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Where are the Female Composers? Evidence on the Extent and Causes of Gender Inequality in Music History

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Abstract

Ludwig van Beethoven, Johann Sebastian Bach, and Frédéric Chopin are household names, but few will recognize Francesca Caccini, Elisabeth Lutyens or Amy M. Beach, who are among the top-10 female composers of all time. Why are female composers overshadowed by their male counterparts? Using novel data on over 17,000 composers who lived from the sixth to the twentieth centuries, we conduct the first quantitative exploration of the gender gap among classical composers. We use the length of a composer's biographical entry in *Grove Music Online* to measure composer prominence, and shed light on the determinants of the gender gap with a focus on the development of composers' human capital through families, teachers, and institutionalized music education. The evidence suggests that parental musical background matters for composers' prominence, that the effects of teachers vary by the gender of the composer but the effects of parents do not, and while musician mothers and female teachers are important, they do not narrow the gender gap in composer prominence. We also find that the institutionalization of music education in conservatories increases the relative prominence of female composers.

Keywords: gender gap, human capital, music education, music history, student-teacher interactions, conservatories
JEL Codes: I23, J16, J24, N30, Z11

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1 Introduction

> Women are taught music, but not for the purpose of composing, only for executing it: and accordingly, it is only as composers, that men... are superior to women...
>
> *John Stuart Mill, 1869*

Throughout history, the greatest inventions—from the printing press and the light bulb to artificial intelligence—have primarily been the work of men. Men receive credit for the biggest discoveries, whether of new lands or in outer space. The most highly acclaimed works of art—paintings like the *Mona Lisa* or *Guernica*, or sculptures like *David* or the *Thinker*—were male creations. Science is still male dominated: only five women have won a Nobel Prize for physics and even fewer have been awarded the economics Nobel or the Fields Medal for mathematics. These observations raise two questions. First, are men, in fact, more prominent than women when it comes to significant human accomplishments, as our first impressions suggest? And, if they are, why?

We address these two questions through the lens of classical music. Classical composers have bequeathed civilization with a legacy of magnificent and timeless musical compositions, masterpieces that continue to shape the cultural landscape. Nevertheless, it is striking that the vast bulk of the classical cannon was written by men, and that the composers with whom the general public is most familiar—Bach, Beethoven, and Mozart, for instance—constitute an almost exclusively male club.[1] We focus on classical composers for three reasons. First, we can measure the gender gap among composers over an extremely long period of time (i.e., 1,500 years), far longer than has been done for any other area of human endeavour. Second, the technology of musical composition bestows no obvious advantage to one gender over the other, and has remained essentially unchanged until very recently.[2] Third, for composers we

[1] The UK-based radio station, Classic FM, includes only two women in its recent ranking of the 30 greatest composers of all time (Pentreath, 2023). Similarly, there are only two women in *BBC Music Magazine's* list of the top 50 composers (Wright, 2023).

[2] Musical instruments have changed over time, as have the technologies we use to consume music, but not

can measure their early exposure to music, as well as access to informal and formal training, which gives us leverage to investigate factors that drive the gender gap.

Using data on composers from the music encyclopedia *Grove Music Online* (henceforth *Grove*) we conduct the first systematic quantitative exploration of the gender gap in classical music, encompassing over 17,000 composers who lived from the sixth to the twentieth centuries. Following Borowiecki et al. (2023) we measure the prominence of composers using the lengths of their individual biographical entries in *Grove*. *Grove* entries are written by experts who are charged with explaining the musical careers and contributions of their subjects. If experts have more to say about composers who are judged favorably by posterity than those who are not, the length of a biographical entry should be a reasonable proxy for a composer's prominence, with longer entries signifying greater importance.[3]

Consistent with first impressions, we find that there is indeed a significant gender gap among classical composers in terms of their prominence and representation. Only six percent of composers in *Grove* are women, and, holding constant a composer's time period and country of birth, the biographical entries of female composers are 25 percent shorter than those of male composers. However, we also document that the extent of this gap narrows with time and varies by geographic region.

We then turn to an investigation of the determinants of this gender gap. Music composition has, until very recently, been a human capital intensive endeavour. Accordingly, our attention focuses on factors that influence composers' musical training, specifically their families (i.e., whether their parents were musicians), their teachers (i.e., the number of teachers and their prominence), and their proximity to institutionalized musical education (i.e., conservatories).[4]

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the art of composition, which, at least until the rise of computing, has only required a pen, paper, and brain.

[3]There are other ways one could measure composer prominence, for instance, how frequently a composer's music is streamed online, or expert rankings by musicologists. However, these alternative approaches are unlikely to allow us to say much about women, which is an advantage of *Grove*. It is noteworthy, for instance, that there are no women in Murray's list of the top 500 composers of all time (Murray, 2003).

[4]We are not the first to suspect that the gender gap among composers is rooted in human capital formation. In his celebrated essay, *The Subjection of Women*, John Stuart Mill speculated that the paucity of notable female composers could be attributed to women receiving inadequate training in music theory. According to Mill, "Women are taught music, but not for the purpose of composing, only for executing it: and accordingly, it is only as composers, that men... are superior to women... But even this natural gift [for composition], to be made available for great creations, requires study, and professional devotion to the pursuit.... [T]he men who are acquainted with the principles of musical composition must be counted by hundreds, or more probably by

This analysis of the causes of the gender gap draws on data from three sources: information on parental musical background and composers' birthplaces, birthdays, and death dates from *Grove* biographical entries, data on student-teacher linkages from Pfitzinger (2017), and details about the location and founding dates of conservatories provided by the International Directory of Music and Music Education Institutions (henceforth IDMMEI).

Our exploration begins with families. Throughout history, parents have been an important, if not primary, conduit for the transmission of human capital (see, for instance, De la Croix and Goñi (2021)). This is especially the case in music, where a child's first exposure likely occurs within the home. However, given historical gender norms, a parent's willingness to invest in a child's musical education may depend on the gender of the child, or, for that matter, on the gender of the parent who possesses a musical background. Accordingly, it is worth asking whether female composers were more or less likely to have musician-parents; whether having musician-parents raises a composer's subsequent prominence; whether male or female composers benefit more from musician-parents; and, finally, whether musician-mothers are especially helpful for female composers.[5]

Because the likelihood we have any information on whether a composer has a musician-parent is increasing in the length of a composer's biographical entry in *Grove*, and because male composers have, on average, longer entries than female composers, a naive comparison based on the full sample of composers is likely to over-estimate the extent to which male composers have musician-parents relative to female composers, which would in turn bias our estimate of the impact of musician-parents on composers' prominence. To address this selection problem, we use propensity scores to create a matched sample of male and female composers who have biographical entries of similar length (and, therefore, have a similar likelihood of reporting information on parents' musical backgrounds). Analyzing this matched sample, we uncover the following results. First, while male and female composers were equally likely

thousands, the women barely by scores: so that here again, on the doctrine of averages, we cannot reasonably expect to see more than one eminent women to fifty eminent men." See Mill 1869, p. 134-136.

[5]Gates (1997) notes that, prior to the acceptance of women within conservatories, only three groups of women had adequate musical instruction to become composers: nuns, those born into wealth or the aristocracy, and those who had musician parents who were equally willing to invest in the training of their sons and daughters.

to have musician-fathers, female composers were three times more likely to have musician-mothers than male composers, suggesting that mothers were important in developing female talent in composition. Second, composers with musician-parents (musician-mothers, in particular) enjoy an economically substantial premium in terms of their measured prominence in *Grove*, underscoring the key role of the family for the transmission of musical human capital.[6] Third, female composers do not benefit relative to male composers in terms of their measured prominence if they have a musician-parent, or if their musician-parent is their mother. Accordingly, our evidence suggests that musician-parents, and musician-mothers in particular, do not narrow the gender gap in composer prominence, although mothers appear to play a role in determining whether their daughters become composers.

We next turn to teachers. A large body of evidence shows that teachers play a significant role in the formation of human capital (see, for instance, Hanushek et al. (2019); Chetty et al. (2014); Rivkin et al. (2005)). However, for a variety of reasons, including gender discrimination and cultural biases, men and women have not enjoyed equal access to teachers throughout history.[7] It is therefore worth asking if gender differences in access to composition teachers are related to the gender gap. Using data from Pfitzinger (2017) that traces the lineage between composers and their students, we establish the following. First, female composers had more teachers than male counterparts, but they were not disadvantaged with respect to their access to teacher quality. Second, as also documented by Borowiecki et al. (2023), teacher quality matters for musical composition. We find that composers who had access to more and better teachers themselves became more prominent, but the benefits were attenuated for female students.[8] Third, female composer-teachers do not narrow the gender gap.

Over time, formal institutionalized education (i.e., schooling) has become increasingly im-

[6]We are agnostic about whether this reflects the role of environment or genetics. Having a musician-parent increases musical exposure and also increases the likelihood of inheriting musical genes.

[7]For instance, Amy Beach (1867-1944), née Cheney, was prohibited by her husband from having a composition tutor. Beach was only 18 years old when she married and was still developing her skills in composition. Accordingly, she was largely self-taught (Block, 2000).

[8]Female composition students may have had too many teachers than optimal, perhaps because their relationships with their teachers were more likely to be ad hoc on account of prevailing gender norms that discouraged significant investments in female talent. For similar reasons, it seems possible that the best composition teachers, who had the opportunity to teach the very best students of both genders, may have preferred to invest in their male students.

portant in building human capital. This is also the case for music, where musical training shifted away from households and informal networks towards conservatories, especially since the nineteenth century (Weber et al., 2001). Conservatories, however, have not always welcomed women; the Paris Conservatory, for instance, did not permit its female students to enroll in composition classes.[9] Additionally, parents were sometimes unwilling to allow their musical daughters to enroll in conservatories.[10] Nevertheless, the presence of a conservatory might still benefit women in the vicinity if it attracts composition professors who also teach privately.[11] We investigate how the rise of conservatories is related to composer prominence, and whether the relationships were different for male and female composers, using composers' geographic and temporal proximity to conservatories to proxy for being exposed to one. Our strategy involves comparing the change in average prominence and the change in the gender gap (in terms of female versus male prominence and female representation) among two groups of composers–those born near a conservatory and those born farther away–across two cohorts–composers born during the 20 years before the opening of the conservatory and those born during the 20 years after. Our findings suggest that conservatories matter. The opening of a conservatory is correlated with an increase in the average prominence of composers born near the conservatory relative to those born farther away, an increase in the prominence of female composers relative to male composers, and a reduction in the representation of female composers relative to male composers. The institutionalization of music education in conservatories may therefore have increased composer quality and also contributed to narrowing the gender gap in composer prominence at the expense of female representation.

We finally turn to the downstream consequences of the gender gap, focusing on the impact of being a female on the number and quality of composition students she attracts, and the likelihood of adopting a pseudonym. We find no correlation between a composer's gender

[9]For instance, Louise Farrenc (1804-1875) was prohibited from enrolling in composition classes at the Paris Conservatory. In 1842 Farrenc became a professor of piano at the Conservatory, but was not permitted to teach composition in the school (Wehrich, 2024b). Gates (2006) discusses the barriers women faced in German conservatories.

[10]The parents of Cécile Chaminade (1857-1944), for example, forbid her from studying at the Paris Conservatory (Wehrich, 2024a; Citron, 1988).

[11]At the age of 15, Farrenc began private studies in composition with the Czech-born Anton Reicha (1770-1836), who taught at the Paris Conservatory. A friend of Beethoven's, Reicha's students included Franz Liszt, Hector Berlioz, César Franck, and Pauline Viardot (Wehrich, 2024b; Friedland, 2001).

and the number or quality of her composition students, controlling for teacher prominence. However, female composers were more likely to adopt pseudonyms than male composers, and especially likely to adopt opposite-gender pseudonyms. Accordingly the need to overcome discrimination in the market for new compositions was likely important to female composers, especially with the rise of music publishing in the nineteenth century.[12]

Before proceeding, it is important to clarify the scope and limitations of this study. First, *Grove* is not a timeless nor flawless source of information about composers. Entries within *Grove* are periodically updated, and, as such, they reflect scholars' current views about the significance of individual composers, which, while highly persistent, are not static. If one were to base this study on an earlier edition, the relative status enjoyed by some composers would be slightly different, and the share of female composers included would be somewhat smaller.[13] Second, while our data set includes a large number of composers, we have limited information about their individual characteristics. Accordingly, our estimate of the gender gap should not be interpreted in the same way that it is in modern labor market studies that can adjust for more covariates. Third, non-economic forces like social norms or historical prejudices concerning the role of women undoubtedly matter for understanding classical composer gender gap.[14] We cannot control for these influences, but we do condition the interpretation of our findings in light of them. Finally, when it comes to the factors that we do investigate, we hesitate to make strong causal claims since our data are non-experimental, what variation that we have (e.g., the matching of students to teachers, and the timing and location of conservatories) is noisy indeed, and we can hold constant relatively few confounding variables. The value of this study lies in the fact that it is the first serious quantitative analysis of women

[12]In order to get her music published, Fanny Hensel (1805-1847), née Mendelssohn, passed off some of her compositions under her brother's name (Felix). Other famous examples include Mélanie Bonis (1858-1937), who published as Mel Bonis, and Augusta Holmès (1847-1903) whose early work was printed under the name Hermann Zenta. See Todd (2009); Myers (1967); Géliot (2009).

[13]Another often levied criticism of *Grove* is that it over-emphasizes composers from the United Kingdom. See, for instance, O'Hagan and Borowiecki (2010).

[14]For instance, Fanny Hensel's father, Abraham Mendelssohn, was tolerant but not supportive of his daughter's desire to compose. In an often quoted letter, he wrote to his daughter, "Music will perhaps become his [Felix's] profession, while for you it can and must be only an ornament" (see letter of 16 July 1820 in Hensel 1884, p. 82). Music historian Richard Taruskin has argued that Hensel's life is "compelling proof that women's failure to 'compete' with men on the compositional playing-field has been the result of social prejudice and patriarchal mores." See Taruskin 2006, p. 186. Alas, Hensel is unlikely to be unique in this respect.

composers, that it sheds some, albeit faint, light on the factors that may have disadvantaged them, and that it speaks to larger historical issues concerning the role of families, teachers, and institutions in shaping an important realm of human achievement.

The remainder of this paper is structured as follows. In Section 2 we review the related literature. Section 3 concerns our data sources. We discuss the use of the length of biographical entries as a metric for composer prominence, outline our procedures for coding composer gender and pseudonym use, and show the growth of conservatories over time. Section 4 presents descriptive statistics on the *Grove* and Pfitzinger (2017) samples of composers. In Section 5 we present empirical estimates of the gender gap, controlling for composers' country and half-century of birth. Section 6 follows with our empirical exploration of the various factors (families, teachers, and conservatories) that influence the extent of the gender gap. We then discuss some of the downstream consequences of the gender gap in Section 7 and conclude.

2 Related literature

Our work contributes to the large literature in economics on labor market gender gaps (for an overview, see Blau and Kahn (2017)). In addition to measuring gender gaps in wages and labor force participation in different countries and time periods, scholars have investigated the role of discrimination (e.g., Aigner and Cain (1977); Becker (1957)), sex segregation (e.g., Bayard et al. (2003)), access to birth control (e.g., Goldin and Katz (2002); Bailey (2006)), labor regulations (e.g., Goldin (1990, 1988)), occupational characteristics (e.g., Goldin (2021)), and other factors in explaining the gap. A more recent body of work to which our work relates examines gender gaps in high human capital intensive occupations over time. Iaria et al. (2022), for instance, investigate the gender gap among university faculty over the twentieth century. Card et al. (2023, 2022) analyze gender gaps in peer recognition in science. We add to this vein of scholarship by documenting the gender gap in a different domain (musical composition), using a different approach (the length of composers' biographical entries in *Grove*) and over a much longer time horizon (several centuries) than previous studies.

We also add to the literature on the role of teachers in narrowing the gender gap. In the context of K-12 education, several studies examine the effect of being assigned a "teacher like me" (along gender or racial lines) on student learning outcomes. Many of these studies report favorable effects. Dee (2007), for instance, finds that matching students to teachers of the same gender results in improved academic performance (for both male and female students) as well as improved teacher perception of student performance and engagement. Female teachers also narrow the gender gap in K-12 student performance (Winters et al., 2013; Muralidharan and Sheth, 2016). We extend this literature to a new setting, looking at the impact of same-gender matching on composer prominence. Unlike these studies, however, we do not find evidence that same-gender matching improves student outcomes, nor that female teachers are more effective than male ones in reducing the gender gap in composer prominence. However, we caution that our findings are not directly comparable, since the assignment of composition students to teachers is not random.

We contribute to a growing body of quantitative scholarship on "famous people"–inventors, academics, artists, and other creative individuals–who represent the far right tail of human talent and accomplishment. Among other things, these studies find that famous people are geographically mobile, tend to cluster geographically, are more likely to be from high income families, benefit from early exposure to their craft (either through their families or their proximity to others), and experienced improvements in longevity in advance of the general population (see, for example, Bell et al. (2019); De la Croix et al. (2023); De la Croix and Goñi (2021); De la Croix and Licandro (2015); Serafinelli and Tabellini (2022)). In line with these studies, we show how family background and proximity to other creatives–via teachers or conservatories–matter for composer greatness. However, we go beyond this to investigate whether the importance of these factors varies by gender.

Methodologically, this paper is related to studies that use biographies as a data source. In economic history, scholars have used biographical data from a wide range of sources–for instance, *Deutsche Biographie*, *Wikipedia*, *Wikidata* and *Freebase.com*–to investigate far-right tail human capital individuals of earlier times (Dittmar and Meisenzahl, 2019; Laouenan et al.,

2022; Yu et al., 2016; Serafinelli and Tabellini, 2022). Biographical data have also been used by cultural economists to study the clustering of visual artists and composers (Kelly and O'Hagan, 2007; O'Hagan and Borowiecki, 2010; Borowiecki, 2013). We extend this literature by adding gender to the analysis to see if the benefits of teacher quality and access were different for female composition students, and whether the gender of the teacher matters. We also go beyond teachers and gather information on composers' parents to investigate if parental musical background matters, and if the effects differ by gender.

Finally, we add directly to the literature on the gender gap in artistic professions (Cowen (1996)). Much of this literature focuses on visual artists (e.g., painters). A large body of research uses auction prices to measure the magnitude of the gender gap, with studies generally finding that the work of female artists is discounted and less likely to appear at auction (see, for instance, de Beyssat et al. (2023); LeBlanc and Sheppard (2022); Bocart et al. (2022); Hoffmann and Coate (2022); Adams et al. (2021)).[15] A smaller set of studies examines gender gaps in classical music performance. Goldin and Rouse (2000) find that the introduction of blind orchestra auditions raises the probability that female musicians advance in the recruitment process. Examining international classical music competitions, Asmat et al. (2023a,b) present evidence suggesting that competition judges are biased against women. We document the gender gap in a new artistic occupational (composers) using a different measure of the gender gap (the gap in terms of prominence). We also go beyond this literature to investigate the downstream consequences of the gender gap in terms of the use of pseudonyms to conceal gender, and whether being a woman affected a composer's ability to attract composition students.

[15]The penalty goes beyond auction prices. Marchenko and Sonnabend (2022) find evidence of a gender gap in the earnings of German artists.

3 Data

3.1 Biographical entries and teacher-student linkages

We obtain our primary source of data on composers by scraping the music encyclopedia *Grove Music Online*, an English-language encyclopedia covering music, musicians, and related topics. This source incorporates and extends the printed volumes of the *New Grove Dictionary of Music and Musicians* and is widely regarded as the most authoritative English-language music encyclopedia.[16] From *Grove* we obtain information about each composer's birth and death places, birth and death dates, nationality, and other known occupations.[17] We then hand-collect information on parents' musical backgrounds and the use of pseudonyms.

Conceptually, the prominence, importance, or quality of a composer should be assessed according to the composer's overall reputation and impact, which, unfortunately, does not have a natural unit of measurement. However, we believe that a composer's prominence as viewed through the lens of posterity can be approximated by the length (in words) of a composer's biographical entry. Entries in *Grove* are written by musicologists whose primary focus is on the musical careers and contributions of their subjects. The length of a musician's biographical entry in *Grove* therefore reflects expert assessment of the subject's significance within music history, with longer entries indicative of greater importance.[18] Not all biographies have a works, writings, or bibliography section. Accordingly, our primary metric for composer prominence or quality will be the length of the composer's main description, which is available for all composers with a *Grove* entry. For a subset of these composers, we can also use the length of their works section to measure their output, which is potentially related to

[16] The *New Grove* is itself a successor to the *Dictionary of Music and Musicians*, the first edition of which was published in four volumes between 1879 and 1889.

[17] *Grove* biographies usually consist of four sections: (1) a section discussing the life and career of the musician (we will refer to this section as the "main description"); 2) a works section listing the subject's musical compositions (a complete listing of known composition for major composers and an outline of their works for lesser-known ones); 3) a writings section listing other works (e.g. books, articles, etc.) written by the subject; and finally, 4) the bibliography which lists the different sources used as references. For a visual overview of the structure of a *Grove* biographical entry, see Figure A1. While all four measures are distinct, they are highly correlated.

[18] Our approach is not unlike a citation study in which scientists are ranked according to how frequently their papers are cited. In a similar spirit, Galenson (2002) compares painters based on how often images of their work appear in leading art history textbooks.

their prominence.[19] Our results are robust to this alternative approach.

We extract data on teacher-student pairings from Pfitzinger (2017), who assembled a musical genealogy of more than 17,000 composers that links each composer with her teachers and her students. The composers included in Pfitzinger (2017) are described as "composers that wrote music in the broader classical tradition" and include academic composers as well as composers writing film music or electronic music. To obtain information about these composers' birthplaces, death places, and other occupations, we merge this data with information from the *Grove* sample of composers. However, not all composers listed in Pfitzinger (2017) have a biographical entry in *Grove*.

3.2 Gender inference

Grove and Pfitzinger (2017) generally do not report a composer's gender. To code gender, we follow a procedure that combines data-driven and manual inference of gender. The process is as follows. We use an *R* package called *gender* (Mullen, 2021) to infer gender based on the first names of each composer in combination with a database of names developed by the World Gender-Name Dictionary (Martínez et al., 2021). This database includes historical data on names from the U.S. Social Security Administration (SSA), U.S. Census (IPUMS), census microdata created by the North Atlantic Population Project (NAPP), and the Kantrowitz name corpus. SSA, IPUMS, and NAPP also report the fraction of females and males with each name. We assign a gender to a name-nationality combination if each of these three sources agree on the classification (male or female) at the 95 percent confidence level. The name-nationality combinations that remain unclassified at this point are then considered case-by-case. In some of these instances, gender classification is obvious.[20] For those cases in which it is not, we infer gender using online sources, including *Grove*, *Wikipedia*, and other resources.

[19] The true correlation between prominence and output is likely positive but not perfect. Bach, Schubert, and Mozart were prolific and important. On the other hand, the reputation of other composers often rests entirely on a single work. For instance, Pietro Mascagni (1863-1945) is known almost exclusively for *Cavalliera rusticana*, a one-act opera, while Carl Orff's (1895-1982) acclaim is heavily based on the cantata *Carmina Burana*. These "one-note wonders" weaken the correlation.

[20] For example, Mohammed from Egypt is classified as male, while Georgina from the United Kingdom is classified as female.

3.3 Pseudonyms

We manually extract information on composers' pseudonyms from *Grove* and find that one percent of composers the *Grove* sample used a pseudonym. In addition to recording the pseudonym(s), we classify each composer's pseudonym as male, female, or gender neutral.[21]

3.4 Music conservatories

Data on music conservatories are taken from the International Directory of Music & Music Education Institutions (Bartle, 2023). From IDMMEI, we collect the name, country, state, and city of each conservatory and extract information about the founding date of each conservatory by reading each conservatory's description. The resulting data set consists of 2,174 conservatory observations, each of which we geocode. Figure A2 shows spread of conservatories over time within Europe, which houses the bulk of conservatories. Before the nineteenth century, there were few conservatories, and the earliest ones were primarily located in southern and central Europe. Consistent with other qualitative accounts (e.g., Weber et al. (2001)), we provide quantitative evidence showing that that the number of conservatories grew rapidly in the nineteenth century, with conservatories being established in nearly all parts of Europe during that period.

4 Descriptive statistics

Table 1 presents an overview of the key variables we collect from the *Grove* and Pfitzinger (2017) samples. The Pfitzinger (2017) sample is slightly larger than the *Grove* sample (17,390 composers versus 15,637 composers), reflecting the fact that there are composers listed in the first source that do not have entries in the second. However, the female fraction of composers is similar in both samples of composers (8 percent in Pfitzinger (2017) versus 6 percent in *Grove*). Additionally, there are some differences in the average birth and death years across the two samples, with the Pfitzinger (2017) sample representing a somewhat more recent

[21] When a composer employs multiple pseudonyms, we classify the types of pseudonyms based on the predominant gender of the pseudonyms.

group of composers than the *Grove* sample.

Table 1: Summary statistics

	Sample					
	Pfitzinger (2017)			Grove		
Variable	Obs.	Mean	SD	Obs.	Mean	SD
Female	17,390	0.08	0.27	15,637	0.06	0.24
Born	17,271	1,882.42	99.41	13,737	1,815.88	138.86
Died	10,666	1,909.97	108.65	10,818	1,831.62	148.84
No. students	7,746	4.76	11.33	-	-	-
No. teachers	17,316	2.13	2.03	-	-	-
Teacher qual.	11,752	1,707.10	3,341.19	-	-	-
Pseudonym	-	-	-	15,707	0.01	0.10
Occupations						
Composer	7,537	1.00	0.05	15,707	0.98	0.15
Conductor	7,537	0.15	0.36	15,707	0.10	0.30
Teacher	7,537	0.13	0.33	15,707	0.08	0.27
Pianist	7,537	0.11	0.31	15,707	0.10	0.30
Organist	7,537	0.09	0.29	15,707	0.10	0.30
Violinist	7,537	0.06	0.23	15,707	0.05	0.22
Singer	7,537	0.02	0.15	15,707	0.05	0.21
Word counts						
Main desc.	7,537	663.67	1,752.18	15,707	461.18	1,260.76
Works	7,537	388.50	1,156.45	15,707	233.58	839.32
Bibliography	7,537	149.25	670.40	15,707	101.81	466.41
Writings	7,537	19.04	66.97	15,707	12.01	52.58

Notes: This table shows the number of observations, the average values, and standard deviation (SD) for variables in the Pfitzinger (2017) and *Grove* samples. 'Teacher qual.' is the average number of words in the main description of the teachers of a given composer.

Full information on composers' other reported occupations and biographical entries is available for 15,707 composers in *Grove* and 7,537 composers in Pfitzinger (2017). The composers in the Pfitzinger (2017) sample for which we have full information are more distinguished; the average length of a main description entry in the Pfitzinger (2017) sample is 664 words, versus 461 words in *Grove*. Additionally the composers in the Pfitzinger (2017) sample have longer entries discussing their output and other writings. However, in terms of the frequency of composers' other reported occupations, the two samples are roughly similar.

How do male and female composers compare? A preliminary glimpse is provided by Table 2, which lists the ten most prominent male and female composers, using the word

count of composers' main descriptions in *Grove* to measure prominence. While the ten most prominent male composers will likely be familiar to most laypersons, we suspect relatively few will recognize the ten most prominent women, with perhaps the exceptions of Clara Schumann (1819-1896), née Wieck, who was married to Robert Schumann and is primarily known as a concert pianist, and possibly Dame Ethel Smyth (1858-1944), who was a key member of the UK women's suffrage movement. It is also worth noting that the biographical entries of the top-10 male composers are approximately 20 times longer than those of the top-10 female composers, implying an enormous (95 percent) gender gap in prominence in the extreme far right tail of composers.

Table 2: Top 10 most prominent composers by gender

Male composers		Female composers	
Name	Word count	Name	Word count
Ludwig van Beethoven	42,011	Clara Schumann	2,358
Johann Sebastian Bach	39,533	Hildegard of Bingen	1,998
Joseph Haydn	32,325	Dame Ethel Smyth	1,852
Robert Schumann	29,997	Elisabeth Lutyens	1,594
George Frederic Handel	29,560	Amy Marcy Beach	1,589
Wolfgang Amadeus Mozart	27,670	Francesca Caccini	1,406
Antonio Vivaldi	25,699	Thea Musgrave	1,318
Hugo Wolf	25,699	Pauline Viardot	1,315
Igor Stravinsky	24,703	Rebecca Clarke	1,126
Franz Liszt	24,370	Ruth Crawford	1,058

Notes: Prominence is measured by the number of words in the main description section of a composers' biographical entry in *Grove*.

More complete evidence of the differences between male and female composers is provided by Table A1, which displays summary statistics by gender for the Pfitzinger (2017) and *Grove* samples. As established by the t-tests, for all four components of composers' biographical entries, the entries of male composers are significantly longer than the entries of female composers. Focusing on the *Grove* sample, the gap in the word counts of the main description section of male and female composer's entries is 47 percent; the magnitude of the raw gender gap remains substantial when looking at a broader sample of composers.

Male and female composers are also different from each other in terms their other occupations as reported in *Grove*. Male composers are more likely to have been conductors,

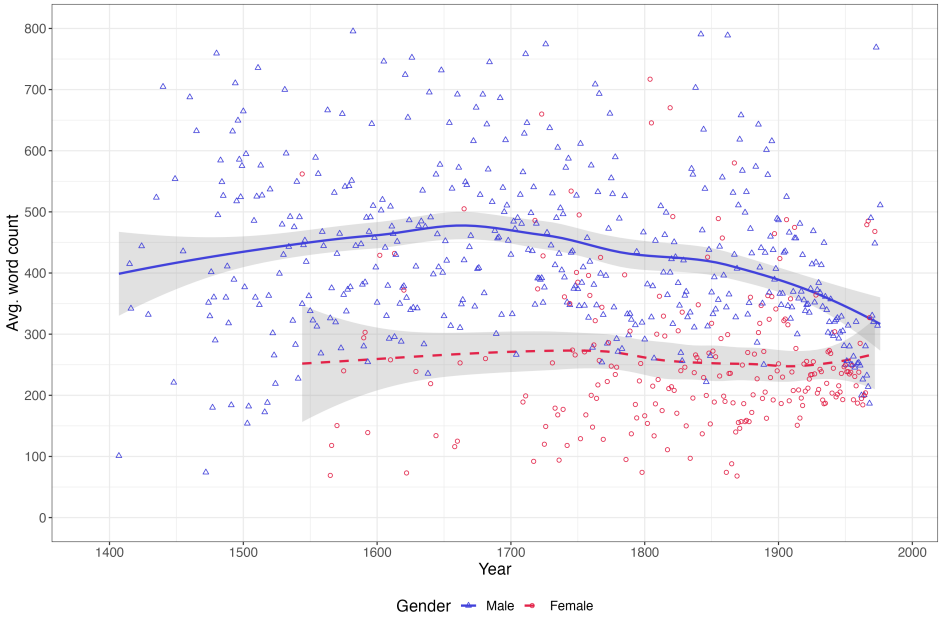
violinists, and organists, while female composers are more likely to have been pianists and singers. These differences are shared by both samples. In the Pfitzinger (2017) sample we can also compare male and female composers in terms of the number of teachers that they had, the quality of their teachers, and the number of students they taught. As students, female composers had more teachers than their male counterparts, but male composers had higher quality teachers on average. As teachers, male and female composers had a similar number of students.

Having established a raw gender gap between male and female composers in terms of their prominence, it is worth asking if the size of the gender gap in prominence has changed over time. Figure 1 plots the average word count of composers' main descriptions in *Grove* by gender and birth year from the fifteenth century until the end of the twentieth. Across all periods, male composers, on average, have longer biographical entries in *Grove* than female composers. However, the average prominence of male composers has declined since 1700, while the average prominence of female composers has remained relatively flat. Accordingly, the magnitude of the raw gender gap in composer prominence has narrowed with time.

We also use our data to trace the representation of female composers over time. To do this, we bin composer birth years into 50 year intervals and compute the share of composers born within each 50 year interval who are female. Figure 2 plots these series for the *Grove* and Pfitzinger (2017) samples from 1250 to 2000. There are some divergences in the two series, but the overall trend is similar regardless of the sample. While female composers are underrepresented in all periods, the female share of composers increased dramatically beginning in the eighteenth century, reaching approximately 15 percent by the 1950 for the *Grove* sample and almost 20 percent by 2000 for the Pfitzinger (2017) sample.

We next use our data to track where composers were born, whether there are differences by gender, and how this may have changed over time. Figure 3 displays the spatial distribution of male and female composers within Europe (where the lion's share–approximately 80 percent–of the composers in our sample were born), categorized according to their birth location and century of birth from the sixteenth to the twentieth centuries. As shown in Panel (a), in

Figure 1: Avg. word count over time

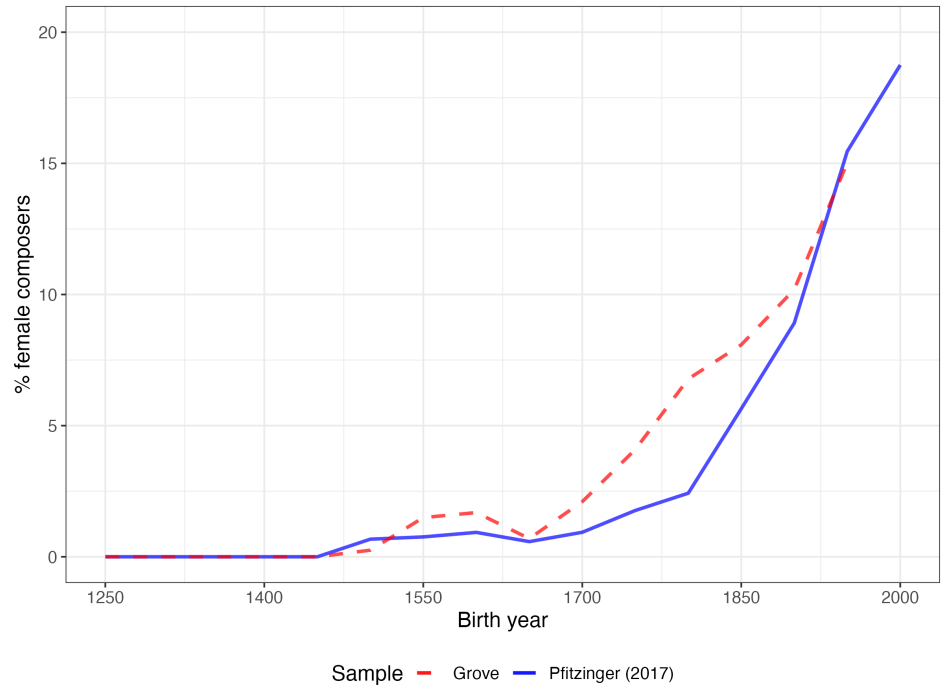


Notes: This figure depicts the average word count of composers' main description on *Grove* by gender and birth year. The average word count of male composers in a given year is shown as a triangle, while that of female composers is depicted as a circle. The best fit lines are estimated using local polynomial regression.

the sixteenth century, male composers were primarily from central and southern Europe. In subsequent centuries, the birth locations of male composers spread outward, gravitating to northern and eastern European countries. Panel (b) shows that the birth locations of female composers follow the same pattern as male composers, beginning in the southern and central Europe and spreading east and north with time. However, the process was delayed for female composers. Going beyond composers from Europe, Figure A3 presents the spatial distribution of male and female composer births in the United States from the eighteenth to the twentieth centuries (composers from the U.S. comprise 14 percent of the sample). For both male and female composers, birth locations are primarily in the northeast in the eighteenth century and gradually spread south and west in subsequent centuries.

Finally, Figure 4 depicts the correlation between teacher and student prominence divided into male-female panels using the Pfitzinger (2017) sample of composers. In all plots there is a positive relationship between teacher and student prominence. However, because there are few female teachers in the sample, the relationships, while steeper, are not statistically

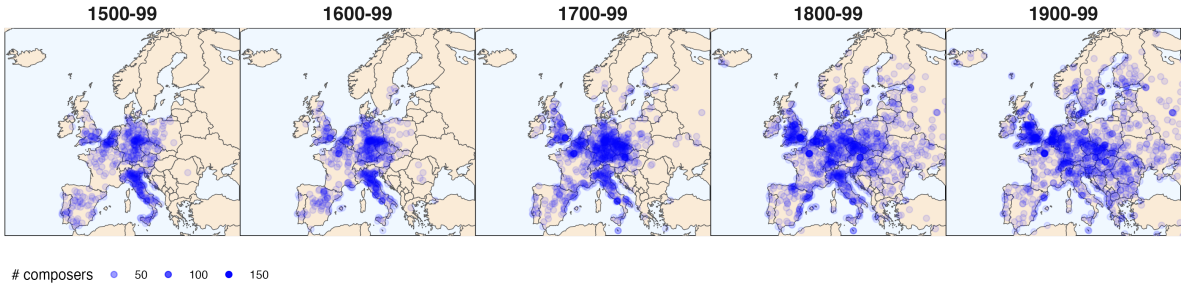
Figure 2: Fraction of female composers over time



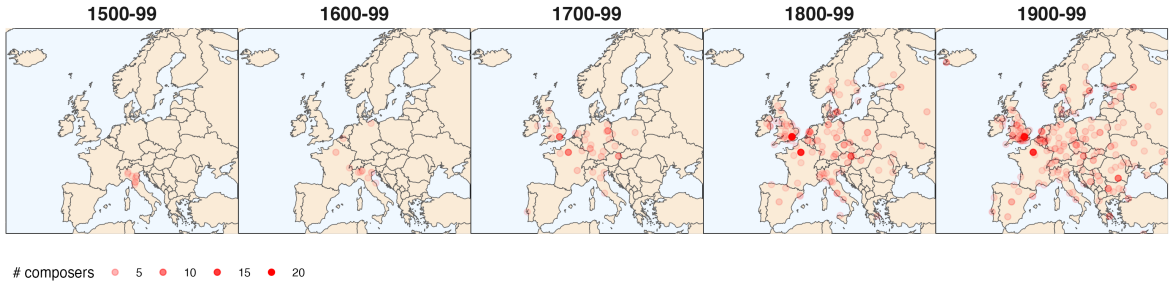
Notes: This figure depicts the share of female composers in the sample. Birth years are binned in 50-year intervals. Years before 1250 are excluded as the number of observations is too small.

Figure 3: Number of composers by gender, Europe

(a) Male composers



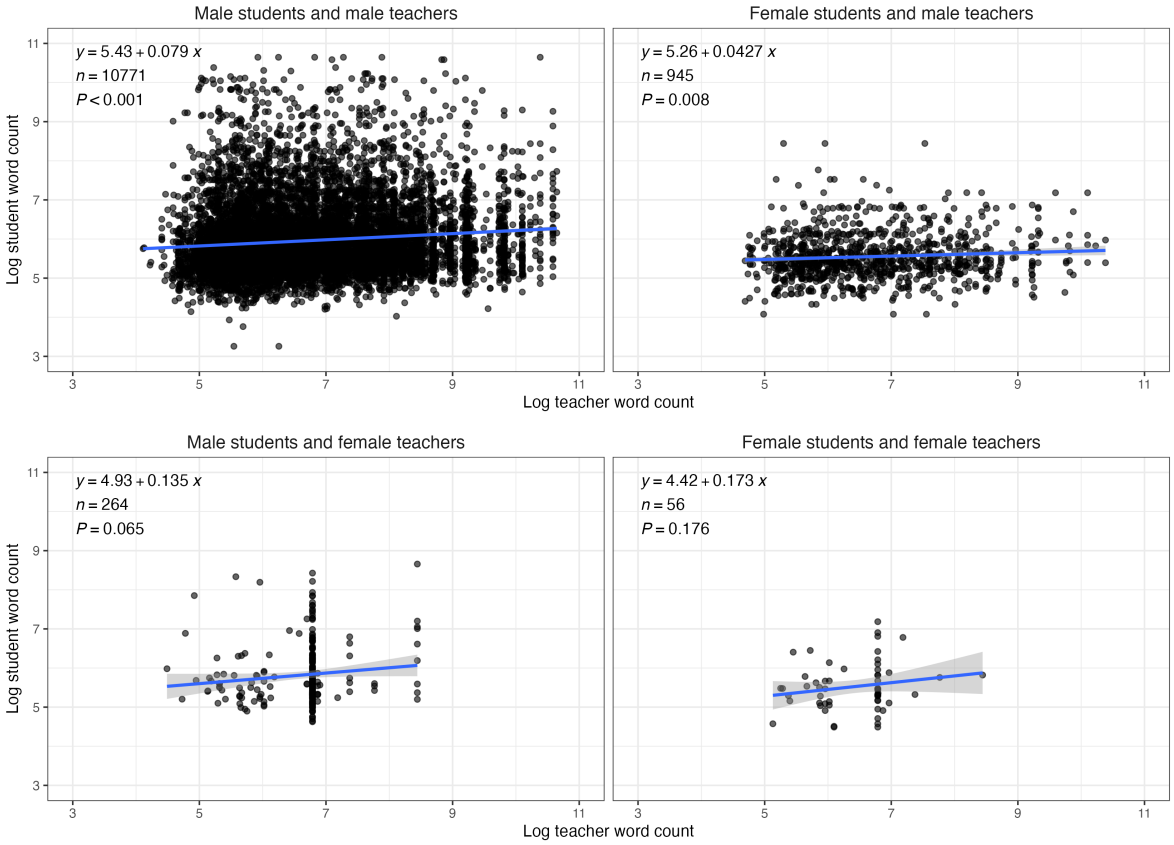
(b) Female composers



Notes: This figure shows the spatial distribution of birth locations of composers in the Pfitzinger (2017) sample by gender in Europe. Each dot represents a city. Darker dots indicate a higher concentration of composers.

significant in the bottom two panels.

Figure 4: Student/teacher quality correlation



Notes: This figure depicts the correlation between the length of student's word count and the word count of their respective teachers' *Grove* biographies.

5 Regression estimates of the extent of the gender gap

Comparing means, the data show a raw gender gap in composer prominence of 47 percent. However, as discussed earlier, there are important differences between male and female composers in terms of when and where they were born. If the time or location of a composer's birth is correlated with composer prominence, our estimate of the magnitude of the gender gap will be biased. This could easily be the case. Posterity does not judge the work of composers who lived in different eras equally; romantic era music from the nineteenth century receives more attention than the works of mid-twentieth century atonal composers or Rococo

composers of the mid-eighteenth century. Additionally, there is geographic variation in what is known and admired; in general, composers from the German-speaking world are more acclaimed than their Spanish-speaking counterparts. Accordingly, it is important to adjust for these factors in our estimate of the gender gap.

Our approach therefore involves estimating the following equation using ordinary least squares using the *Grove* sample of composers:

$$ln(word\ count)_i = \beta_0 + \beta_1(female_i) + \gamma_i + \delta_t + \epsilon_i \tag{1}$$

In this regression, the dependent variable, $ln(word\ count)_i$ is the natural logarithm of the number of words in the main description section of the *Grove* entry of composer i; $female_i$ is a binary indicator equal to one if composer i is female and zero otherwise; γ_i and δ_t are country of birth, and half-century of birth fixed effects; and ϵ_i is an error term. The coefficient of interest in this regression is β_1, which is our estimate of the gender gap in prominence between male and female composers, adjusting for time period and country of birth. In addition to estimating equation (1), on the full sample of composers in *Grove*, we also run regressions using sub-samples based on region, using the UN M49 standard to classify regions. This allows us to see if there are differences in the magnitude of the gender gap among composers from different parts of the world (e.g., Europe versus North America).

Table 3 displays coefficient estimates from equation (1). Column (1) uses the full sample of composers. The estimate of β_1 in the full sample indicates that, holding constant time and country of birth, the main description of female composers is $(e^{(-0.296)} - 1) \times 100 \approx 25.6$ percent shorter than the main description of male composers. Recall that the raw (unadjusted) gender gap in the *Grove* sample is 47 percent. Accordingly, while the magnitude of the gap in prominence remains large, it narrows substantially (by almost half) when we account for the fact that female composers are represented differently across different eras and countries.

Columns (2)-(7) display coefficient estimates of equation (1) using sub-samples of composers born in different regions. There is a statistically significant gender gap in all regions except Africa. However, the magnitude of the gap varies by region. The gender gap in promi-

nence is largest among European and Latin American composers (over 29 percent in each case), smaller for North American and Asian composers (16.6 percent in both cases), and slightly smaller for composers born in Oceania (15.8 percent).

For a subset of the composers in *Grove* we also have the word counts of the works section of their entries, which is a proxy for their output. Since prominence and output may be related, it is worth estimating the magnitude of the gender gap using this alternative metric.[22] To do this we re-estimate equation (1) using the natural log of the word count of a composer's *Grove* entry as the dependent variable. As before, we run these regressions using the full sample, as well as regional sub-samples.

The results from this exercise are displayed in Table 4. For the full sample (column 1), the coefficient indicates a gender gap of 15.3 percent. As before, there is substantial regional variation. The gender gap in output is largest (almost 26 percent) among European composers. In contrast, North American female composers enjoy a premium of roughly 12 percent. However, we note that coefficient in this instance is only marginally significant (at the 10 percent level). The estimated coefficients in columns (4) to (7) are all insignificant, implying that among Latin American, Asian, Oceanan, and African composers, the gender difference in output is indistinguishable from zero.

Table 3: Gender gap in prominence by region

	Dependent variable: ln word count (main desc.)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Female	-0.296^{***}	-0.354^{***}	-0.182^{***}	-0.345^{***}	-0.182^{***}	-0.172^{***}	-0.003
	(0.036)	(0.033)	(0.003)	(0.068)	(0.055)	(0.013)	(0.181)
Country FE	✓	✓	✓	✓	✓	✓	✓
Half-century FE	✓	✓	✓	✓	✓	✓	✓
Sample	All	Europe	N. America	L. America	Asia	Oceania	Africa
Observations	13162	10140	1781	544	473	122	101
Adjusted R^2	0.064	0.065	0.030	0.069	0.104	0.080	0.091

Notes: Standard errors are clustered at the country level. N. America denotes Northern America (US, Canada and Bermuda), while L. America denotes Latin America and the Caribbean.
Significance levels: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

[22] As mentioned earlier, the works section of *Grove* entries lists all known works for important composers, and summarizes works for less important ones. Accordingly, the word count of this section is an imperfect proxy for a composer's total production since it likely underestimates the output of lesser composers.

Table 4: Gender gap in output by region

	Dependent variable: ln word count (works)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Female	-0.166^{**}	-0.299^{***}	0.114^{*}	-0.180	-0.064	0.021	0.239
	(0.074)	(0.055)	(0.011)	(0.234)	(0.078)	(0.204)	(0.162)
Country FE	✓	✓	✓	✓	✓	✓	✓
Half-century FE	✓	✓	✓	✓	✓	✓	✓
Sample	All	Europe	N. America	L. America	Asia	Oceania	Africa
Observations	9359	7235	1231	376	346	105	65
Adjusted R^2	0.053	0.052	0.007	0.066	0.045	-0.009	0.104

Notes: Standard errors are clustered at the country level. N. America denotes Northern America (US, Canada and Bermuda), while L. America denotes Latin America and the Caribbean.
Significance levels: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

A composer's prominence may also depend on what other occupations she is known to have had. Accordingly, it is worth re-estimating the gender gap restricting attention to composers who are reported to have the same other (non-composer) occupation in *Grove*. We focus attention on composers' five most frequently reported other occupations—conductor, pianist, organist, violinist, and singer—and estimate equation (1) separately for sub-samples of composers who are reported to have had each of these other occupations.

The results are shown in Table 5. In columns (1) through (5) the dependent variable is the log word count of a composer's main description; in columns (6) through (10) it is the log word count of a composer's works section. Focusing on our primary measure of prominence, the estimates indicate a gender gap among composer-pianists, composer-conductors, and composer-singers of approximately 28 percent, 19 percent, and 17 respectively. For composer-organists and composer-violinists, there is no statistically significant gender gap. Additionally, we find no statistically significant gender gap among composers with different occupations when we use the word count of a composer's works section as the dependent variable.

Table 5: Gender gap in prominence/output by occupation

	Dependent variable									
	ln word count (main desc.)					ln word count (works)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Female	−0.214**	−0.325***	−0.205	0.195	−0.188**	−0.206	−0.147	0.008	0.422	−0.422
	(0.085)	(0.053)	(0.124)	(0.197)	(0.081)	(0.158)	(0.138)	(0.411)	(0.299)	(0.262)
Country FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Half-century FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Occupation	Conductor	Pianist	Organist	Violinist	Singer	Conductor	Pianist	Organist	Violinist	Singer
Observations	1565	1516	1245	719	560	1068	1010	746	439	271
Adjusted R^2	0.029	0.067	0.062	0.055	0.074	0.054	0.090	0.002	0.092	0.157

Notes: Standard errors are clustered at the country level.
Significance levels: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

6 Explaining the gender gap

6.1 Family musical background

We now turn to an exploration of the factors driving the gender gap among composers. Because exposure to music generally starts at home, we first focus on the family, with specific attention to the role of musician-parents. As discussed earlier, parents' willingness to invest in their child's musical training may depend on the gender of the child, the gender of the parent with the musical-background, or some interaction of the two. The goal here is to determine how these factors are related to the gender gap between male and female composers.

Our source of information on whether a composer has musician parents is a composer's biographical entry in *Grove*. This creates a selection problem because whether or not any information on parents is provided in *Grove* is positively related to the length of a composer's biographical entry (i.e., longer biographical entries are more likely to disclose information about musicians-parents than shorter entries). Because male composers have longer biographies than female composers, the presence of musician-parents is likely to be over-estimated for male composers relative to female composers. This may, in turn, bias estimates of any gender differences in the consequences of having musician-parents.

To address this selection problem, we create a matched sample of comparable male and female composers by extracting the propensity scores from the following selection equation estimated using the Pfitzinger (2017) sample of composers:

$$P(female_i = 1|X) = \beta_0 + \beta_1 main\ description_i + \beta_2 works_i + \beta_3 birth\ year_i + \epsilon_i \quad (2)$$

In this equation, $main\ description_i$ is the number of words in the main description of the *Grove* entry of composer i, and $works_i$ is the number of words in the works section of composer i. We then extract the propensity scores for male and female composers and match based on the respective length of their *main description* and *works* section in *Grove*, as well as their birth year. The resulting sample consists of 888 composers (444 male and 444 female).

We then read the *Grove* entries of each of the 888 composers to obtain information on whether they come from a family of musicians (i.e., if a composer's *Grove* entry mentions a musician-mother or musician-father). Table A2 presents summary statistics for the matched sample. As indicated by the t-statistics reported in the table, male and female composers in the matched sample are similar in terms of birth and death years and the length of their biographies, which is as intended. However, male and female composers still differ along other margins. In common with the full (un-matched) sample, male composers in the matched sample are more likely to have also been conductors, organists and violinists, while female composers are more likely also have been pianists, and singers.

Using this matched sample, we first investigate whether male and female composers differ in their likelihood of having musician-parents. To do this, we estimate a linear probability regression model where the dependent variable is an indicator equal to one if composer i has musician parents (either musician-mother or musician-father) and the explanatory variable is an indicator equal to one if composer i is female. We estimate this equation with and without fixed effects for a composer's half-century and country of birth. The coefficient on the female indicator tells us if female composers were more or less likely to have musician-mothers or musician-fathers than their male counterparts.

The results from this regression are shown in columns (1) through (4) of Table 6. In the first two columns, the dependent variable is an indicator for whether a composer has a musician-mother; in the next two columns, the dependent variable is an indicator for a

Table 6: Gender differences in composers' family background and teacher access

	Dependent variable							
	Mother musician		Father musician		Num. teachers		ln mean teacher prom.	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female	0.056***	0.060***	−0.002	−0.002	0.724***	0.225*	−0.024***	0.061
	(0.016)	(0.014)	(0.020)	(0.022)	(0.075)	(0.123)	(0.054)	(0.064)
Country FE		✓		✓		✓		✓
Half-century FE		✓		✓		✓		✓
Observations	888	888	888	888	7539	7505	5548	5542
Adjusted R^2	0.014	0.005	−0.001	0.121	0.012	0.192	−0.000	0.066

Notes: Standard errors are clustered at the country level.
Significance levels: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

musician-father. The coefficient estimates indicate that while male and female composers were equally likely to have musician-fathers, female composers were a statistically significant 6 percentage points more likely to have musician-mothers than male composers. Given that only 3 percent of male composers had composer-mother, female composers were three times more likely to have a musician-mother than male composers. Musician-mothers may therefore have been especially important in nurturing female musical talent.

We next turn to the consequences of musician-parents for composer prominence. To do this, we estimate the following regression:

$$\begin{aligned} ln(word\ count)_i = \beta_0 + \beta_1(female_i) \ &+ \beta_2(mother\ musician) + \\ \beta_3(father\ musician_i) \ &+ \beta_4(female_i) \times (mother\ musician_i) + \\ \beta_5(female_i) \times (father\ musician_i) \ &+ \gamma_i + \delta_t + \epsilon_i \end{aligned} \tag{3}$$

The outcome variable in this equation is the natural logarithm of the word count of composer $i's$ main description; $female_i$ is a binary indicator equal to one if composer i is female; $mother\ musician_i$ and $father\ musician_i$ are binary indicators equal to one if composer i has a musician-mother or musician-father, and the remaining variables are defined as before. If musician-parents are beneficial for a composer's future prominence, β_2 or β_3 should be positive

and statistically significant. The coefficients on the interaction terms (β_4 and β_5) tell us if there are differences by gender. For instance, $\beta_5 > 0$ would suggest that musician-mothers are especially beneficial to composer-daughters. On the other hand, $\beta_4 < 0$ would suggest that musician-fathers are less beneficial for their composer-daughters than their composer-sons.

Coefficient estimates of equation 3 are shown in Table 7. In all regressions, the dependent variable is our measure of composer prominence. In columns (1) and (2) we estimate the effect of having either parent (mother or father) a musician. Columns (3) and (4) control for only musician-mothers; columns (5) and (6) control for only musician-fathers; and columns (7) and (8) control for musician-mothers and musician-fathers separately. The odd numbered columns exclude interactions with gender while the even numbered columns include them.

The coefficients on *parent musician*, *mother musician* and $father\ musician$ in the even-numbered columns are all positive and statistically significant; having a musician-parent is positively related to future prominence, regardless of the gender of composer or parent. In terms of magnitudes, having either musician-parent raises a composer's prominence by 44 percent, having a musician-mother raises prominence by 68 percent, and having a musician father raises prominence by 36 percent. Accordingly, the benefits of coming from a musical family are economically large. Interestingly, the magnitude of the relationship is larger for musician-mothers than musician-fathers, and when we control for them independently in the same regression, the coefficient on musician mother is more than twice as large as the coefficient on musician-father (column 7); mothers may therefore be more important than fathers for the transmission of musical human capital. Finally, the interaction terms reported in the even-numbered columns are positive but imprecisely estimated. Daughters may have benefited disproportionately from having musician-parents, regardless of the gender of the parent with the musical background, but the data are too noisy for us to detect these effects at conventional levels of statistical significance.

Table 7: Family background and composer prominence

	Dependent variable: ln(word count)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female	−0.057	−0.079**	−0.075*	−0.080**	−0.044	−0.058	−0.071*	−0.078**
	(0.041)	(0.039)	(0.038)	(0.037)	(0.042)	(0.041)	(0.039)	(0.039)
Parent musician	0.364***	0.266**						
	(0.081)	(0.102)						
Mother musician			0.519***	0.434***			0.447***	0.343***
			(0.065)	(0.109)			(0.061)	(0.129)
Father musician					0.305***	0.233**	0.185**	0.179
					(0.085)	(0.114)	(0.073)	(0.119)
Female × Parent musician		0.176						
		(0.108)						
Female × Mother musician				0.115				0.137
				(0.139)				(0.177)
Female × Father musician						0.145		0.021
						(0.159)		(0.183)
Country FE	✓	✓	✓	✓	✓	✓	✓	✓
Half-century FE	✓	✓	✓	✓	✓	✓	✓	✓
Observations	888	888	888	888	888	888	888	888
Adjusted R^2	0.144	0.145	0.148	0.147	0.125	0.126	0.155	0.153

Notes: Standard errors are clustered at the country level. All regressions include fixed effects for half-century and country of birth.
Significance levels: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

6.2 The role of teachers

Our exploration next turns to teachers. We first investigate whether access to teachers—in terms of quantity and quality—varies by the gender of the composer. Using the Pfitzinger (2017) sample, we estimate regressions where the dependent variable is either the number of teachers who taught composer i or the average quality of those teachers (measured by the log average word count of those teachers) and the key independent variable is an indicator equal to one if composer i is female. We estimate these regressions with and without fixed effects for the composer's half century and country of birth.

Coefficient estimates are shown in columns (5)-(8) of Table 6, which was displayed in the previous section. In columns (5) and (6) of Table 6 the dependent variable is the number of teachers who taught composer i while in columns (7) and (8) the dependent variable is the average quality of composer i's teachers. The coefficient estimates suggest that female composers had more teachers than male composers. The average male composer in the Pfitzinger

(2017) had 2.06 teachers. Based on the coefficient estimate shown in column (6), this implies that female students had approximately 11 percent more teachers than male composers. The evidence on teacher quality, however, is mixed. Without the fixed effects, the estimate indicates that female composers had weaker teachers. On the other hand, when we include them, the sign flips and the estimate loses statistical significance. Accordingly, accounting for when and where composers were born, the evidence does not suggest that female composers had lower quality teachers.

We now turn to the relationship between the number and quality of a composer's teachers and a composer's future prominence. To do this, we estimate regressions of the following form:

$$\begin{aligned} ln(word\ count)_i = \beta_0 + \beta_1(female_i) \ &+ \beta_2(number\ teachers_i) + \\ &\beta_3(avg\ teacher\ prominence_i) \ + \beta_4(female_i) \times (number\ teachers_i) + \\ &\beta_5(female_i) \times (avg\ teacher\ prominence_i) \ + \gamma_i + \delta_t + \epsilon_i \end{aligned} \tag{4}$$

In this equation the dependent variable, $ln(word\ count)_i$, is the natural log of composer $i's$ biographical entry; $female_i$ is an indicator equal to one if composer i is female; $number\ teachers_i$ is a count of the number of teachers who taught composer i; $avg\ teacher\ prominence_i$ is the log of the average word count of composer i's teachers, which is computed using the word counts of $i's$ teachers' biographical entries; and the remaining variables are defined as before. If having more or better teachers improves a composer's prominence, then β_2 and β_3 should be positive and statistically significant. The coefficients on β_4 and β_5 tell us if teacher quantity or quality have different effects depending on the gender of the student-composer. For instance, if having more or better teachers affects female composition students differently from their male counterparts, then the coefficients on these interactions should be different from zero. Once again, we use the Pfitzinger (2017) sample of composers. Additionally, we estimate the model with and without interaction terms, and using different configurations of teacher quality and quantity.

Coefficient estimates of equation (4) are displayed in the first six columns of Table 8. In all regressions, the dependent variable is our measure of a composer's prominence. Columns (1) and (2) control for teacher quantity; columns (3) and (4) control for average teacher quality; and columns (5) and (6) control for both. Interaction terms are excluded in the odd-numbered columns and included in the even-numbered columns.

Across all specifications, the coefficients on the number of teachers and average teacher quality (i.e., β_2 and β_3) are positive and statistically significant at conventional levels. Additionally, the implied effects are economically large. Having one additional teacher increases a composer's prominence by approximately 10 percent and a doubling of average teacher quality raises a composer's prominence by 68 percent.[23] Since there was likely positive selection at work, with the best pupils studying with the best teachers, this is probably an overestimate of the impact of teachers. Interestingly, however, the interaction terms are negative and statistically significant in all specifications. For female composers, the gains from having an additional teacher are cut in half, and the benefits of an increase in average teacher prominence are fully attenuated.

Taking this finding at face value, why might female composers' have benefited less from having more and better teachers? While our data do not allow us to answer this definitively, we speculate that it can be attributed to the fact that composition teachers, at least historically, were reluctant to make serious investments in their female students, since even female students of great promise were unlikely to raise a teacher's reputation.[24] Female composition-students may therefore have had more teachers than optimal, and the most distinguished composition-teachers—who had access to the best male and female students—may have been reluctant to commit much attention to their female pupils. Increases in the quantity and quality of teachers may therefore have widened the gender gap among composition-students.[25]

In the context of K-12 education, several studies have found that female teachers, when

[23]The average teacher in the Pfitzinger sample has a word count of 1707.1, which is 7.44 log points. Multiplying this by 0.07, the coefficient on the log of mean teacher prominence, gives us 0.52. $(e^{(-0.52)}-1)\times 100 \approx 68$.

[24]Given prevailing gender norms, a female composer might, upon marriage, be compelled to stop composing. Gustav Mahler, for instance, discouraged his wife, Alma (1879-1964), née Schindler, from composing during the early years of their marriage (Monson, 1983). Additionally, the market for music by female composers was itself discounted. In a discussion of the critical response to Ethel Smyth's (1858-1944) music, Gates 1997, p. 68 writes that "Smyth's music was seldom evaluated as a work of a composer among composers but as that of

Table 8: How teachers matter

	Dependent variable: ln(student word count)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female student	−0.267***	−0.089*	−0.264***	0.252	−0.283***	0.433*	−0.282***	−0.282***
	(0.047)	(0.049)	(0.037)	(0.195)	(0.047)	(0.239)	(0.031)	(0.032)
Number of teachers	0.107***	0.112***			0.099***	0.104***		
	(0.028)	(0.029)			(0.025)	(0.026)		
Mean T prom.			0.070***	0.074***	0.064***	0.068***		
			(0.011)	(0.012)	(0.010)	(0.011)		
Female S * Num. teachers		−0.063***				−0.052**		
		(0.021)				(0.025)		
Female S * Mean T prom.				−0.077**		−0.082**		
				(0.030)		(0.033)		
Female teacher							0.028	−0.002
							(0.029)	(0.036)
Female S * Female T							0.001	0.019
							(0.086)	(0.088)
Country FE	✓	✓	✓	✓	✓	✓	✓	✓
Half-century FE	✓	✓	✓	✓	✓	✓	✓	✓
Commonality controls								✓
Observations	7505	7505	5542	5542	5542	5542	12026	12012
Adjusted R^2	0.157	0.158	0.132	0.133	0.161	0.162	0.139	0.140

Notes: Standard errors are clustered at the country level. Commonality controls includes age distance between student and teacher, same-nationality indicator, and a shared country of birth-indicator. Significance levels: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

paired with female students, improve the relative performance of female students and narrow gender achievement gaps (see, for example, Winters et al. (2013)). Might this also be the case for musical composition? Following Muralidharan and Sheth (2016) and Holmlund and Sund (2008), we estimate regressions of the following form:

$$\begin{aligned} ln(word\ count)_i = \beta_0 \ &+ \beta_1 female\ student_i + \\ &\beta_2 female\ teacher_j + \\ &\beta_3 female\ student_i \times female\ teacher_j + \\ &\alpha_i \ + \ \delta_t \ + \ \epsilon_i \end{aligned} \tag{5}$$

a 'woman composer.' This worked to keep her on the margins of the profession.

[25]Even women composition teachers may have discounted their female pupils. Nadia Boulanger (1887-1979), possibly the most important female composition teacher of all time, is reported to have ostracized female students who contemplated marriage and to have preferred her male students. A graduate of the Paris Conservatory, Boulanger taught at the Conservatoire Femina-Musica, the L'ecole Normale de la Musique, and the American Conservatory at Fontainebleau (which she established), and was named a full professor at the Paris Conservatory in 1948. See Rorem (1982), who also notes that Boulanger held the view that there was no room for women composers aside from her sister, Lili Boulanger (1893-1918), whom Nadia idolized and who died at the young age of 24.

The dependent variable, $word\ count_i$, is the word count of student $i's$ entry in *Grove*; $female\ student_i$ is a binary variable equal to one student i is female; $female\ teacher_j$ is a binary variable equal to one if teacher j is female; and the remaining variables are defined as before. The coefficient on the interaction term, β_3, captures the relative effectiveness of female teachers in reducing the gender gap. If $\beta_3 = 0$, male and female composition teachers are equally effective in reducing the gender gap among composition-students; if $\beta_3 > 0$ female teachers are more effective; and if $\beta_3 < 0$ male teachers are more effective.

Columns (7) and (8) of Table 8 display the coefficient estimates from estimating equation 5. The dependent variable is the log of the word count of student $i's$ main description in *Grove*. Column (8) also includes commonality controls, which hold constant other factors that a teacher and student may share in common (e.g. nationality, age). The coefficients on the interaction term are positive but imprecisely estimated. Accordingly, neither male nor female composition teachers appear better at reducing the gender gap in composer prominence.

6.3 The role of conservatories

During the nineteenth century, music education shifted away from families and informal networks of teachers and students towards conservatories. How did the rise of conservatories affect composer quality? And were the effects different for female composers relative to their male counterparts?

We posit that the opening of a conservatory is likely to increase average composer quality in its vicinity, to the extent that it attracts talented teachers and lowers the cost of accessing musical instruction (by centralizing it within a specific place and reducing search costs). The beneficial effects of a conservatory may even extend beyond its own students, if composition professors also teach privately. However, the effect of a conservatory on the the gender gap is less clear. If conservatories are closed to women, as they have sometimes been, then women may not benefit from the consolidation of teaching in a single institution and the gender gap may widen in surrounding area. On the other hand, if the conservatory is open to women, or if composition professors are willing to teach women privately, female compositional talent

may be locally nurtured.

From IDMMEI we know the addresses and founding dates of over 2,000 conservatories. Our strategy for exploring the impact of conservatories involves geo-locating conservatories and composers (using their places of birth), and dividing composers into two groups—those who were born "near" the conservatory (the treatment group) and those who were born "far" away (the control group)—and, in turn, sub-dividing these two groups into two cohorts: a "before" cohort that were born in the 20-year interval before the founding of the conservatory (i.e., composers who are unlikely to have been able to benefit from the conservatory), and an "after" cohort that was born in the 20 years after its founding (i.e., composers who could potentially benefit from it). We then estimate the impact of the conservatory by comparing the change in average outcomes between composers born after and before the founding of the conservatory in the treatment group with the change in average outcomes of composers born after and before the founding of the conservatory in the control group. We focus on three outcomes: the average prominence of composers in a group-cohort, the relative prominence of female composers in a group-cohort, and the fraction of female composers in a group-cohort.

Our basic empirical framework can be summarized by the following equation:

$$\begin{aligned} Y_{sgk} = \beta_0 \ &+ \beta_1(near_{sgk}) \ + \beta_2(after_{sgk}) \\ &\beta_3(near_{sgk}) \times (after_{sgk}) \ + \\ &\alpha_c \ + \ \delta_t \ + \ \theta_{sgk} + \ \epsilon_{sgk} \end{aligned} \tag{6}$$

In this equation, s denotes conservatory, g denotes group ("near" or "far" from conservatory s), and k denotes cohort (born "before" or "after" the founding of conservatory s). The dependent variable, Y_{sgk}, is an average outcome among composers in a given conservatory-group-cohort; $near_{sgk}$ is an indicator equal to one for conservatory-group-cohorts born near (i.e., within a distance threshold) of conservatory s; $after_{sgk}$ is an indicator equal one for conservatory-group-cohorts born after conservatory s is founded; α_c is a fixed effect for the country in which a conservatory is located; δ_t is fixed effect for the half-century in which a conservatory was founded; θ_{sgk} is a fixed effect for conservatory s; and ϵ_{sgk} is an error term.

The coefficient on the interaction term, β_3 can be interpreted as a difference-in-differences estimate of the effect of conservatories on average outcomes among composers born nearby.

We face several challenges when implementing this framework, most of which do not have obvious solutions. We first need to decide on a distance threshold for "near" and an outer limit to "far." For "near" we simply experimented with different thresholds (20km, 50km, 100km, and 200km). Given that most of our composers were born and lived in Europe, and musical styles tended to be similar among composers within Europe in a given period, we choose 500 km as the outer limit for "far." A downside with using such a generous outer-distance threshold, however, is that it is possible that composers born in the "far" category could themselves have been exposed to other conservatories, which would contaminate our estimates. Second, we need to decide on the time frame (relative to the founding of a conservatory) in which to focus our analysis. Because musical styles evolve over time, we restrict attention to a 40-year period. Third, it is an open question as to when treatment (i.e., "after") begins. For simplicity and ease of exposition, we use the founding date of the conservatory as the time of treatment and place composers born in the 20-year interval post-founding within the "after" cohort and composers born in the 20-year interval prior within the "before" cohort. To the extent that it takes a few years for a conservatory to establish itself and develop a reputation, this seems reasonable; composers generally attended conservatories in their late teens or early 20s, which means that composers born in the 20 years prior to a conservatory's founding are unlikely to have been affected by it. On the other hand, if the effects of a conservatory are felt more immediately, then we should not exclude from the treated group those who were born within a few years prior to its founding (e.g., if, for instance, a conservatory is founded in 1870, someone born in 1860 could well have attended it). Accordingly, we also experimented by classifying composers born in the [-30, -10] interval prior to founding as "before" and any composer born in the [-10, +10] interval as being "after." Finally, within each group-cohort, we have a choice about how to aggregate our data. The simplest approach is to aggregate across an entire group-cohort (which is consistent with the set up outlined in equation 6). This gives us four observations per conservatory (two groups, "near" and "far", multiplied by

two cohorts, "before" and "after"). However, since we know composers' birth years, we can also aggregate by group-cohort-year, which yields up to 80 observations per conservatory (two groups, "near" and "far", multiplied by two cohorts, "before" and "after", each of which has 20 annual observations).[26] An intermediate approach is to aggregate by 10-year intervals for each group-cohort, which generates 8 observations per conservatory (two groups multiplied by two cohorts, each of which has two 10-year interval bins).

We cannot discuss nor display the results from all these permutations. The overall pattern that emerges, however, is roughly similar regardless of when we decided to turn on treatment, and how we aggregate the data (annually, in 10-year bins, or across an entire cohort-group). Accordingly, we present the results using the 10-year bins and in which we classify composers born after the establishment of a conservatory as "after."

Table 9 displays coefficient estimates using closeness thresholds of 20km and 50km. In columns (1) and (4) the dependent variable is average composer prominence; in columns (2) and (5) the dependent variable is the relative prominence of female composers (i.e., average prominence of women less average prominence of men), while in columns (3) and (6) it is the fraction of composers who are women. The coefficient of interest is the interaction term, which is the average treatment effect of a conservatory. Across the two distance thresholds, the overall pattern is the same: the opening of a conservatory is positively correlated with the average prominence of composers in the area as well as the relative prominence of female composers, and negatively related to the female fraction of composers. As shown in Table A3, we obtain a similar pattern of results using distance thresholds of 100km and 200km.

These findings provide suggestive evidence of the importance of conservatories for composer-prominence and their mixed effects on women (positive effects for their relative prominence but negative for relative representation). While we are heartened by the fact that they are reasonably robust across specifications, we note that this is a very noisy experiment for the reasons discussed earlier. To these reservations, we add that, while we include conservatory-level fixed effects, conservatories are heterogeneous and their quality may change with time. Moreover, the founding of a conservatory is itself endogenous and we have no way to instru-

[26] Some annual observations may be missing if no composers were born in those years.

Table 9: Conservatories (20 & 50 km thresholds)

	Avg. prom.	F/M prom.	F/M share	Avg. prom.	F/M prom.	F/M share
	(1)	(2)	(3)	(4)	(5)	(6)
Born after	0.019***	0.000***	0.002***	0.019***	−0.000***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Born within threshold	0.009***	0.001***	0.044***	0.035***	−0.001***	0.041***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Born after × Born within	0.017***	0.002***	−0.005***	0.007***	0.006***	−0.008***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Threshold (km)	20	20	20	50	50	50
Conservatory FE	✓	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓
Half-century FE	✓	✓	✓	✓	✓	✓
Observations	9788	9788	9788	10580	10580	10580
Num. conservatories	2174	2174	2174	2174	2174	2174
Adjusted R^2	0.547	−0.128	0.940	0.868	−0.002	0.927

Notes: "Avg. prom" is the the natural log of the average word count. "F/M prom" is the ratio of the natural log of the average female word count to natural log of the average male word count. "F/M share is the fraction of composers who are female. Standard errors are clustered at the country level.
Significance levels: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

ment for that. Accordingly, we view these as a "first-cut" effort to untangle the effects of conservatories on composers and the gender gap.

7 Downstream consequences of the gender gap

We have documented a gender gap among female composers, which, along with our historical understanding of the barriers that women composers faced, suggests that women composers were indeed disadvantaged.[27] We now turn to the downstream consequences of this gender gap. If the market for musical compositions by women was discounted, what were the implications for women composers as teachers? Additionally, what strategies might women composers have followed to adapt to a market that discounted their work?

We first examine women as composition teachers, specifically whether they attracted fewer or weaker students than male composition teachers. This involves estimating regressions of the following form:

[27] For a discussion of these barriers see Gates (2006).

Table 10: Women as teachers

	Dependent variable			
	Num. students		Avg. student qual.	
	(1)	(2)	(3)	(4)
Female teacher (T)	−0.977	−34.301	0.010	0.220
	(3.672)	(34.537)	(0.071)	(0.609)
ln(T word count)	4.733***	4.624***	0.053***	0.053***
	(0.793)	(0.762)	(0.011)	(0.011)
Female T × ln(T word count)		5.861		−0.036
		(6.621)		(0.101)
Country FE	✓	✓	✓	✓
Half-century FE	✓	✓	✓	✓
Observations	3780	3780	2790	2790
Adjusted R^2	0.126	0.128	0.231	0.230

Notes: Standard errors are clustered at the country level.
Significance levels: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

$$
\begin{aligned}
Y_j = \beta_0 \; &+ \beta_1 female\ teacher_j + \\
&\beta_2 ln(word\ count\ (main\ desc.))_j + \\
&\beta_3 female\ teacher_j \times ln(word\ count\ (main\ desc.))_j + \\
&\alpha_j \; + \; \delta_t \; + \; \epsilon_j
\end{aligned}
\tag{7}
$$

In this equation, j denotes teacher. The dependent variable, Y_j, is either the number of students or the average prominence of the students of teacher j, where the average prominence of students is measured using the average word count of the students' main description in *Grove*; $female\ teacher_j$ is an indicator equal to one if teacher j is female; $ln(word\ count\ (main\ desc.))_j$ is the prominence of teacher j; α_j and δ_t are indicators for teacher $j's$ country and half century of birth; and ϵ_j is an error term.

Regression results are shown in Table 10. In columns (1) and (2), the dependent variable is the number of students taught by teacher j, while in columns (3) and (4) it is the average prominence of teacher $j's$ students. We note that the results in columns (3) and (4) should be interpreted cautiously; ideally, we would like to measure, on average, how promising $j's$

students are, not how prominent they became (which is a function of $j's$ efforts after they became $j's$ students). Unfortunately, a student's promise is unobservable. Taking the results at face value, the coefficients indicate that, holding constant a teacher's era and country, female teachers appear to have attracted fewer students, but the coefficient is imprecisely estimated. The data are therefore too noisy for us to make any clear inferences on the quantity dimension. Our findings do indicate, however, that more prominent teachers attracted more students, and that any penalty female teachers may have suffered in terms of student numbers was partially attenuated by female teacher quality (although, again, the coefficient is statistically significant). In terms of average student quality, the coefficient on the female indicator is positive but statistically indistinguishable from zero. This could imply that female teachers were not disadvantaged in their ability to attract promising students, but as pointed out earlier, the dependent variable is a measure of average student prominence, not average student promise. Accordingly, perhaps a more correct interpretation is that female composer-teachers added at least as much value to their students as their male counterparts, assuming that their students were, on average, no more promising than the students of male composer-teachers (which seems a reasonable assumption). This, in turn, suggests that, as composition teachers, women were at least as effective as men, despite the significant disadvantages they may have faced.[28]

Finally, we turn to how female composers adapted to the barriers they faced. Our investigation focuses on the likelihood of adopting a pseudonym, and, conditional on having done so, the likelihood of adopting a pseudonym of the opposite gender. We estimate linear probability regressions where the dependent variable is either an indicator equal to one if a composer is reported in *Grove* to have used a pseudonym or an indicator equal to one if that pseudonym is of the opposite gender, and the key right hand side variable is an indicator equal to one if the composer is female.

[28]The case of Nadia Boulanger is worth mentioning again. Boulanger can possibly claim credit for having had more students (not only composition students, but also pianists, conductors, singers, etc.,) than any other musician of any period. According to Pfitzinger (2017) she had 413 composition students, which is 100 times more students than the average female teacher in our sample (a difference of almost 20 standard deviations) and more than twice as many students as the most prolific male teacher. Many of Boulanger's students became highly influential, including Aaron Copeland, Elliott Carter, Jean Françaix, Virgil Thomson, Darius Milhaud,

Table 11: Likelihood of adopting a pseudonym

	Dependent variable: Adopted pseudonym			
	Any pseudonym		Opp gender pseudonym	
	(1)	(2)	(3)	(4)
Female	0.022***	0.021**	0.186***	0.154***
	(0.003)	(0.009)	(0.037)	(0.046)
Country FE		✓		✓
Half-century FE		✓		✓
Observations	15637	13162	169	161
Adjusted R^2	0.003	0.010	0.126	0.044

Notes: Standard errors are clustered at the country level.
Significance levels: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

Columns (1) and (2) of Table 11 indicate that female composers are two percentage points more likely to adopt a pseudonym compared to male composers. Only one percent of composers in *Grove* used a pseudonym; this implies that women composers were three times more likely to adopt a pseudonym, an economically significant difference. Columns (3) and (4) show that, among composers who used a pseudonym, female composers are approximately 16 percentage points more likely to use an opposite gender pseudonym. Given that 4 percent of pseudonym-using composers adopted an alias of the opposite gender, this represents a four-fold increase. Accordingly, concealing their gender was one way female composers adapted to a market where their music was dismissed and disregarded.

8 Conclusion

Using unique data on several thousand composers who lived between the middle ages until the end of the last century, we document an economically significant gender gap among classical composers in terms of their prominence. Consistent with popular perceptions, we find women composers are indeed less acclaimed than their male counterparts, although the gap in their

Astor Piazzola, George Walker and Philip Glass (Rosenstiel, 1998).

relative prominence has narrowed with time and varies by region. We then conduct the first systematic quantitative exploration of the factors behind this gap, focusing on family musical background, composition teachers, and conservatories, factors that shape the acquisition of musical human capital and that may have had different effects by gender.

While the data do not permit definitive causal claims, our findings point to the nuanced ways in which families, teachers, and institutions have mattered for female composers. Composers who had musician-parents (musician-mothers, especially) are more prominent than composers who did not, but the effects were not different for composer-sons than composer-daughters. However, female composers were three times more likely to have a musician mother than male composers, suggesting an important role for mothers in encouraging their daughters to compose. Composers who had more and better teachers became prominent, but the effects are substantially attenuated for female composers, which is consistent with a well documented reluctance on the part of composition teachers of the past to make significant investments in their female pupils. Finally, the establishment of conservatories raised the prominence of composers in the vicinity of the conservatory, as well as the relative standing of women composers, but at the expense of female representation. Conservatories may have benefited those women who were determined enough to gain entry (or who could study privately with conservatory professors), but these barriers could easily have deterred others. An understanding of the composer gender gap must therefore be conditioned on an appreciation of history and the significant obstacles that women confronted in the past.

What were the downstream consequences of the gender gap for women composers? In spite of the barriers that women faced as composers, they do not appear to have been disadvantaged as composition teachers and may have been at least as effective as men in that role. Additionally, female composers were more likely to adopt a pseudonym than their male counterparts, especially one of the opposite gender. This need to conceal the feminine gender underscores the extent to which music by female composers was simply not taken seriously in the past, which may well be the most important reason for classical composer gender gap.

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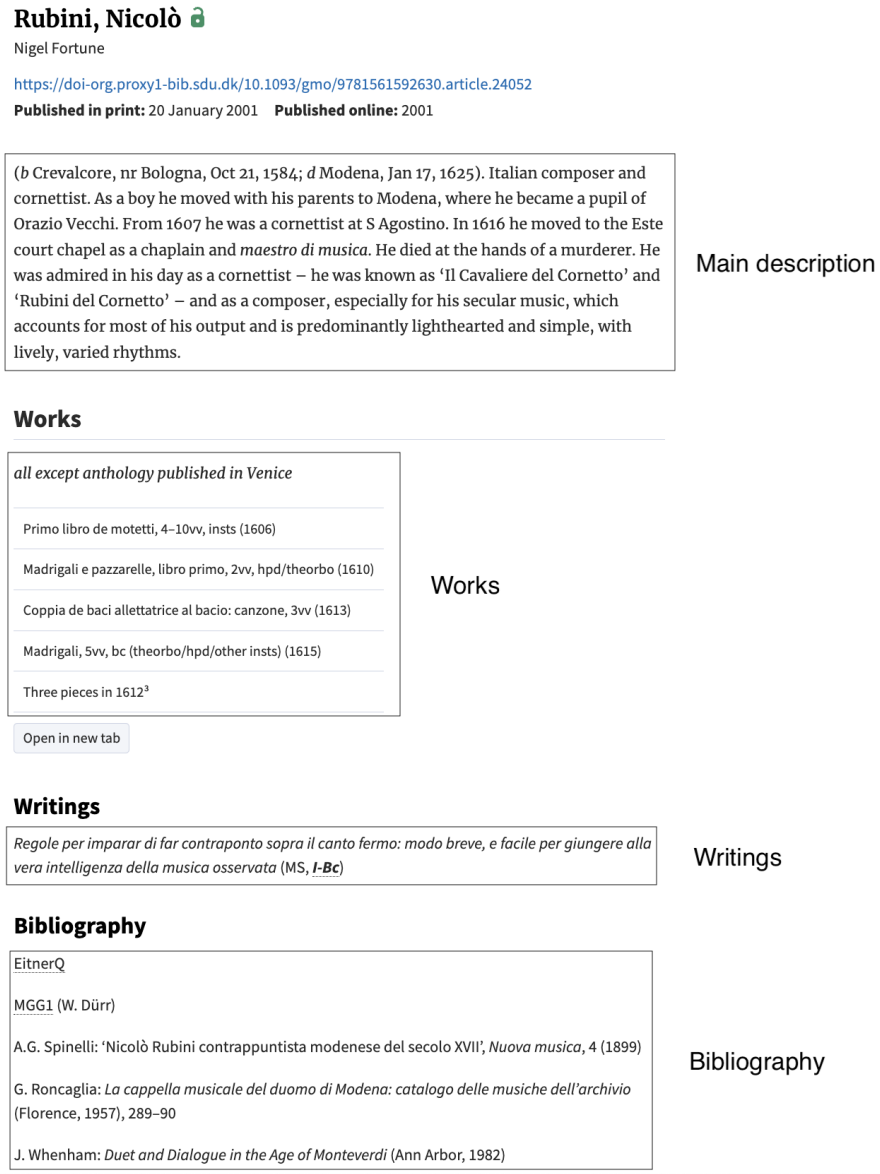
Appendix

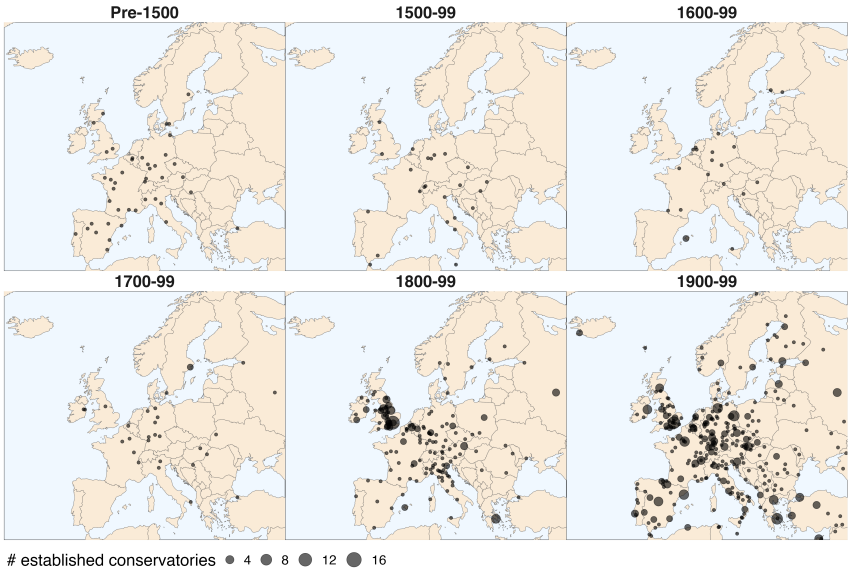
Appendix A: Anatomy of a *Grove* entry

Figure A1: Anatomy of a *Grove* entry



Appendix B: Location of conservatories, Europe

Figure A2: Location of conservatories, Europe



Notes: This figure depicts the spatial distribution of conservatories according to their century of establishment.

Appendix C: Summary statistics by gender

Table A1: Summary statistics by gender

(a) (Pfitzinger, 2017) sample

	Male composers					Female composers					*t*-test	
Variable	Obs.	Mean	SD	Min	Max	Obs.	Mean	SD	Min	Max	*t*-statistic	*p*-value
Born	15,887	1,878.20	101.38	505.00	2,001.00	1,384	1,930.80	53.02	1,098.00	2,001.00	-32.14	0.00
Died	10,171	1,907.45	109.65	571.00	2,016.00	495	1,961.78	67.16	1,179.00	2,016.00	-16.93	0.00
No. students	7,370	4.79	10.55	1.00	206.00	376	4.15	21.60	1.00	412.00	0.57	0.57
No. teachers	15,930	2.06	2.00	0.00	22.00	1,386	2.87	2.26	0.00	13.00	-12.88	0.00
Teacher qual.	10,740	1,743.16	3,410.10	21.00	42,011.00	1,012	1,324.41	2,464.29	97.00	39,533.00	4.98	0.00
Occupations												
Composer	7,093	1.00	0.05	0.00	1.00	444	1.00	0.00	1.00	1.00	-4.13	0.00
Conductor	7,093	0.16	0.36	0.00	1.00	444	0.06	0.24	0.00	1.00	8.00	0.00
Teacher	7,093	0.13	0.34	0.00	1.00	444	0.10	0.30	0.00	1.00	1.93	0.05
Pianist	7,093	0.10	0.30	0.00	1.00	444	0.22	0.42	0.00	1.00	-6.03	0.00
Organist	7,093	0.10	0.30	0.00	1.00	444	0.02	0.15	0.00	1.00	9.49	0.00
Violinist	7,093	0.06	0.23	0.00	1.00	444	0.01	0.12	0.00	1.00	7.25	0.00
Singer	7,093	0.02	0.14	0.00	1.00	444	0.05	0.22	0.00	1.00	-2.85	0.00
Word counts												
Main desc.	7,093	685.84	1,802.68	15.00	42,011.00	440	309.51	263.70	58.00	2,358.00	15.18	0.00
Works	7,093	397.03	1,189.38	0.00	46,397.00	444	252.13	289.60	0.00	2,898.00	7.35	0.00
Bibliography	7,093	154.72	689.93	0.00	16,402.00	444	61.96	130.02	0.00	2,263.00	9.04	0.00
Writings	7,093	19.88	68.67	0.00	1,616.00	444	5.60	25.04	0.00	264.00	9.91	0.00

(b) *Grove* sample

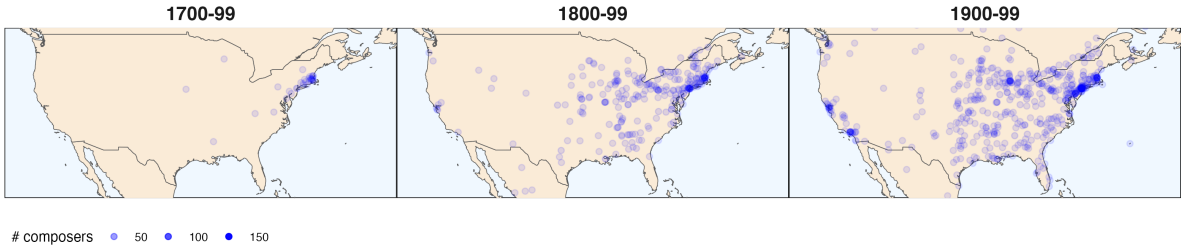
	Male composers					Female composers					*t*-test	
Variable	Obs.	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max	*t*-statistic	*p*-value
Born	12,781	1,810.29	140.44	154.00	1,976.00	954	1,890.87	85.83	810.00	1,972.00	-26.47	0.00
Died	10,314	1,827.50	149.60	163.00	2,010.00	502	1,916.12	100.29	867.00	2,009.00	-18.80	0.00
Pseudonym	14,645	0.01	0.10	0.00	1.00	992	0.03	0.17	0.00	1.00	-3.91	0.00
Occupations												
Composer	14,645	0.98	0.15	0.00	1.00	992	0.97	0.16	0.00	1.00	0.65	0.52
Conductor	14,645	0.11	0.31	0.00	1.00	992	0.04	0.20	0.00	1.00	9.21	0.00
Teacher	14,645	0.08	0.28	0.00	1.00	992	0.08	0.27	0.00	1.00	0.22	0.83
Pianist	14,645	0.09	0.29	0.00	1.00	992	0.23	0.42	0.00	1.00	-10.54	0.00
Organist	14,645	0.11	0.31	0.00	1.00	992	0.03	0.16	0.00	1.00	14.33	0.00
Violinist	14,645	0.05	0.23	0.00	1.00	992	0.01	0.11	0.00	1.00	10.24	0.00
Singer	14,645	0.04	0.21	0.00	1.00	992	0.10	0.30	0.00	1.00	-5.51	0.00
Word counts												
Main desc.	14,645	476.60	1,300.94	7.00	42,011.00	992	251.71	195.52	17.00	2,358.00	18.12	0.00
Works	14,645	238.18	851.28	0.00	46,397.00	992	161.78	225.53	0.00	2,898.00	7.61	0.00
Bibliography	14,645	105.69	481.26	0.00	16,402.00	992	47.89	95.35	0.00	2,263.00	11.56	0.00
Writings	14,645	12.65	54.17	0.00	1,616.00	992	3.36	18.76	0.00	264.00	12.47	0.00

Notes: This table shows the number of observations, the average values, standard deviation, minimum and maximum values for variables in the Pfitzinger (2017) and *Grove* samples.

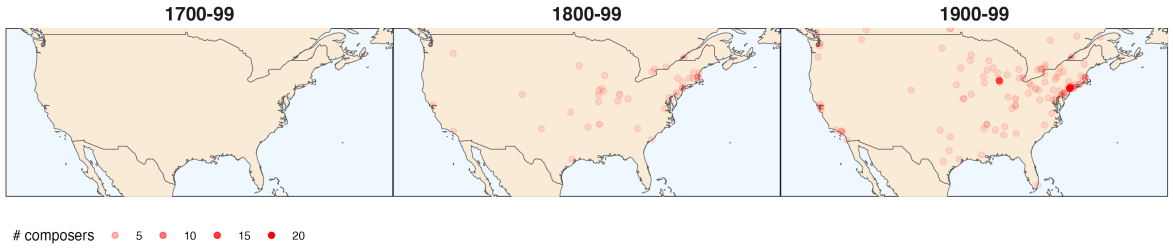
Appendix D: Number of composers by gender, US

Figure A3: Number of composers by gender, US

(a) Male composers



(b) Female composers



Notes: This figure shows the spatial distribution of birth locations of composers by gender in the US. Each dot represents a city and dots that are less transparent indicates a higher concentration of composers.

Appendix E: Matched sample summary statistics

Table A2: Summary statistics by gender (matched sample)

	Male composers					Female composers					*t*-test	
Variable	Obs	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max	*t*-statistic	*p*-value
Born	444	1,904.50	62.90	1,510.00	1,970.00	444	1,903.12	70.62	1,098.00	1,972.00	0.31	0.76
Died	261	1,947.29	73.21	1,559.00	2,015.00	249	1,944.57	84.36	1,179.00	2,016.00	0.39	0.70
No. students	238	6.11	10.47	1.00	62.00	154	7.08	33.48	1.00	412.00	-0.35	0.73
No. teachers	444	2.40	1.91	0.00	12.00	444	2.78	1.87	0.00	11.00	-2.99	0.00
Occupation												
Composer	444	1.00	0.00	1.00	1.00	444	1.00	0.00	1.00	1.00	-	-
Conductor	444	0.13	0.34	0.00	1.00	444	0.06	0.24	0.00	1.00	3.65	0.00
Teacher	444	0.11	0.31	0.00	1.00	444	0.10	0.30	0.00	1.00	0.44	0.66
Pianist	444	0.13	0.33	0.00	1.00	444	0.22	0.42	0.00	1.00	-3.83	0.00
Organist	444	0.05	0.21	0.00	1.00	444	0.02	0.15	0.00	1.00	2.01	0.04
Violinist	444	0.03	0.17	0.00	1.00	444	0.01	0.12	0.00	1.00	1.62	0.10
Singer	444	0.01	0.12	0.00	1.00	444	0.05	0.22	0.00	1.00	-3.22	0.00
Word counts												
Main description	444	320.82	380.43	42.00	7,073.00	444	309.51	263.70	58.00	2,358.00	0.51	0.61
Works	444	247.72	272.79	0.00	4,177.00	444	252.13	289.60	0.00	2,898.00	-0.23	0.82
Bibliography	444	53.41	78.97	0.00	1,133.00	444	61.96	130.02	0.00	2,263.00	-1.18	0.24
Writings	444	16.67	43.35	0.00	345.00	444	5.60	25.04	0.00	264.00	4.66	0.00
Mother musician	444	0.03	0.17	0.00	1.00	444	0.09	0.28	0.00	1.00	-3.63	0.00
Father musician	444	0.10	0.30	0.00	1.00	444	0.10	0.30	0.00	1.00	0.11	0.91
Relative musician	444	0.06	0.23	0.00	1.00	444	0.07	0.25	0.00	1.00	-0.70	0.49
Spouse musician	444	0.04	0.20	0.00	1.00	444	0.13	0.34	0.00	1.00	-4.86	0.00

Notes: This table summarizes the variables of the matched sample constructed via propensity score matching.

Appendix F: Effects of establishment of conservatories

Table A3: Conservatories (100 & 200 km thresholds)

	Avg. prom.	F/M prom.	F/M share	Avg. prom.	F/M prom.	F/M share
	(1)	(2)	(3)	(4)	(5)	(6)
Born after	0.018***	0.000***	0.002***	0.019***	−0.001***	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Born within threshold	0.034***	0.002***	0.031***	0.030***	0.002***	0.017***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Born after × Born within	0.014***	0.001***	−0.010***	0.002***	0.006***	−0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Threshold (km)	100	100	100	200	200	200
Conservatory FE	✓	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓
Half-century FE	✓	✓	✓	✓	✓	✓
Observations	11648	11648	11648	13035	13035	13035
Num. conservatories	2174	2174	2174	2174	2174	2174
Adjusted R^2	0.900	−0.074	0.916	0.800	0.268	0.840

Notes: Standard errors are clustered at the country level.
Significance levels: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.