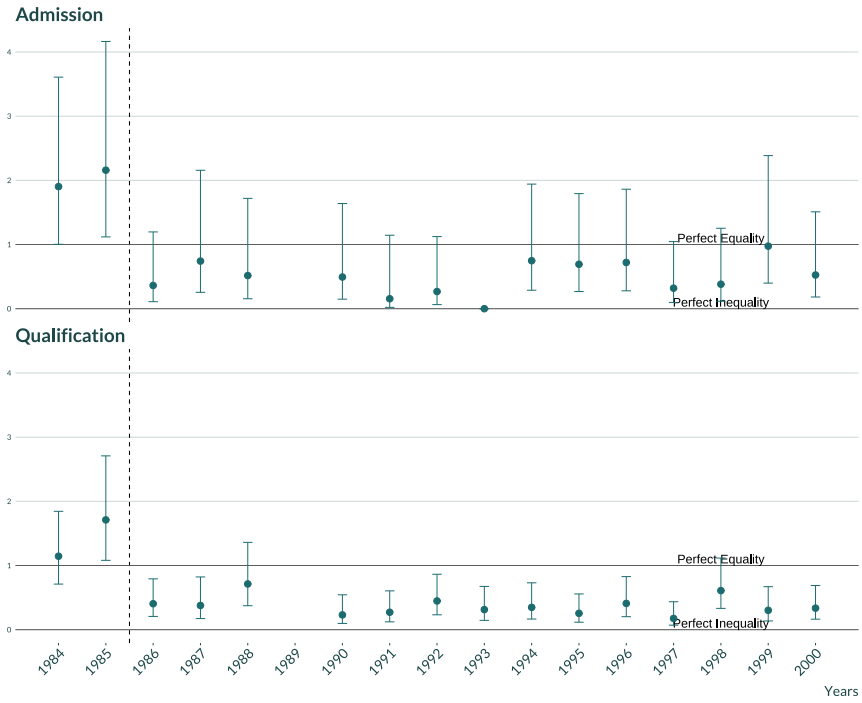
We first compute confidence interval at the 95 % confidence level for the log odds ratio, which is exactly equivalent to a logistic regression model. We then use the exponential of the upper and lower bound to recover the confidence interval for the odds ratio. Since the odds ratios are not distributed symmetrically, confidence intervals are not necessarily centered.

Figure D1: Odds Ratios, Admission and Qualification, 1978 - 2000



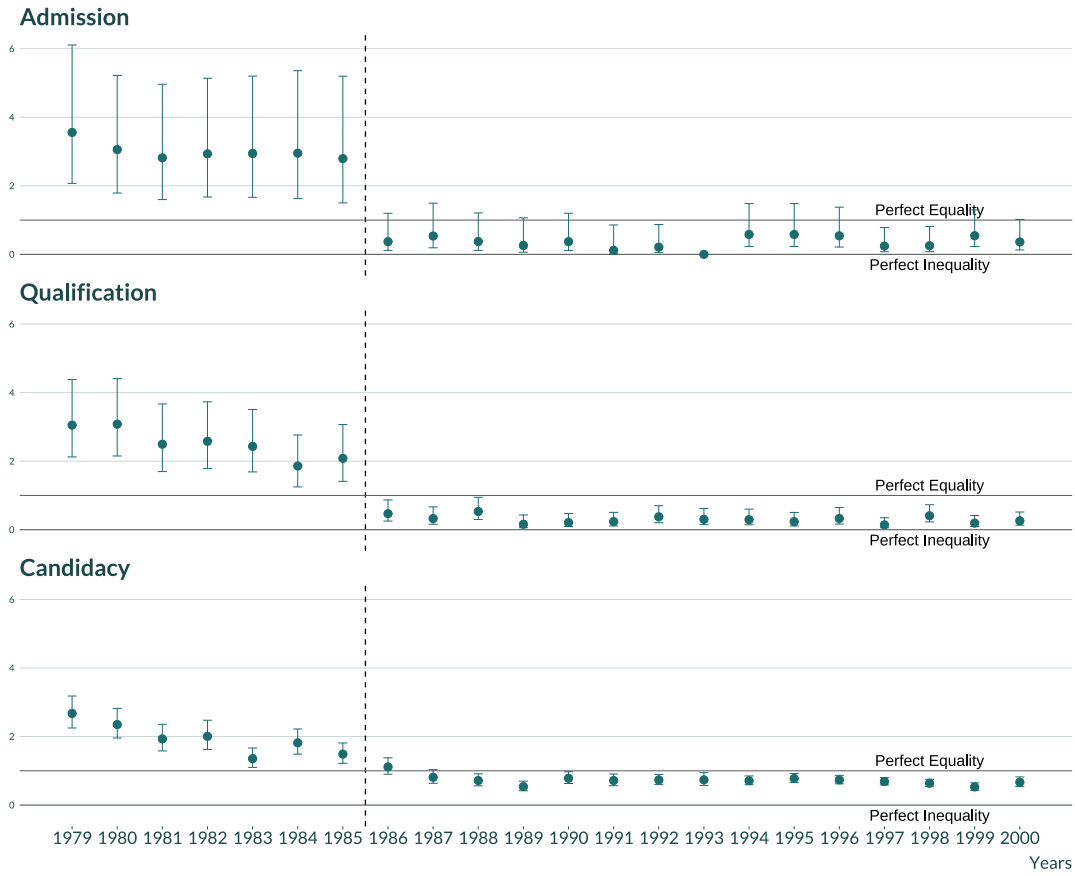
Source: Documentation sourced from the ENS archives.

Figure D2: Odds Ratios, Admission and Qualification, 1978 - 2000, Pool of Candidates which Took the Exam



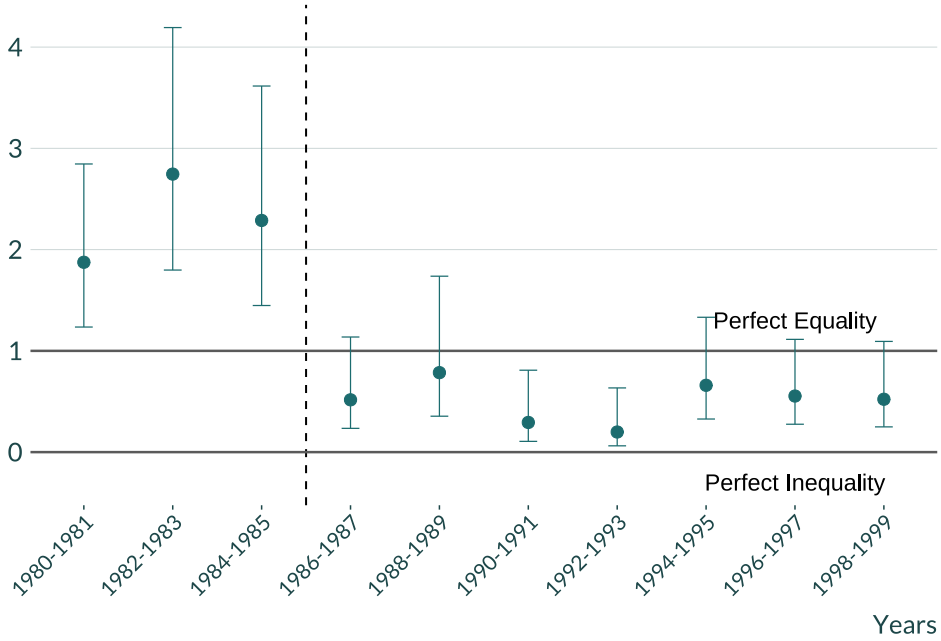
Source: Documentation sourced from the ENS archives.

Figure D3: Odds Ratios, Admission, Qualification and Candidacy, 1978 - 2000



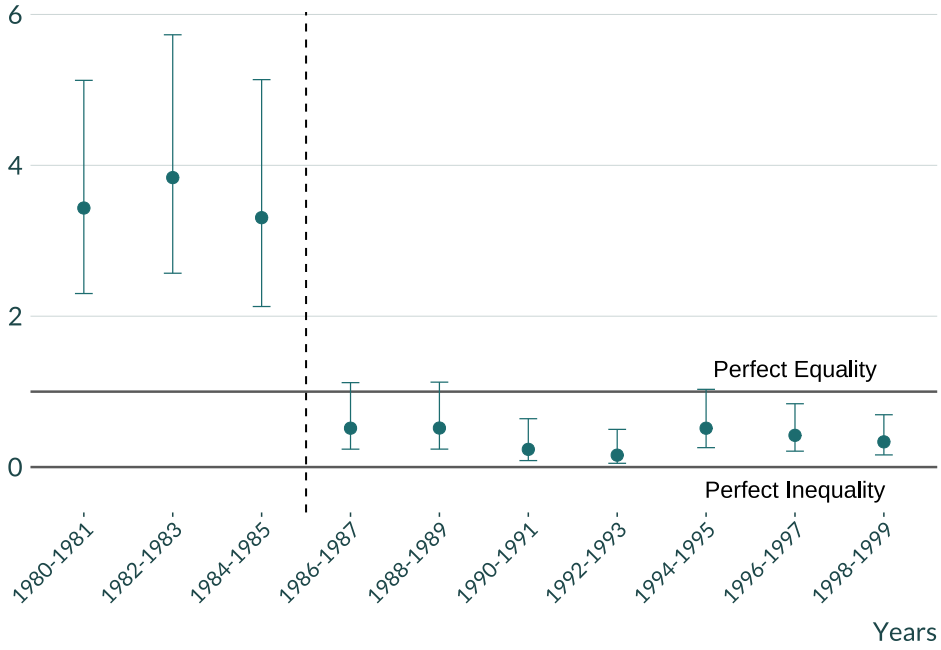
Source: Documentation sourced from the ENS archives.

Figure D4: Odds Ratios, Admission, Final Entrance to the ENS and Pool of Candidates Registered at the Written Exam, 1980-1999



Source: Documentation sourced from the ENS archives.

Figure D5: Odds Ratios, Admission, Final Entrance to the ENS and Pool of Students in Preparatory Classes, 1980-1999



Source: Documentation sourced from the ENS archives.

Figure D6: Simulation of Counterfactuals

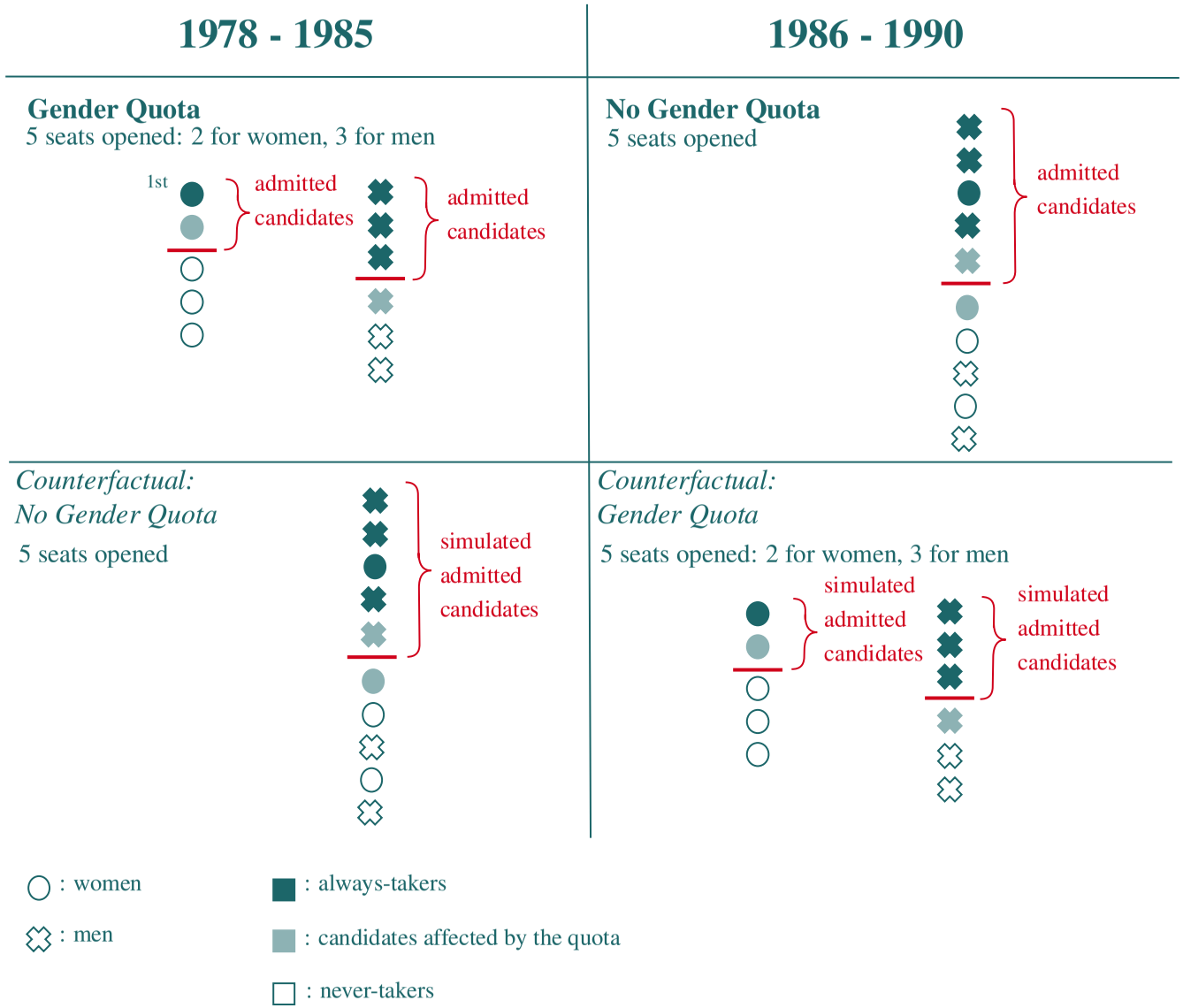
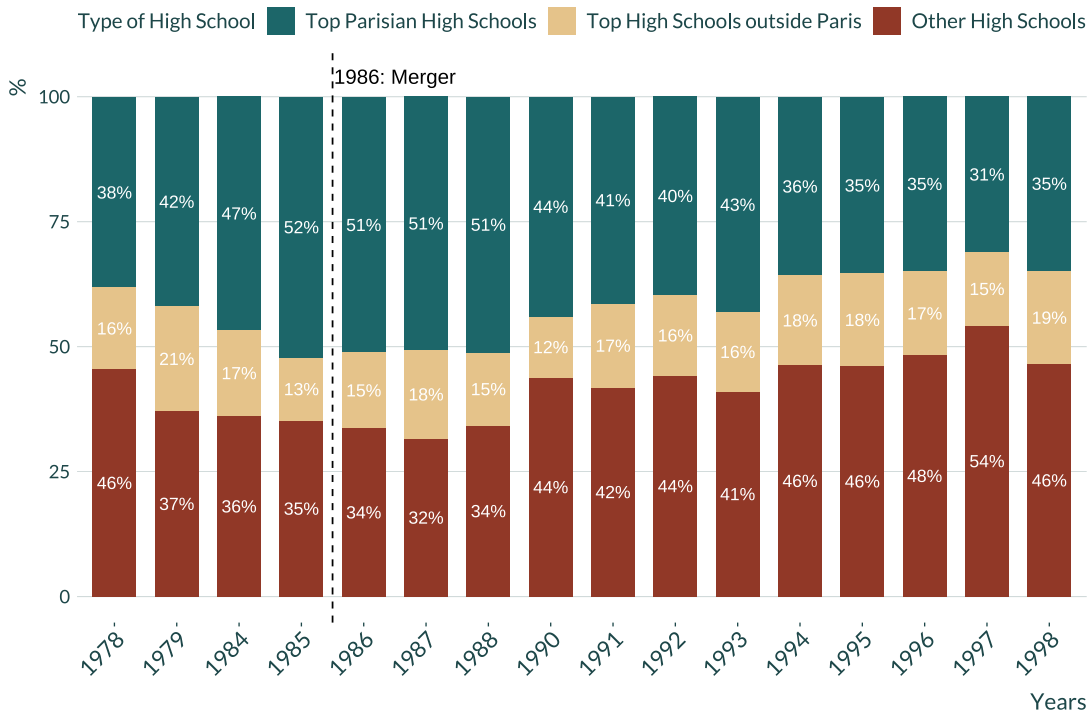


Table D1: Share of Female Among Admitted and Waiting-List Candidates

	1978	1979	1984	1985
Panel A. Number of Candidates				
ENS d'Ulm	46	46	61	61
ENS de Sèvres	26	26	22	23
Total (n_{year})	72	72	83	84
Panel B. Share of Female Candidates				
Actual Share		*with gender quota*		
	36%	36%	27%	27%
Simulated Share		*without gender quota*		
Raw Scores	33%	38%	20%	25%
Transformed Scores	22%	14%	27%	25%

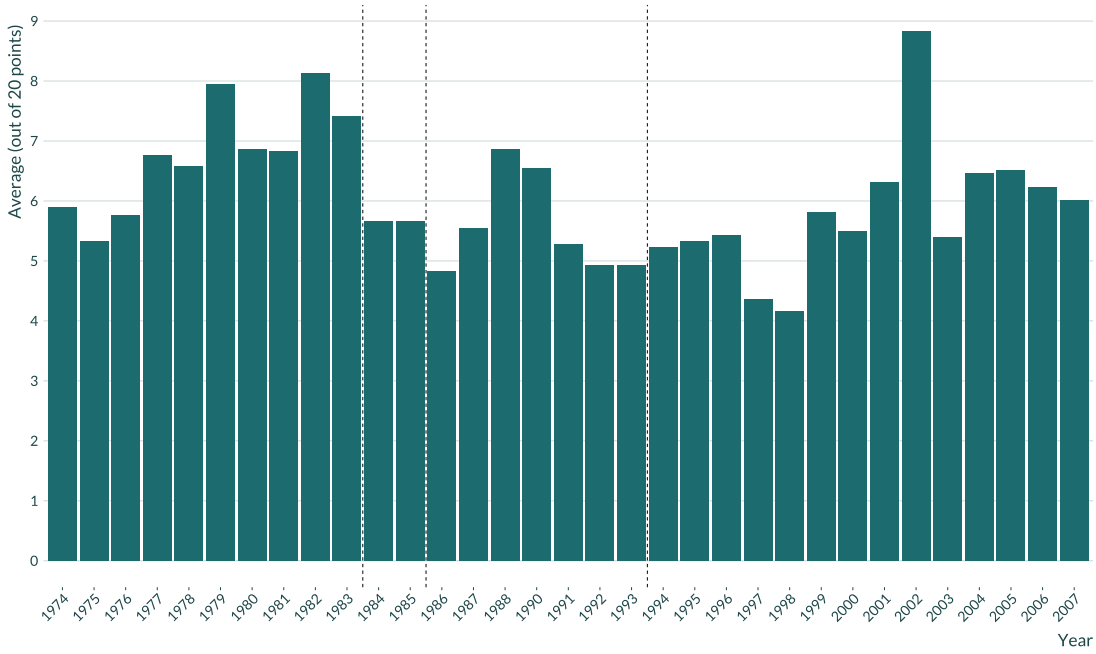
Source: Documentation sourced from the ENS and French National Archives. We use the transformed test scores for the year 1978, 1979 and 1984 to simulated the admitted students.

Figure D7: Share of Male Candidates Coming From Top Parisian High Schools, Top High Schools Outside of Paris and Other High Schools



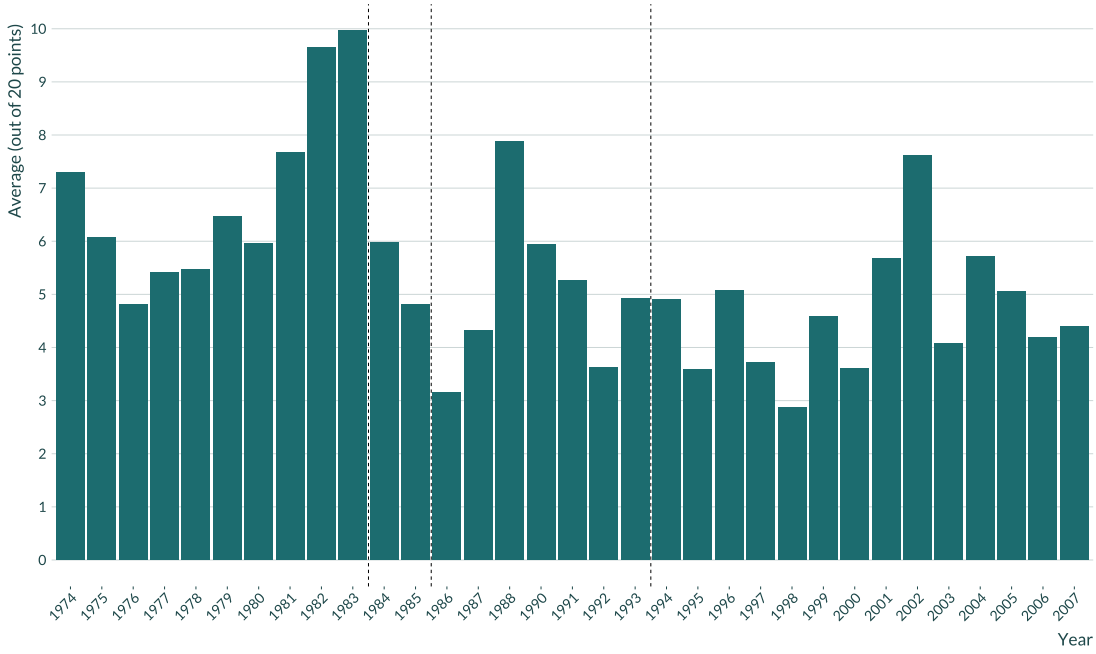
Source: Documentation sourced from the ENS archives.

Figure D8: Average grade at the Written Exam, Female Candidates at the ENS, 1974-2007



Source: Documentation sourced from the ENS archives.

Figure D9: Average grade at the First Mathematics Written Exam, Female Candidates at the ENS, 1974-2007



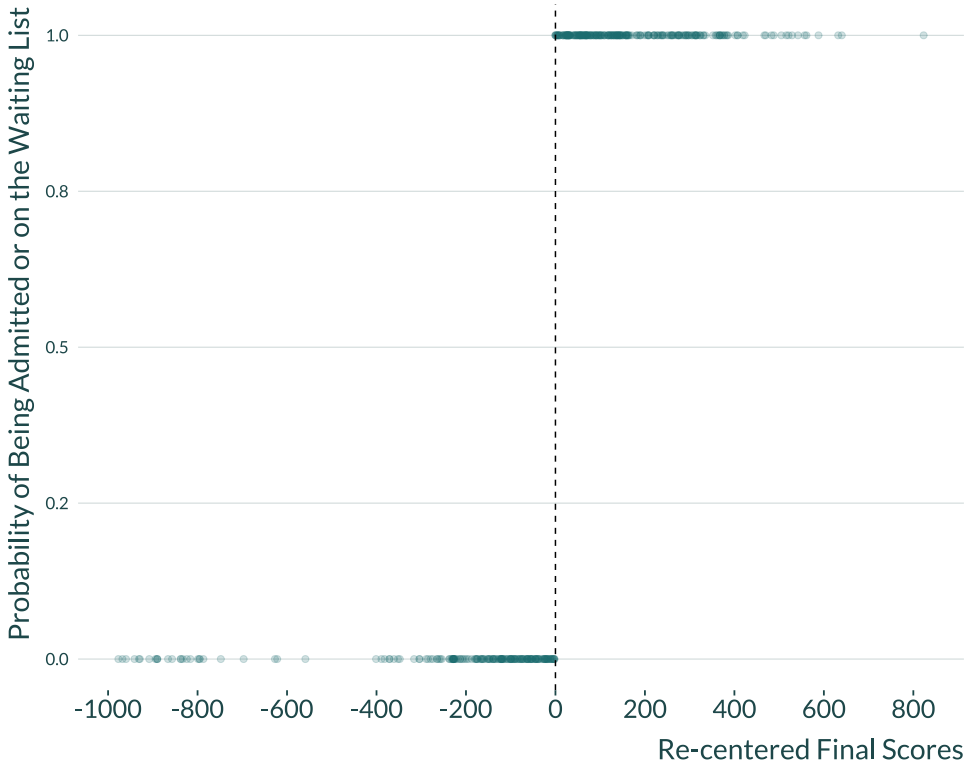
Source: Documentation sourced from the ENS archives.

Table D2: Real and Simulated Number of Female Candidates, Admission Stage, 1987-1993

	Qualification		Admission	
Years	Real Share	Simulated Share	Real Number	Simulated Number
1986	7.8	7.1		
1987	5.4	5.4	4	4
1988	9.1	7.0	3	3
1990	4.0	3.4	3	3
1991	4.8	4.1	3	1
1992	7.7	6.3	2	2
1993	6.3	7.9	0	0
1994	6.6	6.6		
1995	5.4	8.5		
1996	7.4	7.4		
1997	4.3	4.3		
1998	11.4	7.8		
1999	5.8	5.8		
2000	7.3	11.4		

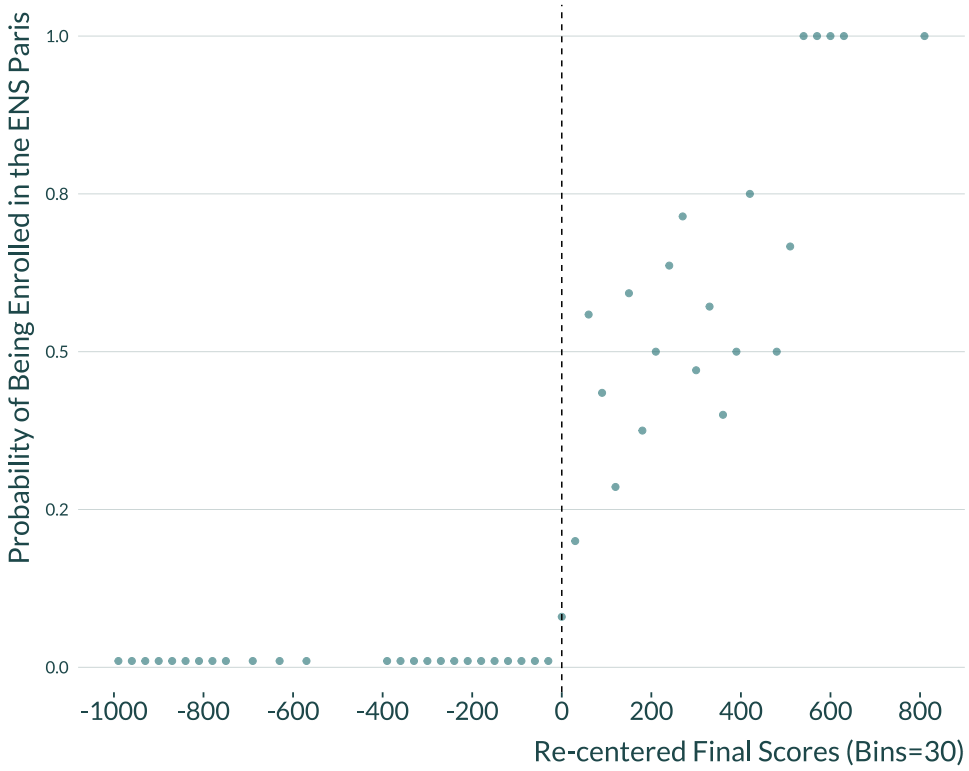
Source: Documentation sourced from the ENS archives.

Figure D10: Probability of Being Admitted or on the Waiting list for the Mathematics Track as a Function of Re-Centered Total Scores, 1987-1990



Source: Documentation sourced from the ENS archives.
Notes: The 0 is set at the total score of the last student on the waiting list.

Figure D11: Probability of Enrolling in the ENS Paris in the Mathematics Track as a Function of Re-Centered Total Scores, 1987-1990



Source: Documentation sourced from the ENS archives.
Notes: The 0 is set at the total score of the last student on the waiting list.

E Jurys

Table E1 presents the gender decomposition of the jurys of the ENS de Sèvres and the ENS d'Ulm for the sciences subjects of the mathematics entrance exam, for the years we could recover from the archives. Prior to the merger, the ENS d'Ulm jurys were composed of 100% male professors for the available years. The ENS de Sèvres jurys included some female professors, ranging from 0 % in 1985 to 40 % in 1975 and 1983. After the merger, the share of female professors in the jurys quickly dropped at 0 %.

Table E1: Jurys of Mathematics Entrance Exam in Sciences Subjects

	ENS de Sèvres (women only)		**ENS d'Ulm (men only)**	
	number of female jury members	number of male jury members	number of female jury members	number of male jury members
1975	2	3	0	5
1979	1	4	0	5
1982	1	5	0	6
1983	2	3	0	5
1984	1	7	0	5
1985	0	7	0	7
	ENS de Paris (mixed-gender)			
	number of female jury members		number of male jury members	
1986	1		5	
1989	0		6	
1991	0		7	
1993	2		15	

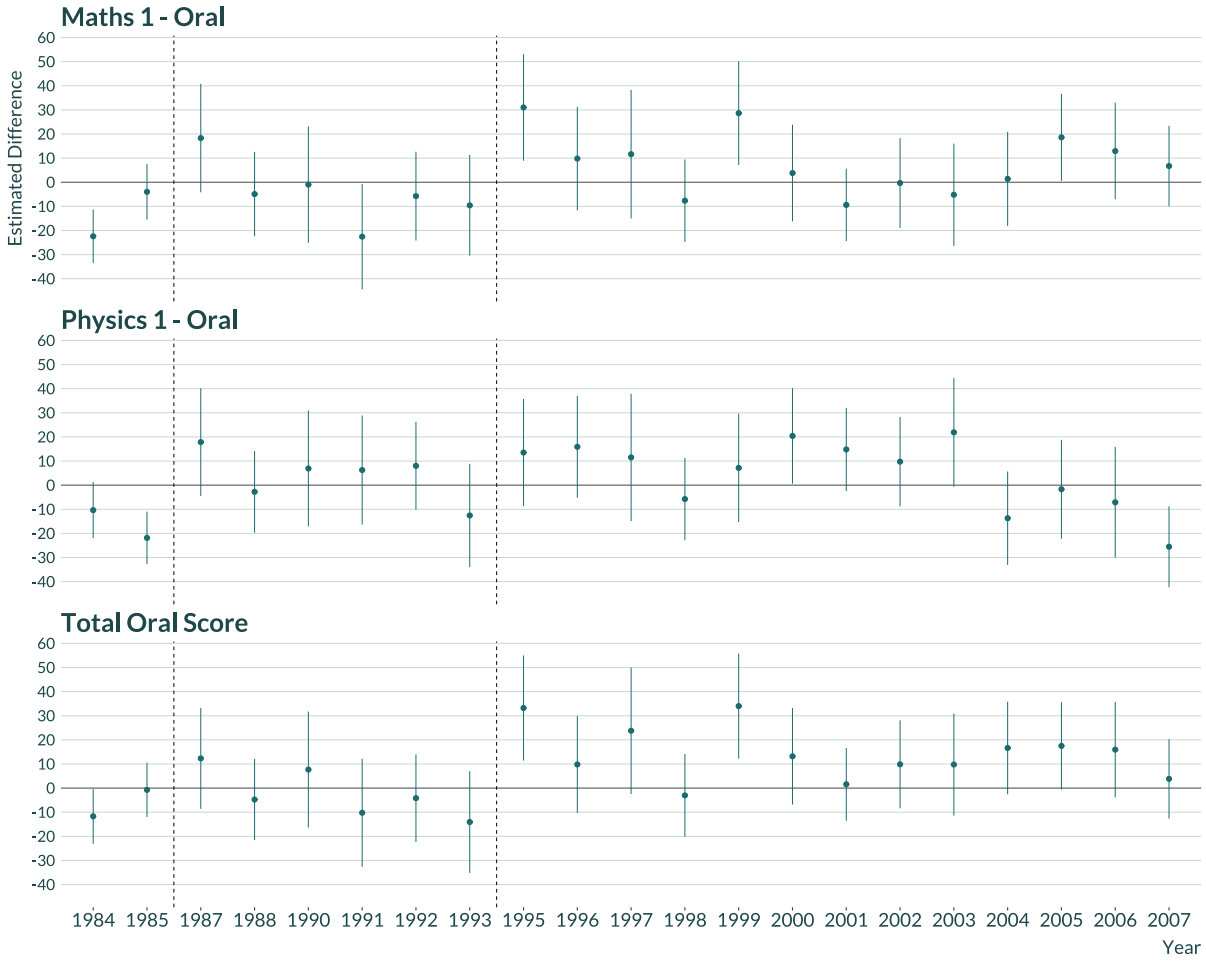
Source: Documentation sourced from the ENS archives. Before 1986, we only display the years for which we have both the ENS de Sèvres and the ENS d'Ulm jury members.
Lecture: In 1982, there were one female jury member and five male jury members at the ENS de Sèvres mathematics entrance exams in sciences subjects, while there were zero female jury member and five jury members at the ENS d'Ulm mathematics entrance exams in sciences subjects.
Notes: The sciences subjects are the two mathematics written exams, the physics written exam, the mathematics oral exam and the physics/chemistry oral exam.

Before 1984, the jurys for the mathematics entrance exams in sciences subjects in the ENS d'Ulm and the ENS de Sèvres were different. In 1975 and 1979, the jurys at the mathematics entrance exam in sciences subjects of the two ENS were completely different. In 1982, the jurys for the sciences written exams were different individuals for the two ENS but the jurys for the sciences oral exams were the same persons. In 1983, the jury members for the two ENS were different except for the mathematics oral exam.

However, we observe a strong overlap of the jurys in 1984 and 1985. In 1984, the jury of the ENS de Sèvres is composed of the same professors than the jury of the ENS d'Ulm with two extra professors (one for the first mathematics written exam and one for the physics/chemistry oral exam). In 1985, we observe the opposite: the jury of the ENS d'Ulm is composed of the same professors than the jury of the ENS de Sèvres. The jury in 1986 is composed of the same professors than the ones of the ENS de Sèvres in 1985 with an extra professor (one extra female professor for the physics written exam).

Given the missing data about jury composition for some years pre and post-merger, the missing information about the matching between students and examiners for the oral exams, and the low variability of the female professors in the jurys post-merger, we cannot investigate the potential role of the jury gender composition on female students' success rate at the ENS mathematics entrance exam.

Figure F1: Raw Differences in Mean Percentile Rank, by Gender, Subject and Year
ENS Paris (Ulm & Sèvres) Entrance Oral Exam, 1978-2007

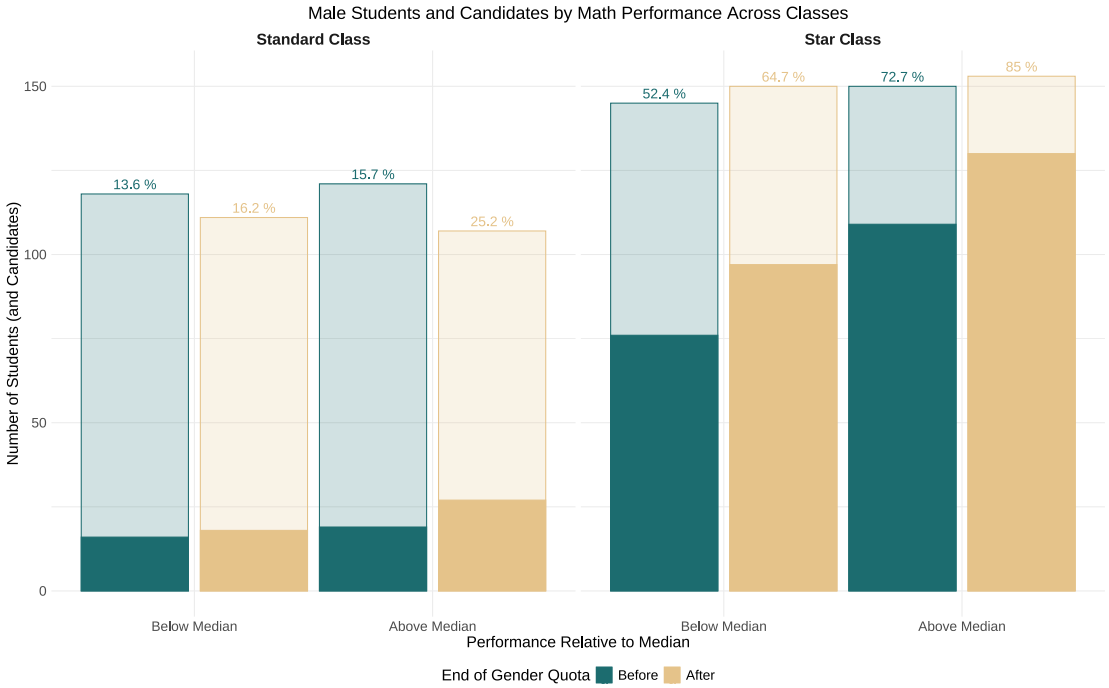


Source: Documentation from the ENS archives.
Note: Error bars represent the 95 % confidence interval.
Lecture: In 1985, the average percentile rank of female candidates at the total oral score was 50, whereas it was 49 for female candidates. The difference between the two is -1, which is reported in the graph.

F Gender Perfomance Gap

G Louis le Grand Students Analyses

Figure G2: Male Students Application Behavior, by Math Performance at the End of Prep Program



Source: Documentation sourced from the *Louis le Grand* and ENS archives.
Notes: The sample consists of male students who are in second year in the best mathematics preparatory program in France, *Louis le Grand* in 1982, 1984 and 1985 (Before) and in 1986-1988 (After). They are ranked by their mathematics GPA at the end of the school year, just prior taking the ENS entrance exam. In the second year of maths prep program, students are placed either in star or standard class, depending on their achievement at the end of their first year. Star classes concentrate the best students. Therefore, one can consider that a student below the median in a star class has higher academic ability that another student who is above the median in a standard class.
Reading: There were 97 male students who were below the median in star class in our cohorts after the end of the gender quota (1986-1988), and 64.7% of them applied to the ENS, while there were 76 before (1982, 1984, 1985) and 52,4% of them took the ENS entrance exam.