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TRICKLE-DOWN EFFECTS OF AFFIRMATIVE ACTION: A CASE STUDY IN FRANCE

José De Sousa
Muriel Niederle

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José De Sousa
University of Paris-Saclay
Department of Economics
54 Boulevard Desgranges
92331 Sceaux, Cedex
France
and Sciences Po Paris LIEPP
jose.de-sousa@universite-paris-saclay.fr

Muriel Niederle
Department of Economics
579 Jane Stanford Way
Stanford University
Stanford, CA 94305-6072
and NBER
niederle@stanford.edu

A data appendix is available at http://www.nber.org/data-appendix/w30367

Trickle-Down Effects of Affirmative Action: A Case Study in France*

José De Sousa† Muriel Niederle‡

August 6, 2022

Abstract

The introduction of a quota in the French chess Club Championship in 1990, an activity many players engage in next to playing in individual tournaments, provides a quite unique environment to study its effects on three levels. We find that women selected by the quota improve their performance. We show large spillover and trickle-down effects: There are more and better qualified women. International comparisons confirm that the results are unique to France and that there are no substantial adverse effects on French male players. We discuss the properties of this quota and how to implement it in other environments.

1 Introduction

An affirmative action quota is a popular way to address gender inequalities.[1] Ideally, we study the effects of such a quota on three levels. Foremost a quota, hopefully, directly

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†U. Paris-Saclay, RITM and Sciences Po, LIEPP: jose.de-sousa@universite-paris-saclay.fr

‡Stanford University and NBER and SIEPR: niederle@stanford.edu

[1]For example, gender quotas are popular in public elections. According to the Gender Quota Database, half the countries use some type of electoral quota for their parliament. Gender quotas are also present in the corporate sector. Norway, in 2003, was first to mandate a 40 percent representation of each gender on corporate boards of public limited liability companies. Similar regulations have meanwhile passed in Austria, Belgium, Denmark, France, Iceland, Ireland, Germany and the Netherlands. The European

increases the number and perhaps even the ability and performance of selected women. Second, a quota may generate spillover and trickle-down effects: There could now be more and especially more high performing women. Finally, a quota may have a negative externality on the non-minority group, in this case men. To address whether a quota has all those effects, we need an environment with three features. First, the quota needs to have been implemented sufficiently long ago. Second, we need access to the whole pool of participants, not only the women selected by the quota. Third, we need a reliable ability or performance measure to compare individuals across gender, over time, and perhaps even across countries to account for the effect of time trends independent of the quota. Most environments lack some of these features, which is why evidence on spillover and trickle-down effects, as well as externalities on men have been difficult to show, see the literature review below. In this paper we present an environment which, while on its own maybe not particularly interesting, has the almost unique property of fulfilling all three features: French Chess players.

Chess is quite extremely male dominated, with women representing only about 10% of internationally rated players. Chess also suffers from an attitude problem towards women.[2] Chess is therefore an activity where a quota might be implemented. This is what the French Chess Federation did in 1990 in its Club Championship. While French chess players mostly participate in individual chess tournaments, many participate in the Club Championship. Starting with division 1 in 1990 up to division 3 in 1992, Club Championship teams were required to have one French female chess player. The time frame of decades allows us to study spillover and trickle-down effects, as well as potential negative effects on men. Second, the universal Elo rating in chess provides a reliable performance measure, which has been in place for decades.[3] We can therefore compare

Commission in the Europe 2020 Strategy proposes a law of 40 percent female representation in boards of companies listed across the EU. Finally, an extreme form of a quota is the creation of separate contests for women and men, such as in sports, but even in activities where men need not necessarily have a biological advantage, such as in chess, mathematics (see, e.g., Math Prize for Girls, the European Girls' Mathematical Olympiad since 2012, and the China Girls Mathematical Olympiad since 2002), or computer science (see, e.g., Technovation Girls or the European Girls' Olympiad in Informatics since 2021).

[2]In the not so distant past, the 13th World Chess Champion Garry Kasparov and only a few years ago the UK's greatest chess player, Nigel Short, claimed that women were worse at chess than men and that this should just be accepted (see Section 2.2 for exact quotes).

[3]For the power of the Elo rating in predicting chess results see e.g. De Sousa and Hollard (2015) and Backus et al. (2022). Perhaps for this reason, chess has quite a presence in the economics literature, see Palacios-Huerta and Volij (2009); Moul and Nye (2009); Levitt et al. (2011); Bühren et al. (2012); Gränsmark (2012); Bertoni et al. (2015); Linnemer and Visser (2016); González-Díaz and Palacios-Huerta (2016); Matros (2018); Künn et al. (2022); Strittmatter et al. (2020); Avoyan et al. (2021). Chess has also been ex-

players across gender, years, and countries. Cross-country comparisons allow us to examine whether the quota had an impact on French chess players. Finally, to participate in official tournaments chess players have to be registered. Registered players represent the pool of individuals we use to study trickle-down and spillover effects for women.

To study the effect of the quota on women selected to participate in the Club Championship, we gathered data on division 1 (roughly 12 teams) from 1986 to 2015. We use multiple sources including archival work and prominent chess forums. Of the 2,313 match-ups we gathered data on all but 11 (see Appendix Table 2), representing 185 and 1,275 unique female and male players, respectively. While women were almost absent from division 1 in the eighties, teams have roughly one female player in each match-up since 1990. We find that the performance ability (the Elo rating) of these women increased over time. The average woman in 2015 has an about 80 percent chance of winning against the average woman in 1990. These performance gains are driven by women who play in Club Championships over several years rather than one female player being replaced by a better one. Furthermore, these gains are not a direct result of playing more games in the Club Championship (CC). Rather, women selected by the quota increase their Elo rating due to games played in individual tournaments where the quota does not apply. We confirm that these increases in performance are not driven by trends in Elo ratings by showing that male CC players do not similarly improve their performance.

The truly exciting feature of our setting is the ability to study spillover and trickle-down effects. We use data from the French chess federation on all active chess players in France to show that the pool of Female chess players has increased since 1990 at a larger rate than the pool of men. We show that these gains are largely driven by a disproportional increase in the number of adult female chess players (20 years or older). This number of adult female players is, furthermore, orders of magnitude larger than the number of women needed to fulfill quota requirements.[4] Two measures show that since 1990 there are not only more, but also better female chess players. First, the number of women among France's top chess players has increased. Second, the absolute number of elite female chess players has increased dramatically since 1990.[5]

ploited for its complexity, see Salant and Spenkuch (2021).

[4]In fact, a woman is only slightly more likely than a man to play in a division 1 to division 3 CC game in any given year. In 2015, this chance was 5.52 percent for women and 5.22 percent for men.

[5]Elite chess players are those whose Elo ratings are sufficiently high that they were eligible to be rated by the international chess federation (FIDE). These thresholds were 1805 Elo points for women and 2205 for men, though they are meanwhile abolished. For more information see Online Appendix K.1.

To confirm that effects on women selected by the quota as well as trickle-down effects on the pool of all women are caused by the quota, we consider three approaches. The first two investigations focus on France. First, we show that while both the labor force participation and the employment of women has increased, there has been no change in trends in 1990. Second, ideally, we would study the counterfactual of no quota to establish to what extent changes in the French chess community are responsible for our results. While this is impossible, we can exploit several policy changes in division 4. In 2004, CC divisions were restructured with most of the clubs in division 3 being put in division 4 which, perhaps as a consequence, was at the same time put under the quota rule. The quota (in division 4) was ended in 2013. We show that women who played in division 4 in 2013, compared to other years, disproportionally stopped playing in CCs in the following year, and, in addition, in standard tournaments over the next five years. Furthermore, the effects on women in 2013 who lose their special status are *larger* than the effects on the marginal male team-member in 2006 when his position was cut as teams went from 9 back to 8 players. This confirms that among selected women, the effects of the quota are above and beyond those due to general changes in the French chess community.

The final set of investigations to establish causality of the quota for our results, especially the spillover and trickle-down effects, consists of comparing French chess players to chess players in other European countries. First, we compare the pool of all French chess players to those of Belgium, where no quota was implemented. Unlike France, Belgium has not experienced any significant gain in the fraction of women among adult players. Second, we focus on elite chess players, players who have a rating from FIDE, the international chess federation. We compute the proportion of French among elite EU-15 female chess players. None of the other EU-15 countries had a substantial and sustained quota requirement like France.[6] If the increase in the number of elite female chess players in France is due to EU-15 wide changes in attitudes towards and by female players, we would expect the fraction of the French among EU-15 female elite players to be constant. Instead, we find that France is special: The fraction of French among EU-15 elite female chess players tripled from 6.5% in 1990 to 18.3% in 2015.

Finally, we use EU-15 data to investigate whether the quota had a negative effect on elite male chess players. If competition for limited resources in chess clubs is an important factor, men might be hurt by the female quota. However, it could be that potential

[6]The one exception being the UK, though their requirement was different and much less substantial than the one in France, for a discussion in more detail see Section 6.2.

changes in behavior and the presence by women generate externalities that increase the number of men interested in chess. The fraction of French among EU-15 elite men has increased, though at a lower rate than French women did. This suggests, nonetheless, that the quota had no large negative externalities on the pool of male chess players.

This paper is part of a larger literature on the effects of gender affirmative action quotas. Quotas, in general, increase the proportion of women, though sometimes women are placeholders for men.[7] There is evidence that introducing a quota does not necessarily result in a reduction of quality (at all, or often at least not as much as feared), be it in education, politics or corporate boards, suggesting that in many situations there were highly qualified women who were not participating beforehand.[8] Controlled experiments similarly find a selection effect on applicants, which reduces the costs of a quota, even in environments without discrimination.[9] Some papers are able to show that women selected by the quota benefit, for example in corporate boards and in education, and sometimes selected women can be harmed, for example when they are chosen to sit on committees.[10]

A perhaps even more important aspect of an affirmative action (AA) quota concerns spillover and trickle-down effects: Does the quota result in a bigger pool of women who are eligible, and perhaps increase the number of highly qualified women? Theoretically, quotas need not raise incentives for women to invest in skills (see Coate and Loury, 1993, and for an overview Fang and Moro, 2011). Empirically, it has been challenging to show spillover or trickle-down effects. For example, quotas on corporate boards have not conclusively resulted in increased representation of women in top echelons of companies, nor in more women receiving an MBA (and hence the "necessary" education to be board members), see Bertrand et al. (2018) for Norway and Maida and Weber (2020) for Italy. In academia, putting women on hiring and promotion committees has not resulted in more favorable evaluations of female candidates, which is due to male evaluators becoming less favorable towards women (Bagues et al. 2017; Deschamps 2018).

[7] Evidence of such token women comes in general from politics, see e.g. Chattopadhyay and Duflo (2004) in India and Franceschet and Piscopo (2008) in Argentina.

[8] For evidence in education, see Bagde et al. (2016), in politics see Baltrunaite et al. (2014), O'brien and Rickne (2016), Besley et al. (2017), Bagues and Campa (2021) and in corporate boards see Bertrand et al. (2018).

[9] Niederle et al. (2013) show that a quota increases the number of high performing women who enter a tournament, see also Ibanez and Riener (2018) for a field experiment in Colombia.

[10] See Bertrand et al. (2018) for women in corporate boards in Norway and Bagde et al. (2016) for women in engineering schools in India. In contrast, in Bagues et al. (2017) women selected to be in academic committees do worse than their non-selected peers (private communication, Manuel Bagues, 2022).

In politics, gender quotas sometimes led to more women being elected or being in leadership positions, even after the elimination of the quota, see e.g. Beaman et al. (2009), De Paola et al. (2010), O'brien and Rickne (2016), though not always (Bagues and Campa 2021). Both Beaman et al. (2009) and De Paola et al. (2010) suggest that results are driven by changes in voter attitudes, specifically perceptions of the effectiveness of female leaders and a weakening of gender stereotypes, though see Broockman and Soltas (2020). This latter finding highlights that gender quotas can have additional externalities. First, they can affect opinions of others. Second, political leaders in India tend to invest in infrastructures relevant to the needs of their own gender (Chattopadhyay and Duflo, 2004).[11]

Overall, evidence of spillover and trickle down effects of an affirmative action quota on the pool of women has been difficult to find most environments.

Finally, a gender quota may adversely affect men. First, of course, by women displacing men. More generally, it might be important to evaluate effects on the pool and quality of men available for the task at hand. This is mostly not addressed and mentioned basically only in politics, where Besley et al. (2017) in Sweden and Baltrunaite et al. (2014) in Italy argue that mediocre male leaders were largely displaced.[12]

Overall, our paper contributes to the literature on gender affirmative actions quotas by cleanly showing positive effects on selected women. More importantly, we are quite uniquely able to show clean evidence of significant spillover and trickle-down effects on the pool of women, as well as on their quality. We are also able to show that there were no large negative effects on the pool of men. In the last section of the paper we hypothesize how the quota operated. We discuss how such a quota or a milder subsidy might be implemented in other environments, where we focus on universities as a possible application. We end the paper by discussing different ways to promote women and how they differ in their incentives for organizations.

2 Effects of Affirmative Action, Context and Data

We explain the Elo rating, provide a quick history of women in chess, describe the French Club Championship, and finally the affirmative action policy implemented in 1990.

[11] However, Zonszein and Grossman (2022) in the UK found that a victory of ethnic minorities mobilizes white voters. While this does not, in general, overpower the minorities' incumbency advantage, it polarizes the electorate. This is reminiscent of the backlash observed in Bagues et al. (2017).

[12] In Otero et al. (2021) a quota on minorities did not significantly harm displaced majority students.

2.1 Performance Measure in Chess

Chess provides a good measure of performance ability: the Elo rating (Arpad Elo, 1978). The universal use of the Elo rating since the 70's allows us to compare players across gender, countries and even time.[13] The numerical Elo score determined by the history of play (every official game counts) predicts the performance in future matches (see e.g., De Sousa and Hollard, 2015 and Backus et al., 2022).

While official calculations are given by tables in the FIDE handbook, it also contains the following approximation.[14] If player i plays against j, let E_{ij} be i's expected score, and let S_{ij} be i's actual score, which is 0 for a loss, 0.5 for a draw and 1 for a win. The expected score E_{ij} depends on Δ_{ij}, the difference between i's and j's ratings, and a weight α:

$$E_{ij} = \frac{1}{1 + 10^{-\frac{\Delta_{ij}}{\alpha}}}. \tag{1}$$

After the game, player i's rating of $Elo_{i,t-1}$ is updated to $Elo_{i,t} = Elo_{i,t-1} + K_i(S_{ij} - E_{ij})$, where K_i is player specific, and larger for lower ranked players and beginners.[15]

Equation (1) with $\alpha = 400$, as proposed by FIDE, predicts for each difference in Elo ratings between players i and j the chance that the lower ranked player wins, see the "FIDE formula" line in the Appendix Figure 21. For example, if player i has 100 fewer Elo points than j, i has an expected score of 0.36, that is a 36 percent chance of winning, and a 64 percent chance of losing (see Online Appendix J for details). Additional factors increase the accuracy of predicting the winner. An important one is whether the person plays with white (moves first) or black (moves second). De Sousa and Hollard (2015) using over two million chess games show that, ceteris paribus, white wins more often than black (53.1%), which corresponds to about 22 Elo points.[16] Another predictive variable, especially relevant given our investigation, is gender. Women, when playing against men,

[13] See Appendix K.1 for a short story of the adoption of the Elo rating. Since new players start with Elo points they can lose, it is possible that Elo points become inflated over time. However, many players "retire" with their Elo points. Kasparov, for example, still has an Elo rating of 2812, just shy of his peak rating of 2851 and one of the authors still has a rating of 2264, though not quite at the peak of 2395.

[14] See Section B of the FIDE handbook (https://handbook.fide.com/chapter/B022017).

[15] K never increases over a player's lifetime. For players with the same K, the Elo points a player loses are transferred 1:1 to the winning player. For details on the exact K, see Online Appendix K.2.

[16] See also González-Díaz and Palacios-Huerta (2016) for similar evidence. Presumably for this reason the official tournament rules governing which player receives white are very elaborate and precise, see Section C of the FIDE handbook (https://handbook.fide.com/chapter/C0401).

systematically underperform by about 10 (De Sousa and Hollard, 2015) or 25 (Backus et al., 2022) Elo points.[17] Hence, keeping all else equal, women have only a 49 (or 47) rather than a 50 percent chance of winning against men.

2.2 Women in Chess

While, in principle, "[...] skill rather than age, size or gender is what counts in chess", chess is very male dominated.[18] In the not so distant past, there has been open derision of women in chess. For example, Garry Kasparov, the 13^{th} World Chess Champion said about Judit Polgár, the best female chess player: "She has fantastic chess talent, but she is, after all, a woman. It all comes down to the imperfections of the feminine psyche. No woman can sustain a prolonged battle."[19] Even recently, in 2015, UK's greatest chess player, Grandmaster Nigel Short "incurred the wrath of the female chess community after claiming men are 'hardwired' to be better at the game than women." He said "we should 'gracefully accept it as a fact' that men posses different skills to women, that make them better able to play chess at a high level."[20] The best player in the world, Magnus Carlsen acknowledges that "Chess societies have not been very kind to women and girls over the years. Certainly there needs to be a bit of a change in culture."[21]

As of July 2022, women represent 10.1% of active FIDE rated players. Of the 1,764 living Grandmasters (GMs) – the highest title in chess – only 39 are women. Even more extreme is the fact the best female player, Hou Yifan, is ranked 101 in the world, and only 7 additional women are among the top 500 best chess players. Some highlights of female chess players further showcase the gap to male players. Nona Gaprindashvili was the

[17] The fact that women underperform when competing against men is reminiscent of findings on competitiveness by Gneezy et al. (2003).

[18] The quote is from an August 19, 2017 Photograph by Lennart Ootes, titled "John Urschel vs. Rachael Li at the 2017 Ultimate Moves Match". The description includes: "Here, former National Football League player (Baltimore Ravens) and mathematician (MIT) John Urschel is playing against seven-year-old Rachael Li of Plano, Texas, as part of the 2017 Ultimate Moves Match held at St. Louis Chess Club as a fun side event accompanying the annual Sinquefield Cup and Saint Louis Rapid & Blitz tournaments. Urschel, a US Chess-rated class B player (1723) was defeated by Li, who in January 2019, with a rating of 2079, is the top-rated eight-year-old player in the United States - girl or boy."

[19] In September 2002, in the Russia versus the Rest of the World Match, Polgár finally defeated Garry Kasparov. Judit Polgár is also reported as saying in 2001: "My sister Susan – she was 16 or 17 – said that she never won against a healthy man. After the game, there was always an excuse: 'I had a headache. I had a stomach ache.' There is always something."

[20] Quotes from the article "Nigel Short says men 'hardwired' to be better chess players than women" by Hannah Ellis-Peterson published on Monday April 20, 2015 in the Guardian.

[21] Quotes from the interview by Archie Bland of Magnus Carlsen on November 21, 2020 in the Guardian.

first woman to receive the GM title in 1978, though as a special title. Quite ironically, the *The Queen's Gambit*, which could be viewed as advancing female chess players, dismissed Nona Gaprindashvili's achievements.[22] Only in January 1991, two decades after the modern system of GM norms was introduced, did the first woman, Susan Polgár, earn a Grandmaster on the same basis as men.[23] She was also the first woman to enter the top 200 in January 1987. In December 1991, Judit Polgár fulfilled the GM requirements at the age of 15 years and 5 months, breaking the record as the youngest player to have done so, a record previously held by former World Champion Bobby Fischer.[24] Judit was also the first woman to enter the top 100 in 1989, at the age of 12! Unfortunately, these results were outliers rather than the beginning of a new era; Judit Polgár's top ranking of number 8 in the world in 2004 is still unparalleled. Chess was and remains very male dominated.

2.3 National Club Championship

While chess is often played individually, important team events are National Club Championships such as the one in France,[25] which in 2015 consists of 455 clubs from 416 cities in five hierarchical divisions.[26] Players are registered in only one club at a time and in general play in at most one division.[27] 8,757 players participated in the French CC in 2015, which represents 27.8% of active players (see Table 5 in Data Appendix A.1).[28] Hence, a large fraction of French chess players participate in Club Championships.[29]

[22]What might be especially jarring is that the words of contention did not play any particularly important role for the plot. Talking about the lead character of the show, a commentator says: "The only unusual thing about her [the main character from the Queen's Gambit], really, is her sex, and even that's not unique in Russia. There's Nona Gaprindashvili, but she's the female world champion and has never faced men." As a result Nona Gaprindashvili, who is *Georgian*, is suing Netflix for defamation asking for at least $5 Million in damages as reported on September 16, 2021 in the New York Times and on September 18, 2021 in NPR.

[23]See the Online Appendix K.1 for details on FIDE chess titles.

[24]Ironically, Bobby Fischer in a 1963 Canadian Broadcast Corporation interview said about women: "They're terrible chess players... I guess they're just not so smart ... I don't think they should mess into intellectual affairs, they should keep strictly to the home".

[25]While many European countries have active Club Championships, they do not play a large role in the US. In 2015, the US Chess League consists of only one division with 20 clubs divided into two groups: East and West.

[26]In France, the first two divisions have been created in 1981. The third, fourth and fifth regional divisions turned national in 1986, 1995, and 2004, respectively (see Online Appendix I.3 for details).

[27]Under the current rules, each club can only have one team in each of the first two divisions, and in general has at most one team in each of the other divisions (the average number of teams per club is 1.5 in 2015). A player can only play in a given division if they played at most 2 games in better divisions.

[28]Active players are players who paid their chess dues to the federation for the season regardless of the number of games they play, see Online Appendix I.1.1 for details.

[29]In Online Appendix A.1 we provide additional data on which players participate in CCs.

In general, a match in the French CC is contested over 8 or 9 individual games or "boards" depending on the division and year.[30] Essentially, the top players of each team (by Elo rating) compete in the "first board," the next in the "second board," and so on (see Appendix Table A1 for a match example).[31] Within a team, if any two players are rated more than 103 points apart, the higher rated player must play on the higher board.[32] All boards play a normal chess game. The results of each board (0 for a loss, 0.5 for a draw and 1 for a win) contribute equally to the final score of a team. The team with the higher final score wins and receives three match points compared to one match point for the losing team.[33] A draw results in two match points for each team. The final ranking of teams in a division (and group) is based on the total number of match points.[34] Currently, the three worst teams in division 1 are relegated to division 2, and the best teams in each of the groups from division 2 move to division 1. Similarly, end of season team placings in other divisions determine promotions and relegations for the next season.

2.4 Affirmative Action Quota in France

Before September 1990, every match in the Club Championship was contested over 8 boards, i.e. 8 players against 8 players. In September 1990, an additional ninth board was introduced in division 1 with the requirement that every team had to include at least one French female player. In 1991 and 1992 the same expansion of boards and requirements were introduced in division 2 and division 3, respectively.

In 2004, divisions 2, 3 and 4 were restructured such that almost the entirety of division 3 was pushed into division 4.[35] Perhaps as a result, the gender quota was imple-

[30] Some exceptions are in division 5 in 2002 and 2003, where matches were contested in 4 boards (in Auvergne), in 5 boards (in Bretagne, Bourgogne, Corsica and East Côte d'Azur), and in 6 boards in Languedoc-Roussillon, Midi-Pyrénées, Pays de la Loire, Picardie, Provence, West Côte d'Azur and in some groups in Ile-de-France. In Champagne, matches were contested in 6 boards in 2003 (information is missing in 2002).

[31] First board colors are randomly assigned to teams at the beginning of the Championship. Then, the colors switch on alternating boards.

[32] This number fluctuates, and for example was reduced to 100 points for the 2015 season.

[33] A match lost by forfeit (when the whole team fails to show up) results in zero points.

[34] The top teams in division 1 qualify for the European Club Cup.

[35] Specifically, two-thirds of division 2 moved to division 3, which kept 10 percent of the original division 3 teams. The rest of division 3 became division 4, where the missing "tenth" is kept from the previous division 4 (hence division 4 had as many teams as division 3 used to have). The rest of division 4 together with a large fraction of the previous division 5 teams was renamed division 5 (though from 2003 to 2004 the total number of teams from divisions 1 to 5 was reduced by about 100). For the exact number of teams per year and division, see Appendix Table 3.

mented in the fourth division in 2004.[36]

The penalties for failing to fulfill the quota are quite large. A team without an eligible female player not only loses the game in the last board, but in addition receives a penalty of one point, implying the team loses an equivalent of 2 games. A forfeited board, in addition, carries a monetary fine in the top two divisions.[37]

Which female player was eligible to fulfill the quota changed over time. Until 1995 it was a female player with either French citizenship or registered at FIDE with a French country code (where each player can only have one FIDE country code, which need not be the country of citizenship). In 1996, to comply with the EU single market regulations, any EU female player (by citizenship or FIDE code) was eligible. That year, new female players in division 1 included Pia Cramling (Elo rating 2545) from Sweden, as well as Isabel Delemarre (2215), Veronika Kiefhaber (2180) and Anke Lutz (2200) from Germany. In 1997, they were joined by Natasha Regan (2160) and Heather Richards (2130) from the UK who played for the division 1 club Lille. Perhaps as a response, a year later, in 1998, the rule was for each team to have one French man and one French woman, by citizenship or FIDE code, which complies with EU rules. Finally, since 2007, a woman is eligible to fulfill the quota only if she has French citizenship.

While the requirements for the quota changed over time, the idea was to promote the development of French female players. Even though there was no clear dramatic event that was mentioned as the reason for the affirmative action requirement, perhaps the fact that the best female French player, Christine Flear, decided to change her FIDE affiliation and play for the UK in 1989 might have played a role.

The quota was the result of a quite contested meeting of the French Chess Federation in January 1990. Given the minutes of the meetings (see Online Appendix I.4), it is safe to assume that teams were not certain such a new requirement would be implemented and most likely had about 8 months to find a French female player for their team for the start of the 1990-1991 season in the Fall of 1990.

While the proposal was controversial in the meeting, the reception among the chess community and especially the female chess players was positive according to chess mag-

[36]The quota in division 4 was subsequently removed in 2014, which did not coincide with a restructuring of the national divisions. Furthermore, in one region, Basse Normandie, there was a quota in the fifth division between 2005 and 2009 (see Appendix Table 6).

[37]Currently, the fine is €300 and €200 in divisions 1 and 2, respectively, with fines for the whole team forfeiting the match being up to €3,000.

azines.[38] Private communication with two female players who played in Club Championships not only after, but also before the introduction of the quota, indicates they welcomed the quota.[39] We suspect that there are two main reasons for the positive reception of the quota. First, the quota was accompanied by an increase in the number of boards. Hence, adding a female player did not displace any existing team member. Second, the best clubs may have intuited that they would likely be able to attract one of the few high performing female players, giving them an easy win over other teams on the ninth board.

2.5 The Data

To explore the impact of the gender quota, we use four data sets.

The French Club Championship The data on Club Championships come from four different sources. The main data source is the French Federation website for divisions 1 to 3 from 2001 to 2015, and for divisions 4 and 5 from 2002 to 2015.[40] We also used the on-site archives of the French Federation to gather most of the match data of division 1 from 1986 to 2000, divisions 2 and 3 for the year 2000, and divisions 4 and 5 for the year 2001 (see Appendix A.1, which details the three different layers of data: teams, match-ups and games). To gather missing division 1 data, we used old issues of the French-language chess magazine *Europe Echecs*, and its internet forum *France-Echecs*. We are particularly grateful to GM Glenn Flear and IM Daniel Roos for sharing privately collected data.

As a result of our efforts, from division 1 we have data on all 423 teams[41] from 1986 to 2015 and all but 11 of the 2313 match-ups. These match-ups result in 19,864 games, where we miss 88 (less than 0.5 percent). We have a total of 185 and 1275 unique female and male players, respectively. In all 5 divisions we gathered data from all 10,505 teams of which 3,952 played under the quota (see Appendix Table 3 for a breakdown by division and year). We have data from 42,077 of the 42,175 match-ups and 340,036 of the 340,987 individual games, in each case missing less than 0.3 percent of the data. The data contain 29,931 chess players, of which 3,325 are women. A total of 11,112 men and 2,353 women

[38] See for example the interviews in the number 386 of the French-language chess magazine *Europe Echecs*, https://www.europe-echecs.com/, of April 1991 that we reproduce in the Online Appendix I.5.

[39] One of those players, Chantal Chaudé de Silans, meanwhile deceased, was the chess coach of one of the authors, and the other, Christine Flear, was interviewed by us in the spring of 2019.

[40] See http://www.echecs.asso.fr. The data are organized by season from September to August.

[41] A team is defined as the seasonal representation of a club.

played under the quota at least once (for details see Appendix A.1.)

The Administrative French Data Data from the French Chess organization cover all players registered in France from 1984 to 2015. For each player we observe the federation (FIDE country code), age, gender, national Elo rating (updated yearly), and, when available, the FIDE rating. Some of those players have not paid their dues in years and are even deceased. We therefore restrict attention to active players; players who paid their federation dues for the season, regardless of whether they played any games.[42] This leaves us with 150,550 players from 1984 to 2015, of which 26,472 (17.6 percent) are female. For more information see Appendix A.2.

For the Elo rating of Club Championship players, we use the one reported during the match. This is the most recent FIDE rating (if the player has one), and otherwise the most recent rating from the French Chess Federation, see Online appendix I.1.2.

The Administrative Belgium Data Data from the Belgium Chess Federation cover all players registered in Belgium from 1988 to 2014, where we have information similar to the one on French players. We only use active players, those who paid their dues for the season (regardless of the number of games they play). This leaves us with 25,180 players, of which 2,287 (9.1 percent) are female. For more information see Appendix A.3.

The FIDE Data Data from FIDE cover all FIDE rated players from 1967 to 2015 (where the first official list was from 1971) that contain the name, age, gender and FIDE rating of all FIDE rated players in the world. We restrict attention to active FIDE players from the EU-15 from 1984 to 2015. These are players who played at least one FIDE game in a given year under an EU-15 FIDE country code.[43] This leaves us with 90,508 players of which 5,709 (6.3 percent) are women. For more information see Appendix A.4.

[42] Before the new millennium, we do not have access to all official games. We can therefore not meaningfully condition whether players who paid their dues actually played an official game. For consistency across years we therefore restrict attention to players who paid their dues.

[43] Countries in the EU-15 are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the United Kingdom. One common issue with including Germany is the reunification in 1990, which happened in the same year as the introduction of the quota. We therefore, before 1990, include both data from East and West Germany in the German country data.

3 Effects on Women Selected by the Quota

To study women selected by the quota, we consider the top division and the lower divisions of the Club Championship separately. While there are only a few players in the top division, available data go back to before introduction of the gender quota. We present detailed results for the top 12 teams, and then in Section 3.2 for the next 208 teams.

We face some empirical challenges. One problem is that the number of teams in division 1 changed over time (see Appendix Table 3). There were 10 teams in 1986, 12 from 1987 to 1992, then 16 up to 2009 at which point it fluctuated between 11 and 12 until 2015. To avoid moving from a larger selection of players (15 or 16 teams) to a smaller, more elitist one (11 or 12 teams), we consider the top 12 teams from 1987 to 2015, and the best 10 teams in 1986. When there are more than 12 teams in division 1, we select the 12 best ones, when it is smaller (11 in 2011 and 2013) we add the best team from division 2.[44] We cannot perform a similar exercise in 1986, since in that season we only have division 1 data. We refer to these data as the *Top 12*. The *Top 12* contain 3,890 match-teams, of which 462 are from before the quota (1986-1989). For each team, a match-team consists of the players who represented their team (or club, actually) at that particular match-up (see Appendix B for details).

When we consider the lower divisions, we face the conundrum of the reorganization of the league in 2004. We therefore consider the *Next 208* teams from 2000 to 2013. This represents the maximum additional number of teams in divisions 2, 3 and 4 for which we have data and which fall under the quota rule.[45] When more than 220 teams fall under a quota, we require teams to have played at least one third of their matches and select teams based on the average rating of the best female players in their match-teams (see Appendix C for details). We can hence compare the "best" women over the years, rather than rely on a perfect correlation between average Elo ratings of the whole team and the best female player. For robustness, we also show results in Online Appendix M when considering all teams under the AA quota or the top 118 teams.

Given the changes in the eligibility requirement, we present results using the best female player in a team, even if she is not currently eligible to fulfill the female quota. We

[44] Specifically, for each division 1 and division 2 team we compute the average Elo rating of the team for each match-up, and then average over the number of matches per season. Due to the reshuffling of teams at the end of each season, high performing division 2 teams have in general at some point played in division 1.

[45] Adding 2014 and 2015 would reduce the number of teams under the gender quota to 118 teams.

do, however, want to assess the effect of the quota beyond that of having accomplished female players migrate to France. We therefore define a chess player as homegrown if the player started playing in France, specifically received their first FIDE rating while playing for France.[46] A homegrown player need not currently play for France nor be French, but must have learned chess or more specifically started their chess career while representing France. We present results using the best female player in a team, and sometimes when we restrict attention to those who are homegrown.

3.1 The *Top 12*

We first show the effect of the quota on the representation of women in Club Championship (CC) games. After this extensive margin analysis, we consider the intensive margin, specifically performance abilities of women in CCs. We find that women's Elo ratings increase. We study whether gains are driven by new women entering the *Top 12* or by women in CC's gaining Elo points and if so how: through (quota) CC games, standard tournaments, or (CC-wide) trends in Elo ratings.

3.1.1 Extensive Margin: Number of Women

Given the severe penalties for failing to have a female player, we expect at least one woman per team. Figure 1A shows for each year the average number of woman per match for each team (match-team). Before 1990, the average number of women per match-team was below 0.2.[47] With the introduction of the quota in 1990 the number of women per team jumped to 1, the quota requirement, and stayed just slightly above 1 during 25 years (except in 2003 where a team, *Nancy*, played 4 matches without a female player).[48]

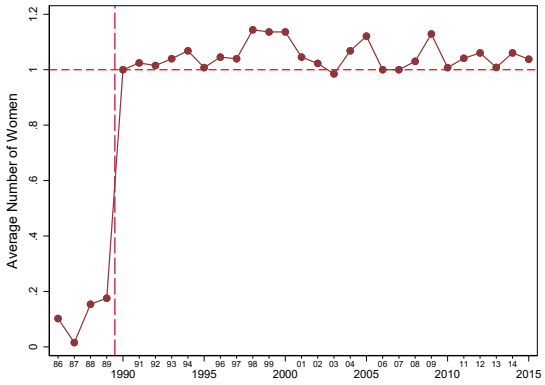
[46] For example, Almira Skripchenko, a Moldovan-French player, holds the IM title since 1998 and received a French FIDE code in January 2002. She attained that year a peak Elo rating of 2498 and became the best French female player until April 2006 (winning six French Women's Chess Champion titles). This phenomenon dates back to the breakdown of the Berlin wall which triggered a wave of migration of Eastern European players to France. Naturalized women then became eligible to fulfill the quota. An iconic example of a homegrown player is Marie Sebag, who became the top ranked French female player in April 2006. Sebag obtained the IM title in 2003 and was the first French female player to earn the GM title in 2008.

[47] In 1989, 3 women played 20 games: Christine Flear (2185 Elo) 11 games, Céline Roos (2125) 5, and Nicole Tagnon (2115) 4. In 1988, 2 women played 20 games: C. Flear (2170) 10, and N. Tagnon (2175) 10. In 1987, only one woman played, Chantal Chaudé de Silans (2000) who played 2 games. In 1986, 3 women played 9 games: C. Flear (2170) 5, C. Chaudé de Silans (2000) 2, and Christiane Piquemal (1870) 2.

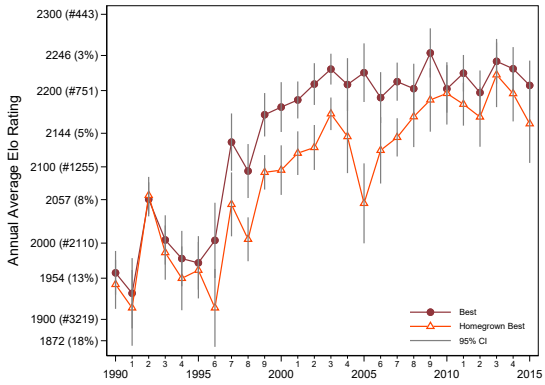
[48] Appendix Figure 28 restricts attention to eligible female players and yields a very similar pattern. Basically, the spikes above 1 in Figure 1A in 1998, 1999, 2005 and 2009, are largely due to non-eligible women.

Figure 1: Women in the *Top 12*

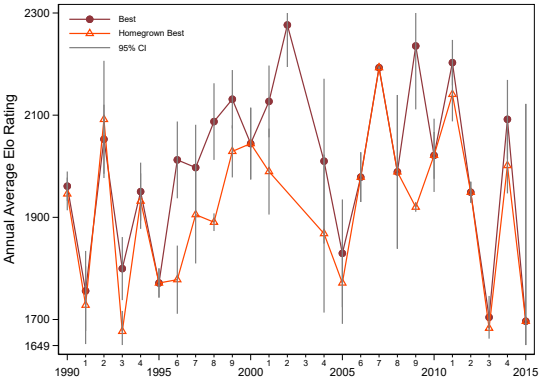
A: Average Number of Women



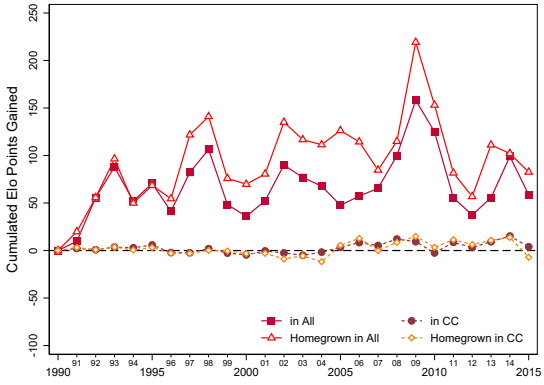
B: Performance - Best Women



C: Performance - Best Women - First Year



D: Points Gained in and outside of CC



Notes: (A) Average number of women in each match-team. Data from 3,473 match-teams with at least one woman, totaling 153 women between 1986 and 2015. The quota was introduced in 1990 (vertical line) requiring one woman per match-team (horizontal line at 1). (B) Average Elo rating of the "Best" female player in the team and when we restrict attention to those who are "Homegrown Best", data from 144 (111) Best (Homegrown Best) women in the Top 12. (C) Average Elo rating of the best female player in the team the first year she has that position "Best" and when we restrict attention to homegrown players "Homegrown Best", data from 144 (111) Best (Homegrown Best) women in the Top 12. (D) "(Homegrown) in CC" means cumulated points gained by (homegrown) best women in Club Championships. "(Homegrown) in All" means cumulated points gained by (homegrown) best women in all competitions.

Since a goal of the quota was to promote French female players, we compute the average number of homegrown women per match-team. This average hovers around 0.8 in the early nineties and since 2000 is around 0.6. Such a drop is also present among men: In the early nineties 6 (of the remaining 8 players) were homegrown, which, since 2006 dropped to 4 or less (of the remaining 7 players), see Figure 14 in the Online Appendix.

While the quota ensured that women play in Club Championships, there is no indication that women are represented above and beyond the required quota.

3.1.2 Intensive Margin: Performance Ability of Women

To study whether the performance of selected women improved over time, we compute the average Elo rating of the best female player in each team. We weigh each female player by how often she was the best female player in a match-team.

Figure 1B shows that the average Elo rating of the best female player in the team increased from 1961 in the year 1990, when the quota was introduced, to 2207 in 2015. An OLS regression on time delivers a slope of 11.43 (s.e. of 1.41).[49] Results are similar when among the best female players we restrict attention to homegrown players (see "Homegrown Best" in Figure 1B),[50] and, in Appendix N, when we consider the best eligible female player (Figure 32), or, among the best female players the median (Figure 33), top 25th (Figure 34), or bottom 25th percentile of Elo ratings (Figure 35).

We provide several measures to put those Elo numbers in perspective. First, using all active players in France in 2015, we show on the y-axis of Figure 1B the rank a player with a given Elo rating would have. Likewise, we indicate thresholds of Elo ratings that put a player, in 2015, among percentiles of top players.[51]

To understand the enormous gains women made, note that the average CC-woman in 2015 had an 80 percent chance to win against the average woman in 1990. The change in Elo ratings would mean a player climbed more than 1500 spots in the 2015 ranking, and moves from the top 13 to the top 3 to 4 percent of French players in 2015.

3.1.3 How Are the Elo Gains Achieved?

There are two ways for the Elo ratings of women selected by the quota to increase. First, it could be due to replacing female players with higher performing ones over time. Second,

[49] Specifically, we regress the average Elo rating of the best female player in the team on a year trend for the 26 years in our *Top 12* data since the introduction of the quota in 1990. The coefficient is 11.43, with a robust s.e. of 1.41, $p < 0.01$ and $R^2 = 0.73$.

[50] When we regress the average Elo rating of homegrown players among the best female player in the team on a year trend for the 26 years in our *Top 12* data since 1990, we obtain a coefficient of 10.79, with a robust s.e. of 1.20, $p < 0.01$ and $R^2 = 0.77$.

[51] For example, a player with an Elo rating of 2200 would be the 751st best player in France in 2015, and to be in the top 3% of players one would need an Elo rating of 2246.

women who play for several seasons in CCs could increase their performance over time.

To show the impact of replacing a *Top 12* female player with a new, and potentially higher performing one, we show in Figure 1C the average Elo rating of the best female player in a match-team when we restrict attention to the first year a woman held that position.[52] An OLS regression of the average Elo rating on time delivers only a coefficient of 1.69 (s.e. 4.80).[53] The estimated parameters from this regression are statistically different from the ones obtained when we used all years of the best female player instead of just the first year.[54] Therefore, observed gains have to be driven by women who play more than one season and improve their Elo rating during their CC tenure.

To compute the Elo gains female players made during their CC tenure, we focus on the best female players who were active in more than one season. Of the 153 women in the *Top 12* from 1990 to 2015, 144 were at least once the best woman of which 111 are homegrown, and 74 played for more than one season of which 56 are homegrown. Christine Flear, whom we mentioned earlier, is one of those best women. She won 50 Elo points in the 1990 season, going from a rating of 2160 to 2210. Hence, in 1991, we would say she gained 50 Elo points during her CC tenure since 1990. Her highest beginning of the season rating of 2257 was in 2004. Since she played in the *Top 12* every year since 1990, she has, in 2004, gained 97 Elo points during her CC tenure since 1990.

In general, consider a woman who is the best female player in her match-team in the *Top 12* in season t (starting in the Fall of year t until the end of Summer of year $t+1$), season $t+k$ and season $t+k+l$ only. Let Elo_t be the Elo rating of September in year t. Then our female player in year $t+k+l$ gained $[Elo_{t+k+1} - Elo_{t+k}] + [Elo_{t+1} - Elo_t]$ Elo points during her CC tenure as a best female player in the *Top 12* since t (for $t \geq 1990$). Figure 1D shows the Elo gains female CC players made during their CC tenure (red solid square line "in All") where in each year the female player is weighted by her appearances as a best female player in her match-team. "Homegrown Best in All" shows the same,

[52] If, alternatively, we consider all female players in the *Top 12*, and for each woman consider the first year in which she played in the *Top 12*, the results are similar, see Appendix Figure 39.

[53] Specifically, we regress the average Elo rating of the best female player in the team when we restrict attention to the first year a woman held this position on a year trend for the 26 years in our *Top 12* data. The coefficient is 1.69, with a robust s.e. of 4.80, $p = 0.728$ and $R^2 = 0.0069$. When we further restrict attention to homegrown female players, the coefficient is 2.87, with a robust s.e. of 4.44, $p = 0.524$, $R^2 = 0.0244$.

[54] The estimated parameters (1.93 + cst) from this fit are statistically different from the "best women" linear fit (slope = 11.43 + cst): F(2, 47) = 9.20; $p < 0.01$. When we restrict attention to the first year of homegrown best female players, the estimated parameters (2.52 [s.e. = 4.37] + cst) from this fit are statistically different from the "best homegrown women" linear fit (slope = 10.90 + cst): F(2, 46) = 15.88; $p < 0.01$.

when we, in addition, require the best female player to be homegrown.

Figure 1D shows that *Top 12* women gain significant Elo points during their tenure. Our preferred explanation is positive effects of the quota. There are however alternative explanations. We discuss some next, as well as in following Sections.

3.1.4 Possible Alternative Explanations for CC-Women's Elo Gains

A first contributor of CC women's Elo gains are the CC games women play as a consequence of the quota. A more mundane explanation for women's gains in Elo ratings are CC-wide Elo trends that apply to all high performing chess players, men and women.

Gains driven by CC games — The points from the extra CC games a woman plays due to the quota can increase or decrease a woman's Elo rating. On average, over the years of 1990 to 2015, the best woman loses 0.136 Elo points in each Club Championship game, a loss that increases to 0.233 per game if we restrict attention to homegrown players. For all female players in the *Top 12*, the average loss per CC game is 0.106.

While the best female player on average loses Elo points in CC games, the story may be different if we focus on women who play in CCs for more than one season. We mentioned Christine Flear whose Elo rating during the 1990 season increased by 50 points. In that season she played 9 CC games. However, in those games she actually *lost* 11.8 points. When we restrict attention in season t to female players who also play a CC game in the *Top 12* in some future season $t + k$ with $k \in \mathbb{N}$, the average loss per game is still 0.114.

Recall that we computed for a woman in (the beginning of season) $t + k + l$ who is the best female player in her match-team only in season t, season $t + k$ and season $t + k + l$, the Elo points she gained during her CC tenure as a best female player in the *Top 12* since t (for $t \geq 1990$). Similarly we can compute the Elo points she gained *only from CC games* in the *Top 12* during her CC tenure as a best female player in the *Top 12* since t.

The results are in Figure 1D, where we weigh a female player in each year by how often she was the best woman in her match-team. The Figure shows that the gains due to CC games are negligible and dwarfed by the total Elo gains. Figure 1D shows the conclusion holds when we restrict attention to homegrown women among the best female players. Appendix Figure 43 shows that the result does not change when we include the Elo points women gained in Club Championship games outside the *Top 12*.

An additional way the experience of playing in a CC game could affect a woman's performance ability is through her being matched with an extraordinary player and perhaps receiving a "Masterclass" lesson. However, women largely play on the last board, and hence against the weakest member of the opponent team, and in fact about two thirds of the time against the other woman. For more details see Appendix F.

Gains driven by CC-wide Elo trends — Another possibility for women's Elo gains could be CC-wide Elo trends that apply to male and female players. Such trends could be due to the advent of chess computers, which may increase the effectiveness of training, or the influx of great chess players, a phenomenon driven by the fall of the iron curtain.

We consider two such possible CC-wide Elo trends. First, all CC players could experience a raise in Elo ratings. We therefore compare the best female player in a match-team to her marginal male teammate. If we find a decrease in the difference in Elo ratings over time, the gains by female players are not due to a CC-wide inflation of Elo points. Second, it could be that Elo ratings of CC players converge, making players more homogeneous. This might, at least partially, account for the closing of the gap between a female player and her marginal male teammate. We address this by comparing the Elo gains of the marginal man to those of the woman as well as to those of the penultimate man in a match-team, and in general between any two teammates on adjacent boards.

One problem when comparing the Elo rating of the female player to her marginal male teammate, is that the number of teammates has changed over time. While it went from 8 to 9 in 1990 to accommodate a female player, it went back to 8 in 2006. By considering the whole period, from 1990 to 2015, we would thus compare the woman to the 8^{th} ranked male player in the match-team until 2006 and the 7^{th} ranked player from then on (a presumably better player). To avoid this bias, we first only consider data from 1990 to 2005. We have 2,006 match-teams where the best female player can easily be compared to her 8^{th}, i.e., her lowest rated male teammate (see Appendix Table 10).[55]

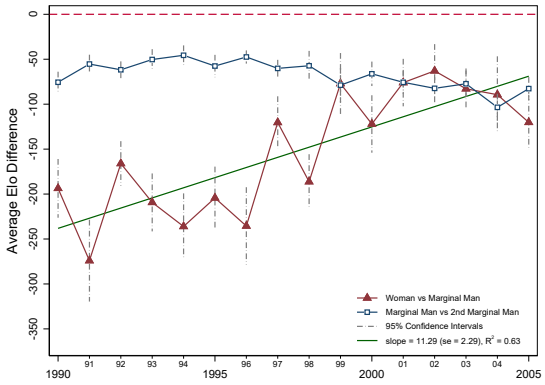
To compare player's Elo ratings, we regress logged Elo ratings on the players' logged age and a rich set of fixed effects:

$$\ln Elo_{it} = \alpha_0 + \alpha_1 \ln Age_{it} + \gamma_f + \delta_d + \lambda_c + \theta_t + \epsilon_{it}, \tag{2}$$

[55] From 2,140 available match-teams, we keep the 2,012 match-teams with only one female player. Then, we discard the 6 match-teams where the team forfeited one board in the match to construct our sample of 2,006 match-teams to compare the best female player to her 8^{th} male teammate (see Appendix Table 10).

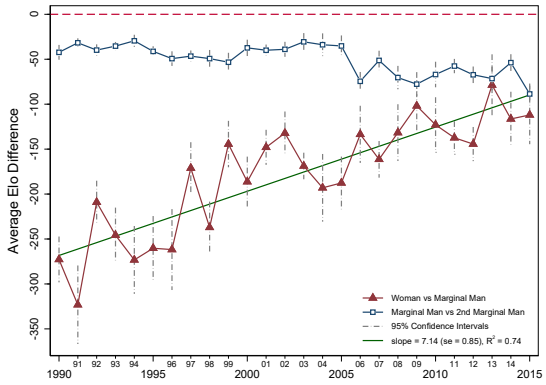
Figure 2: Relative Elo ratings in the *Top 12*

A: 1990-2005



Notes: For each year from 1990 to 2005 and 2,006 match-teams (see column 6 in Table 10), the average difference in conditional Elo ratings between the best woman and the marginal man as well as between the marginal man and the 7th best man in the match-team with 95% confidence intervals. Slopes from OLS regressions on a yearly trend.

B: 1990-2015



Notes: For each year, from 1990 to 2015, for 3,245 match-teams (see column 6 in Table 10), the average difference in conditional Elo ratings between the best woman and the 7th best man as well as between the 7th and 6th best man in the match-team with 95% confidence intervals. Slopes from OLS regressions on a yearly trend.

where Elo_{it} and Age_{it} are the Elo rating and age of player i at time t, respectively. The set of fixed-effects are the player's federation γ_f, the club's division δ_d, the club's city λ_c, the season θ_t, and ϵ_{it} is the usual error term. We use the residuals of the Elo regression (2) to compute a "conditional Elo rating" variable.

In Figure 2A, we plot the average woman's conditional Elo rating (weighted by match-team appearances) minus that of her marginal male teammate from 1990 to 2005. The initial Elo gap of 250 shrinks to less than 100 over 15 years. Using a simple OLS regression of this average of conditional Elo differences on a yearly trend, we obtain a coefficient of 11.29, with a standard error of 2.29. Hence, women's Elo ratings increased not only on absolute terms, but also when compared to her marginal male teammate.

There is no such convergence in Elo ratings when we compare the average conditional Elo rating of the 8th male to the 7th male teammate, see "Marginal Man versus 2nd Marginal Man" in Figure 2A.

To exploit all data from 1990 to 2015, we compute the average difference in conditional Elo ratings between the best female player and her 7th best male teammate (who becomes

the marginal male in 2006) in 3,245 match-teams.[56] Figure 2B documents that the Elo gap is closing at an average pace of a significant 7 Elo points per year. We confirm that the effects are not driven by general trends by computing the average difference in Elo ratings between the 7th and 6th best player in a match-team. In the Online Appendix we show the same difference for all other adjacent boards and similarly find no closing of the Elo gap that even remotely compares to the one we observed between a woman and her 7th board male teammate.[57, 58]

All results are similar when we focus on homegrown women among the best female players, see Online Appendix O.

3.1.5 Women's Gains across Teams

We showed that the quota resulted in each match-team in the *Top 12* essentially having one woman. While the average Elo rating of the female players increased dramatically, they are still largely the player with the lowest Elo rating in their team. The relative ranking within a team may, however, mask the important strides women made when we consider their relative performance across teams.

Specifically, suppose teams instead of having 9 players consisted of 8 players without any quota requirement. How many female players would we expect in such "merit reduced teams" where players are selected from the pool of *Top 12* players based *only* on their Elo ratings? While the woman from a top team might be "cut" because she has the lowest Elo rating among her teammates, she could still outperform men from lower ranked *Top 12* teams. As such we ask whether the efficiency, as measured by the Elo ratings of such *merit reduced teams*, increased with the introduction of the quota.

Even in 1990, the first year of the quota, we expect some women to be represented in these merit reduced teams. For example, Christine Flear played in 1989 for *Metz* (a *Top 12* team) on the 3rd board and hence was one of their better players. A year later she was

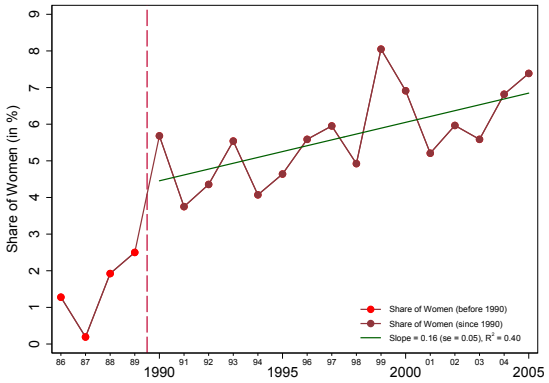
[56] From 3,428 available match-teams, we keep the 3,252 match-teams with only one female player. Then, we discard the 7 match-teams where the team forfeited one board in the match to construct our sample of 3,245 match-teams (see Appendix Table 10).

[57] See the Online Appendix P for differences in Elo ratings between players k and $k+1$ for $k = 1$ to 5.

[58] While Figure 2B confirms that the Elo rating gains are confined to women, we find, however, a small though significant, curious and counter-intuitive effect. Specifically, in 2006, there is a drop in quality of the 7th versus the 6th teammate. However, if anything, after the 8th male player in each team was dropped, we would expect a "surplus" of players, some of which are better than the 7th player in other teams. Hence, we would expect the difference in Elo rating between the 7th and 6th player to *decrease* right after 2006 rather than *increase*. We revisit this curious effect in Section 5.2.

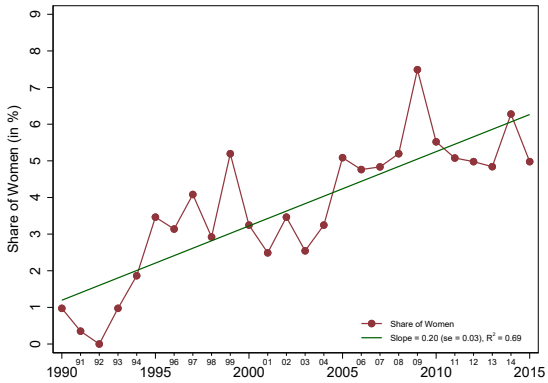
Figure 3: Efficiency Gains in the *Top 12*

A: 1986-2005



Notes: For each year, from 1986 to 2005, the share of women if match-teams had 8 players and no quota. Artificial match-teams are populated using the best player copies among all Top 12 player copies (given by their number of appearances) in a given year.

B: 1990-2015



Notes: For each year, from 1990 to 2015, the share of women if match-teams had 7 players and no quota. Artificial match-teams are populated using the best player copies among all Top 12 player copies (given by their number of appearances) in a given year.

hired by Lyon, the future *Top 12* champion, who had no competitive female player. While Flear played on the 9th board in Lyon, she continued to have a higher Elo rating than many of the male players of her old club *Metz*.

One issue with computing *merit reduced teams* is that in any given year the identity of players in a team changes between match-ups. This could be because players are sick or otherwise engaged. Since we do not know why a given player is present in a match-team, we take for each player the number of appearances as given. Specifically, in any year, the number of copies of a player is given by how often the player is present in a *Top 12* match-team. We order all players (and copies of players) based on their Elo rating. We keep the number of player-copies needed to fill a whole season of the *Top 12* merit reduced match-teams equal to the number of match-teams in our sample.[59] If we are left with fewer open seats than player-copies of the same (threshold) Elo rating, we populate those seats proportionally among player-copies with that same Elo rating.[60]

Figure 3A shows from 1990 to 2005 the fraction of women in those merit reduced match-teams. For comparison, for the years 1986 to 1989, we show the fraction of women

[59] See column 1 of Table 10 for the number of match-teams that are required.

[60] If a match-team had two forfeits or more, we still filled it like a match-team with no forfeit, though we, of course, lost two player copies for our exercise.

among the *Top 12* teams which, recall, in those years had eight players. We highlight two observations. First, the jump in the fraction of women from 2 percent to almost 6 percent after the introduction of the quota shows that only with the quota did some women start playing, even though these women outperform men in the *Top 12*.[61] Second, female *Top 12* CC players increasingly outperform men. An OLS regression of the share of women in merit reduced match-teams on a yearly trend provides a coefficient of 0.16.[62]

To consider data until 2015, recall that the *Top 12* teams reverted to 8 players in 2006. We therefore compose merit reduced match-teams of 7 players from 1990 to 2015. We otherwise use the same analysis, that is, we populate teams with the highest performing player copies. The fraction of women in these *7 player merit reduced teams* from 1990 to 2015 is depicted in Figure 3B. We find once more that the fraction of women increased.[63]

Hence, if the efficiency of a set of players is given by their Elo rating, the quota seems to have *increased* the efficiency of the best players in the *Top 12*. Nonetheless, if teams were fielded by merit alone (and one fewer player), women would be represented at about 6%, only half of the representation required by the quota (1/8). Recall, though, that some women who outperformed *Top 12* players only started to play in the *Top 12* in 1990 when the quota was introduced. We therefore more than hesitate to guess whether the fraction of female players would be roughly half a woman per team if there had been no quota (and if teams were reduced by one player) or if the quota were dropped now.

3.2 *Next 208* Teams: the Mass Effect

The results on *Top 12* teams show that the quota resulted in roughly one female player per match-team, where a large fraction of these female players were homegrown. Furthermore, the performance ability or Elo rating of the female player increased, which was not due to better women entering the *Top 12*, but rather women improving during their CC tenure thanks to games played outside of the CC. In fact, over the years, the Elo rating

[61] If we consider the female players from 1990 who are represented in the merit reduced match-teams, they, to a large extent, outperform male players in 1986-1989 – when adjusting the woman's Elo rating to the relevant year. Specifically, we would expect 6.91, 4.84, 7.06 and 4.38 rather than the 1.28, 0.19, 1.92 and 1.95 percent of women in 1986 to 1989, respectively (though for 1989 we miss Elo ratings of many male players and only "allow" female players to displace rated men, hence we probably underestimate the expected representation of 4.38%).

[62] An OLS regression on the share of women in merit reduced match-teams on a yearly trend from 1990 to 2005 delivers a coefficient of 0.16, $p < 0.01$, s.e. = 0.05, $R^2 = 0.40$.

[63] An OLS regression on the share of women in merit reduced match-teams on a yearly trend from 1990 to 2015 delivers a coefficient of 0.20, $p < 0.01$, s.e. = 0.03, $R^2 = 0.69$.

of the female player steadily approached that of her marginal teammate. While women where still largely the lowest ranked players in their team, they immediately, and more and more so over time, outperformed some male *Top 12* players.

Are these effects in the *Top 12* reflected in the lower divisions with a gender quota? While for lower divisions we have more restricted data access (basically since 2000 only), there are many more teams. We consider the *Next 208* teams which represent the largest number of teams under a quota from 2000 to 2013, see Appendix Table 3.

Extensive Margin — While the quota is in general fulfilled, there are on average less than 1.1 women per match-team, see Online Appendix Figure 29. About 94% of the 1928 female players in the *Next 208* are homegrown. This dispels concerns that the AA quota resulted in "only" importing female players rather than also nurturing homegrown players. Men are also mostly homegrown, apart from about one male player per team.

Intensive Margin: Performance of Women selected by the Quota — Figure 4A shows that the average Elo rating of the best female player in the *Next 208* teams has increased since 2000 (when we start having data for those teams). There is, however, a slight stagnation in Elo ratings since 2009. Just like for women in the *Top 12*, the Elo gains of female players are not driven by women being replaced by better players, see Figure 4B. Therefore, the gains come from CC players improving their Elo ratings over time. Furthermore, once more these gains are not driven by the extra games women play in Club Championships due to the quota, but rather through games outside CCs, see Figure 4C.

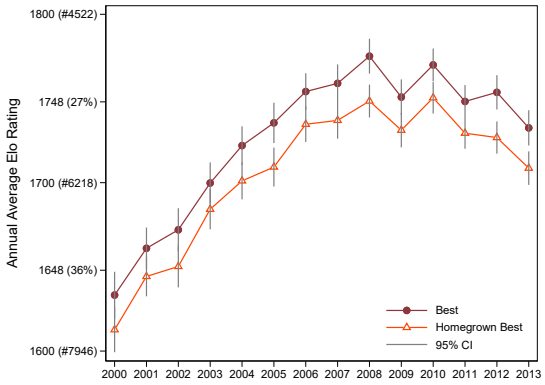
As with the *Top 12*, to assess women's Elo ratings over time, we compare conditional Elo ratings computed using equation (2) of the best female player to that of the 7th male teammate, who becomes the marginal male team-member in 2006, see Figure 4D.[64] We document a significant reduction in the Elo gap between the woman and the 7th best male teammate. An OLS regression of the difference in Elo ratings on a year dummy yields a significantly positive coefficient of 18.28 ($p < 0.01$).[65] Furthermore, just like for the *Top 12*, the gains by female players' conditional Elo ratings vis-a-vis the 7th best male player are not replicated when we compare the 7th best to the 6th best male teammate.

[64] Recall, in 2006, the number of team members is reduced from 9 back to 8.

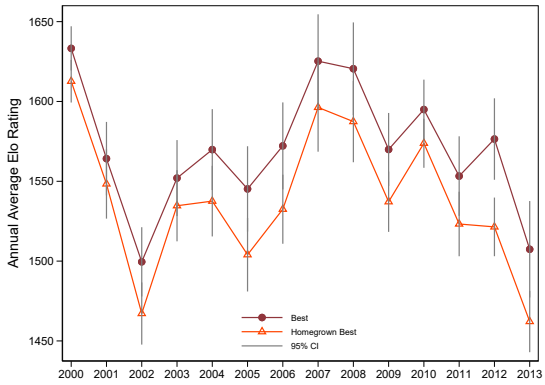
[65] This comparison also shows that the slight reduction in Elo ratings of the best female players since 2011 is not a "female" phenomenon, but is also exhibited by the marginal male, as evidenced by the fact that the difference between the best woman's Elo rating and that to her marginal male teammate is flat since 2011.

Figure 4: Performance Gains of Women in the *Next 208*

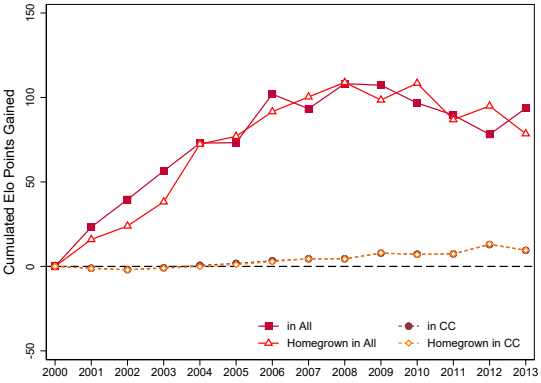
A: Best Women



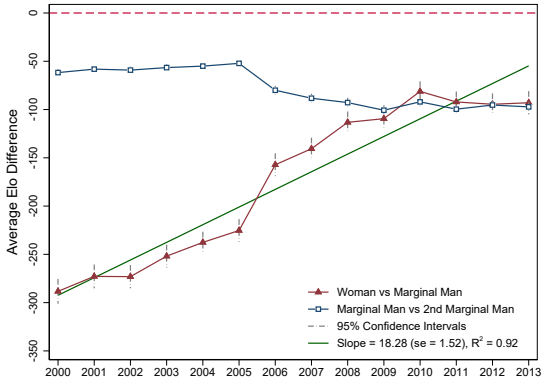
B: Best Women - First Year



C: Points Gained in and outside of CC



D: Relative Performance



Notes: For each year from 2000 to 2013: (A) The average Elo rating of the best female player in the team ("Best") and when we restrict attention to those who are homegrown ("Homegrown Best"), data from 1,819 (1,715) Best (Homegrown Best) women in the Next 208*. (B) The average Elo rating of the (Homegrown) Best female player in the team when we restrict data to the first year she plays in the* Next 208*. (C) "(Homegrown) in All" are the cumulated Elo points the (homegrown) best women win during their CC tenure in the* Next 208*. "(Homegrown) in CC" are the cumulated Elo points they win during their tenure in CC games in the* Next 208*. (D) For 24,556 match-teams, the average difference in conditional Elo ratings between the best woman and the marginal man (the 7th best man) as well as between that man and the 6th best man in the match-team with 95% confidence intervals. Slope from an OLS regression on a yearly trend.*

This confirms that the gains are unique to female players.[66]

The results on the *Next 208* therefore mirror those of the *Top 12*.

[66]We also find, once more, this curious effect that with the reduction of teams from 9 to 8 players in 2006, the 7th best male team-member, who becomes the marginal male actually decreases in his Elo ratings compared to the 6th male team-member rather than, as we would expect, increases.

4 Trickle-down Effects

To study spillover and trickle-down effects of the quota we use the French administrative data of chess players from 1984 to 2015. Did the quota increase the number of female players, and is this increase beyond the number needed to fulfill the quota? Second, we investigate whether the number of *high performing* women has increased.

The French administrative data are organized by season starting in the Fall of year t and ending in the Fall of year $t+1$.[67] Data contain all chess players registered in France, some of which play under the French FIDE code (in 2015 this represents 97.63% of all players, 98.02% of female and 97.56% of male players), and some are additionally homegrown (in 2015 this represents 97.41% of all players, 97.65% of female and 97.37% of male players). In this section we consider all players, though at times we will differentiate between all players, players with a French FIDE code and French and homegrown players.[68] There are 150,550 active players from 1984 to 2015. For 6,246 players we miss the birth year and for 126 the gender, we drop them whenever we provide results using age or gender, respectively; for more information see Online Appendix Table 7.

Figure 5A shows the number and share of female players from 1984 to 2015. There is a substantial increase in the number of women from 493 in 1984 to 4,601 in 2015. While men also increased from 7,146 in 1984 to 27,089 in 2015 (see Panel C), the share of women increased from 6.5% in 1984 to 14.5% in 2015. An OLS regression of the share on a yearly trend delivers a slope of 0.299 with a robust standard error of 0.014 and a R^2 of 0.93. When we restrict attention to adults (20 years or more), we replicate the same pattern.

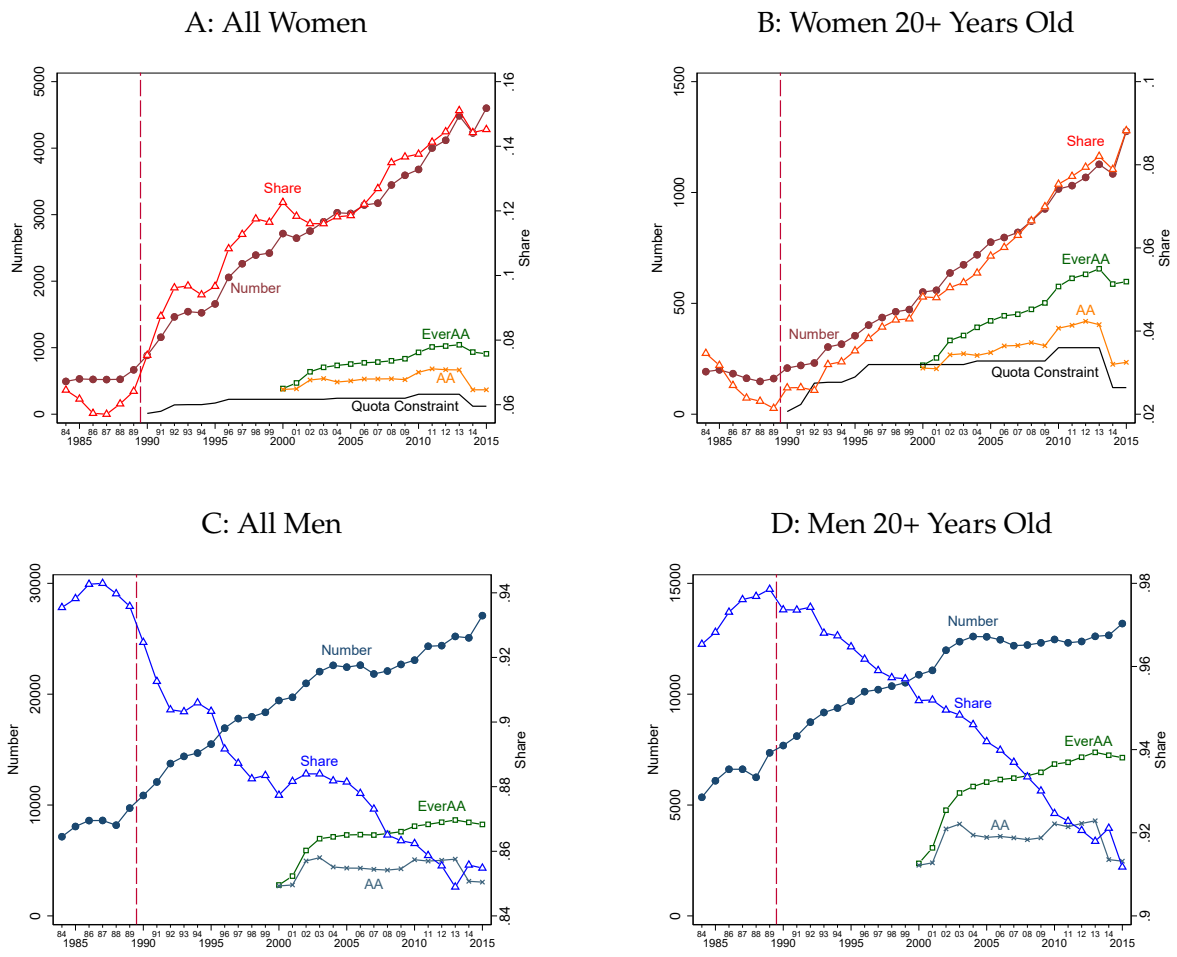
To put the role of the quota in perspective, we also provide in Figure 5 the number of women needed to fulfill the quota requirements ("Quota Constraint"). Teams might, however, have more than one woman to ensure the presence of at least one female player at each match-up. We therefore show, in addition, from 2000 onwards the number of women who played in *a* CC game with a quota ("AA").[69] It is clear that the number of women, even adult women, is vastly larger than the minimum needed to fulfill the quota.

[67] The Elo rating of a player in season t is, however, the one from the Fall of year $t+1$. In the paper we denote with Elo_t the Elo rating of Fall of year t, which is, hence, published in the data with the season $t-1$ ending in the Fall of year t. We therefore have data on Elo ratings starting in the Fall of 1985, but data on players - including their gender, age, etc - starting in the Fall of 1984.

[68] We consider here only homegrown players who are also French, such that the three categories, "all" players, "French" players and "French and homegrown" players are increasingly smaller subsets (though 99.91% of homegrown players are French).

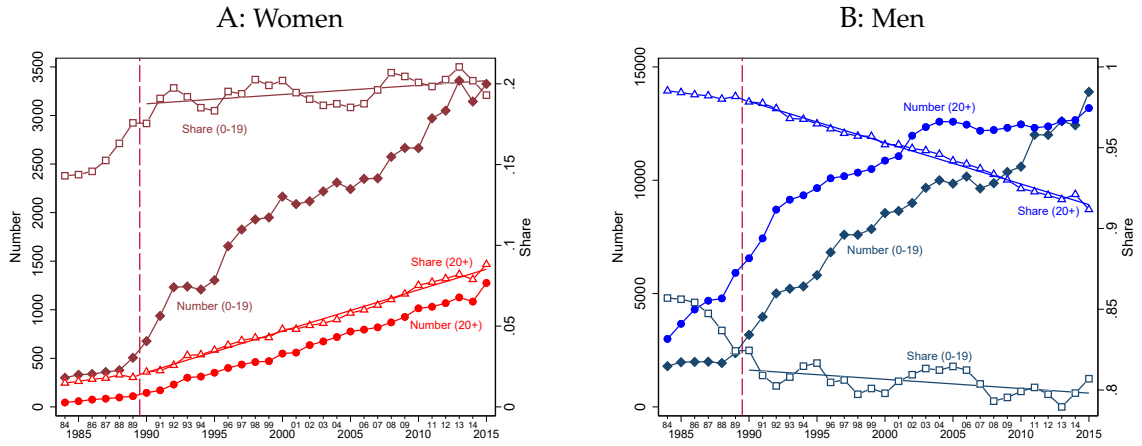
[69] Recall, we have data for division 2 and division 3 only from 2000 onwards.

Figure 5: Female and Male Chess Players in France



Notes: Number and share of women and men among all active players registered at the French Chess Federation between 1984 and 2015 and when we condition on those who are at least 20 years old. "Quota Constraints" is the minimal number of women needed to fulfill the CC quota (1 for each team that plays under a quota). "AA" shows the number of women and men who played a CC game in a division with a quota requirement in that year. "EverAA" shows in each year t the number of women and men who in year t or any year before that played a CC game in a division with a quota requirement. The vertical line divides years before and after the introduction of the quota (1990). See the Online Appendix for corresponding panels with only French (Figure 44) or French and homegrown players (Figure 45).

Figure 6: French Chess Players by Gender and Age



Notes: Active players registered at the French Chess Federation between 1984 and 2015. See the Online Appendix with only French (Figure 47) or French and homegrown players (Figure 48) players.

Finally, we show for all female players the share who ever played in a CC game subjected to a quota, whether in that year or any year prior ("Ever AA" in Figure 5). In 2015, this corresponds to somewhat more than 50% of all adult women. At first glance, a large fraction of adult women benefited from being able to play a CC game thanks to the quota. On the other hand, also roughly half of all adult men played a CC game that was subjected to a quota. Viewed this way it is not obvious that playing a CC game that falls under a quota is a privilege excessively granted to women.

The number of female chess players of all ages have increased dramatically. Figure 6A shows that while the number of female youth has roughly increased sevenfold since 1990, the fraction of youth who are female has been almost constant. For adult female players, both the number (multiplied by 8.8) and the share among adult players (from 2.2 to 8.8 percent) has increased substantially since the introduction of the quota. See Appendix Figure 46 for results by decade.

We next use two statistics to show that not only are there more but also more high performing female players.

For our first measure, we compute for each year the number of women among the top 100, top 1000, top 2000 and top 5000 players. For this exercise, we distinguish between three kinds of players registered in France. First, we consider all players, including foreign players who nonetheless play and often live in France. While these women are not

French, they nonetheless contribute to the representation of women in the French chess landscape.[70] Second, there are players with a French FIDE code who, however, did not necessarily start their career in France, and as such are not considered homegrown, the latter being our third category, that is French and homegrown.

There was at most one and often no female player in the top 100 until 1994. Since then, for one of the three sets of players (all, French, or French homegrown), there has been at least one woman in the top 100, and since 2001 for some measures even 2 up to 4.[71] Panel A of Figure 7 shows that the number of women in the top 1000, top 2000 and top 5000 has increased dramatically. Compared to 1990, there are now almost 60 women in the top 1000 rather than around 15, 100 in the top 2000 rather than around 20, and 250 in the top 5000 rather than 130 or less. Such dramatic increases are also evident when we consider only French players or homegrown and French players in the top 2000 and 5000.

Note that the number of players in the top 220 CC teams (the *Top 12* and the *Next 208*) is roughly 2000. The second figure of Panel A shows that the number of women among the top 2000 players went from around 20 to over 100. If those 2000 players were put into CC teams, this would correspond to slightly less than one woman for every other team.

The second statistic focuses on elite players and shows the gains of women on an absolute measure rather than one relative to men. While elite thresholds are arbitrary, we follow the historical eligibility requirements for an international FIDE rating, namely players with an Elo rating of at least 1805 for women and 2205 for men.

Panel B of Figure 7 shows that the number of elite women has increased dramatically since 1990, from less than 25 to over 200, if we consider all women, or to around 150 if we focus on French or homegrown and French women. While the number of elite men has increased as well, this trend was already evident before 1990. There were about 100 elite men in the mid eighties, more than 200 in 1990, and about 400 or 700 if we consider only French or all elite men in France, respectively.

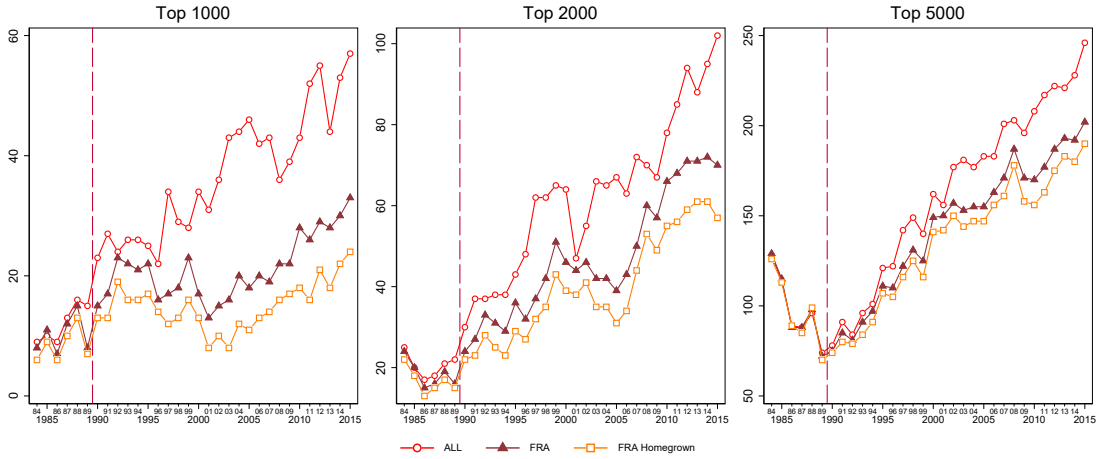
Using French female chess players as the pool of women eligible for the quota, we show large spillover and trickle-down effects of the quota: there are more female chess players, especially adult female players. In addition there are also many more high performing female players. Finally, trends in the number of adults as well as the number of high performing female players since 1990 outpace trends observed among male players.

[70] One of the authors would be such a "player" if we were to consider economics, registration at the American Economic Association and the US instead of chess, the French Chess Federation and France.

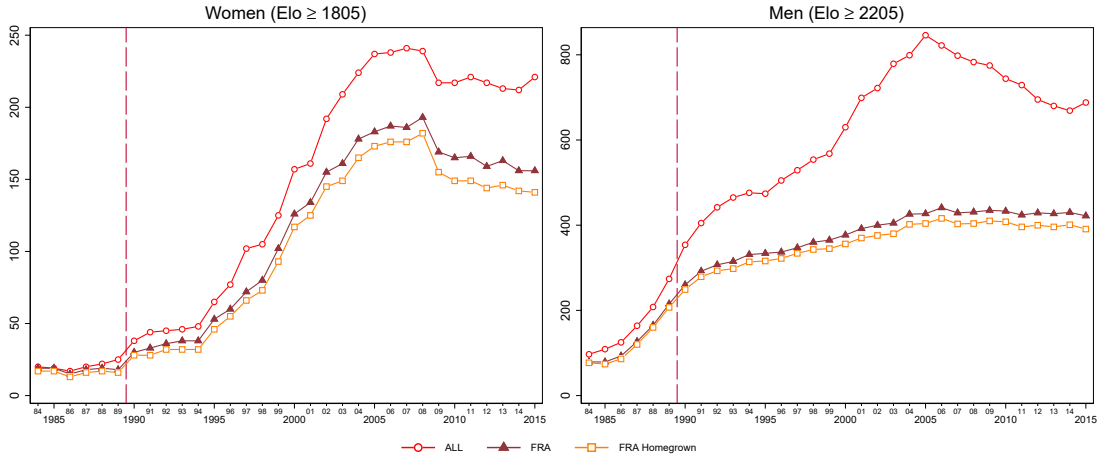
[71] For the number of women in the top 100 see Appendix Figure 17.

Figure 7: High Performing Chess Players in France

A: Fraction of Women among the Top 1000, Top 2000 and Top 5000



B: Elite Players



Notes: For each year from 1984 to 2015: (A) share of women among the Top 1000, Top 2000 and Top 5000 players in France; (B) number of elite players, i.e., with an Elo rating of at least 1805 and 2205 for women and men, respectively. We consider either all active players registered at the French Federation (All), or restrict attention to those with a French FIDE code (FRA) or to those who in addition are homegrown.

5 Trends in France

Are trends in France an alternative explanation for the significant gains among French female players? We consider trends that affect women in every aspect of their lives, not only in chess. Specifically, were there changes in the labor force participation or employment of women around 1990? We then show that changes in the French chess community

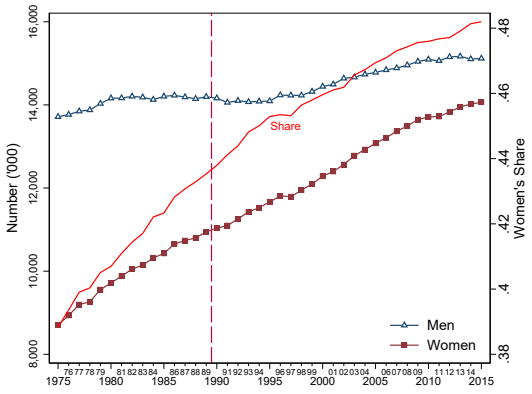
(beyond the quota) did not drive the gains by female players. In the next Section we consider the effects of global, specifically Europe-wide chess trends by comparing gains by French female chess players to gains observed in other countries.

5.1 Women in the French Labor Market

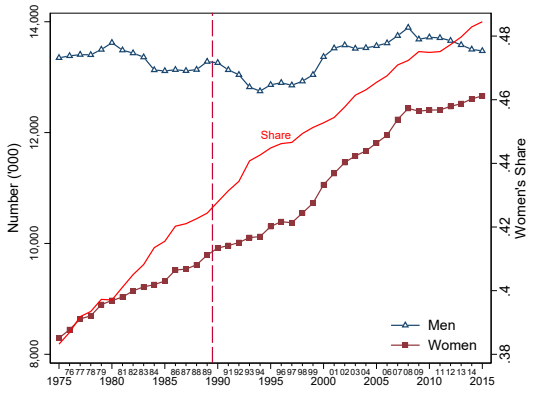
For trends in labor market outcomes we use data from INSEE from 1975 to 2015 and consider men and women who were employed or participated in the labor force.[72] In Figure 8A we plot the number of men and women who participated in the labor force, as well as the fraction who were female. In Figure 8B we plot the same for the employed.

Figure 8: Labor Force Participation and Employment in France

A: Labor Force Participation



B: Employment



Notes: From 1975 until 2015, the number and share of women, as well as the number of men who (A) participated in the labor force and (B) were employed using INSEE data and definitions (which coincide with ILO definitions).

It is evident from the Figures that the female representation has steadily increased in the last forty years. However, there were no significant changes in trends in the female representation when we compare the 80's to the 90's. Therefore, the results from chess, specifically the changes in trends before and after 1990, are not reflected in general trends which affect women in the workforce, suggesting they are chess-specific. We will revisit the role of economic changes in the next Section 6 where we compare France to other EU-15 countries.

[72] INSEE (Institut National de la Statistique et des Etudes Economiques) uses ILO (International Labour Organization) definitions, see https://www.insee.fr/en/metadonnees/definition/c1159.

5.2 Is the Quota Still Necessary?

To what extent do changes in the French chess community, such as changes in attitudes by or attitudes towards female players, drive our results? Put differently, was and is a quota really necessary? Would women not play in CCs and be active players even if we were to remove the quota? While we cannot fully consider this counterfactual, we can exploit policy changes in division 4 for insights on the effects of eliminating the quota.

First, recall that in 2004 the divisions were restructured such that the vast majority of division 3 was turned into division 4, which at this point received the quota. Second, in 2013, the quota requirement was eliminated in division 4 – though retained in divisions 1 to 3. While we have no evidence, complaints about the lack of female players (and a change in leadership in the French chess federation) may have been the major reasons. Of the 14,694 match-teams from 2004 to 2013 in division 4, indeed 360 miss any information about their female player, and a total of 559 forfeit the female board. A forfeit is either because the woman was not announced, or because she failed to play. Hence, while it may have been hard for teams to find a woman, most teams managed. In addition, note that in 492 match-teams there is a missing male player, and in 815 match-teams there is a "male" board that is forfeited.[73]

The average number of women per division 4 match-team, which hovered between 1.08 and 1.07 from 2004 to 2013, fell drastically to 0.27 in 2014 and 0.24 in 2015 (see Online Appendix Figure 52 for details). Hence, women, to a large extent, stopped playing in division 4 as soon as the quota was dropped in 2013.

To put the effects of losing the quota in perspective, we consider a third policy change. In 2006 all CC match-teams, including division 4, were reduced from 9 to 8 players, while retaining the quota. We can therefore compare, in division 4, women who lost their "special status" to the worst men who lost their spot because of the reduced number of boards.

We consider two kinds of players in division 4, from 2004 to 2013, the last year of the quota: first, all female players in a match-team, for a total of 1,649 women; second, the "worst" male player in match-teams with exactly one female player, for a total of 4,144 such men (see Appendix Table A2). In each season, we compute the chance that in the following season the female and the worst male player participate in division 4 or in a

[73] While teams were more likely to miss a male than a female player, note that, in general, there are more male players per team. However, the same is largely true for clubs, hence it should be easier to find a substitute for a man than a woman.

better division, as well as in any of the 5 CC divisions. We then consider two special years. In 2013, the female player loses her special status in the following season. In 2005, the worst man loses his position in the following season.

To explore effects beyond Club Championships, we collect information on all official French tournaments between 2002 and 2018 from the website of the French Chess Organization. Of the 22,294 individual tournaments, most of which are FIDE registered, 49.96% are classic, 49.40% rapid and 0.64% blitz tournaments.[74] In each season, we compute the chance that in the following season the female and the worst male player participate in a classic tournament. We also compute the number of tournaments they participate in, the number of games played in tournaments, as well as the chance to participate in any tournament, be it classic, rapid or blitz in the following season. Finally, we consider whether players are active in the next five years, by computing their chance of participating in classic tournaments (or any tournament, respectively) in every season for the following five seasons, as well as the number of classic tournaments and games played in those in the next five years. Specifically, we estimate:

$$\begin{aligned}\{Y_{i,t+1}, Y_{i,t+1*}\} = \eta(Woman \times 2013) + \gamma(Man \times 2005) + \delta(Woman) \\ + X_{it}\beta + \alpha_{c(i)} + \alpha_t + \{\varepsilon_{i,t+1}, \varepsilon_{i,t+1*}\},\end{aligned} \tag{3}$$

where $Y_{i,t+1}$ and $Y_{i,t+1*}$ represent different measures of participation in CC or individual tournaments for player i during season $t+1$ or the next five seasons $t+1$ up to $t+5$, respectively. We consider any player i who in season t was either a woman or the worst male player in a match-team in division 4. We compare the impact of losing the division 4 affirmative action for women in 2013 (η) to the loss of the spot for the worst men in 2005 (γ). We control for time-varying individual factors X_{it}, that is in season t the age, the average Elo rating (and its square), the proportion of games played as an unrated player, and the number of games played in CC (see Appendix Table A3 for descriptive statistics). We also include club and season fixed effects in order to control for unobserved

[74] The types of tournaments depend on the time available for moves. In a classic game, players typically have 90 minutes for the first 40 moves, followed by 30 minutes for the rest of the game, with an additional 30 seconds per move starting from the first move. In a rapid game, players each have more than 10 but less than 60 minutes. In a blitz game, players each have 10 minutes or less to play the game. These tournaments are described in terms of its participants (including player's ratings, age category and clubs), the number of rounds, the points scored by each participant, the final ranking of the players and their performance. Note, however, that the information is not exhaustive prior to 2012. See Appendix Table A4 for the number of tournaments registered per year at the French Chess Organization.

heterogeneity in clubs and potential aggregate changes over time. Finally, we allow for an error term $\varepsilon_{i,t+1}$, clustered at the player level.[75] The results are presented in Table 1.[76]

Panel A presents results on the short-run effects of the policy changes in division 4. The probability that the average woman plays in division 4 or higher the following season is 14 percentage points (pp) higher than that of the average worst man, but is 5 pp lower if any division is considered. The removal of the gender quota in 2014 has a significant detrimental effect on participation. The chance for the woman to play in division 4 or higher in 2014 drops by 29 pp. This confirms that the loss of the quota has an immediate detrimental effect on the representation of women in CCs. In comparison, the probability for the worst male player drops by only 9 pp when he loses his spot, less than a third of the effect for the woman, a significant difference (see Column 1). When we consider playing in any CC division, including division 5, the effect for the female player who loses her special status is still more than twice that of the man who loses his position, also a significant difference (see Column 2).

Does the quota affect female participation in chess beyond the Club Championship? In general, in terms of participating in tournaments, a woman in division 4 is significantly less likely to be an active chess player in the following season than the worst man is. The female player of 2013 is, however, only directionally less likely to be active chess player on all four measures after she lost her special status (Columns 3-6). When we consider being an active chess player in the next *five* years, effects are more dramatic and significant (see Panel B). Once more, in general, the woman in division 4 in 2013 is significantly less likely to be an active chess player in the next five years than the worst man is. Note, however, that for any of the four activity measures the differences are much more modest than when we considered participation in the next season only. This is in contrast to the effects on players in the two special years. The woman from 2013, who loses her special status in 2014, is twice as much less of an active player than a woman from any other year. Hence, there are large spillover effects for women selected by the quota in terms of their chess careers. Furthermore, the difference between the woman who loses her special status and the man who loses his spot in a match-team is large and significant. Basically, there is almost no long run negative effect for the worst man in a match-team to losing his spot.

Can all changes among chess players be accounted for by changes in attitudes towards

[75] Clustering instead at the club level does not qualitatively affect the results, see Table A8.

[76] Full estimates of Panel A and B are reported in Appendix Tables A5 and A6. As a robustness, we also reproduce Table 1 by considering only the best female players in a match-team (see Appendix Table A7).

Table 1: Future Participation of Women and Men

	in Club Championship		in Tournaments			
	Div. 1 to 4	All	Playing	# Games	# Tournaments	All
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A	Participation Next Year					
Woman × 2013	-0.308***	-0.153***	-0.013	-1.230	-0.161	-0.001
	(0.03)	(0.03)	(0.03)	(1.12)	(0.15)	(0.03)
Man × 2005	-0.085***	-0.060*	0.047	0.410	0.008	0.046
	(0.03)	(0.03)	(0.03)	(0.89)	(0.11)	(0.03)
Woman	0.137***	-0.047***	-0.118***	-2.575***	-0.378***	-0.111***
	(0.01)	(0.01)	(0.02)	(0.52)	(0.07)	(0.02)
R^2	0.267	0.249	0.180	0.196	0.192	0.185
F-tests:						
W2013 = M2005	22.654	4.170	1.716	1.279	0.768	1.056
p-value	0.000	0.041	0.190	0.258	0.381	0.304
W2013 + W = M2005	3.878	10.771	17.031	9.224	8.796	13.235
p-value	0.049	0.001	0.000	0.002	0.003	0.000
Panel B			Participation the next 5 Years			
Woman × 2013			-0.060**	-7.791**	-1.164**	-0.077***
			(0.02)	(3.91)	(0.53)	(0.03)
Man × 2005			0.030	2.746	0.255	0.011
			(0.02)	(3.51)	(0.44)	(0.02)
Woman			-0.041***	-7.191***	-1.047***	-0.047***
			(0.01)	(2.16)	(0.28)	(0.01)
R^2			0.126	0.127	0.128	0.144
F-tests:						
W2013 = M2005			7.709	3.759	3.918	6.356
p-value			0.006	0.053	0.048	0.012
W2013 + W = M2005			17.934	11.718	13.023	16.835
p-value			0.000	0.001	0.000	0.000

*Notes: 9,694 observations in each column. 1,694 women are compared with 4,144 "worst" men, defined as the last ranked men in their match-teams from 2004 to 2013 (see Table A2). In all columns, we include individual controls (Elo Rating$_{it}$ and its square, Unrated$_{it}$, Number of CC Games$_{it}$ and Age$_{it}$) and club and season fixed effects. Standard errors are in parentheses and clustered at the player level with *, **, and *** denoting significance at the 1, 5, and 10 percent levels, respectively. The dependent variable changes across specifications, so the regression is a linear probability model in columns 1-3 and 6 and an ordinary least squares regression in columns 4 and 5 (see Appendix Tables A9 and A10 for robustness using probit regressions).* ***Panel A****. Probability of playing next year in: the top four divisions of the club championship (CC) (col. 1); in any of the 5 CC divisions (col. 2); in classic individual tournaments (CT) (col. 3); in CT, rapid or blitz tournaments (col. 6). Number of games played next year in CT (col. 4) and Number of CT next year (col 5).* ***Panel B****. Probability of playing continuously during 5 years in CT (col. 3); Number of games played in 5 years in CT (col. 4); Number of CT played in 5 years (col 5); Probability of playing continuously during 5 years in CT, rapid or blitz tournaments (col. 6). 'W2013 = M2005' is the test Woman×2013 = Man×2005, and 'W2013 + W = M2005' is the test Woman×2013 + Woman = Man×2005.*

and by women rather than to the introduction of the quota? We found strong evidence against this hypothesis. As soon as the quota was removed in division 4 in 2014 women were significantly less likely not only to play in the CC, but also to be an active chess player. This suggests that even almost a quarter of a century after the introduction of the quota, the quota still plays a large role for women selected by the quota.

6 Global Comparisons

We provide evidence that the quota is responsible not only for the changes on women selected by the quota, but also for the changes in the pool of female chess players documented in Section 4. We show that the increase in the number of adult as well as elite female chess players in France since 1990 is a phenomenon not universally shared by other Western European countries.

We use Belgium, another country for which we have data on all chess players, to show that the rise of adult female players is a French rather than a French and Belgian phenomenon. We use FIDE rated players in EU-15 countries to show that the large increase of elite female players in France is not an EU-15-wide phenomenon. Finally, we use international comparisons to assess potential negative effects of the affirmative action quota on the pool of elite male French chess players.

6.1 France and Belgium

Belgian data are from the Belgium Chess Federation (see Appendix A.3). As for France, we only use active players, i.e., those who paid their dues for the season regardless of the number of games they played. The choice of Belgium is guided by the fact that no gender quota has been implemented and that data on all registered chess players are available since the late eighties.

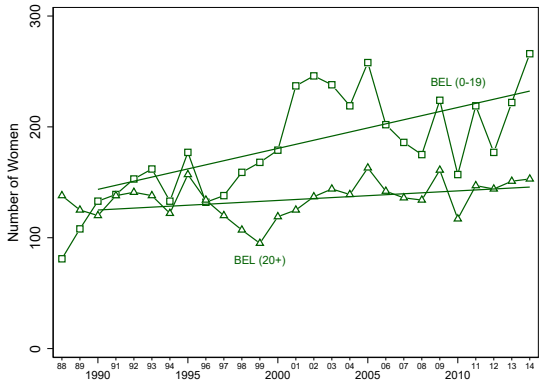
In Figure 9A we show the number of youth (0-19) and adult (20 years or more) female players in Belgium.[77] While there is a slight increase in the number of young women, the number of adult women playing chess has been roughly constant from 1984 to 2014.

For a better comparison to France, Figure 9B shows the share of women among youth and adult players for both countries. While France has a higher share of women among

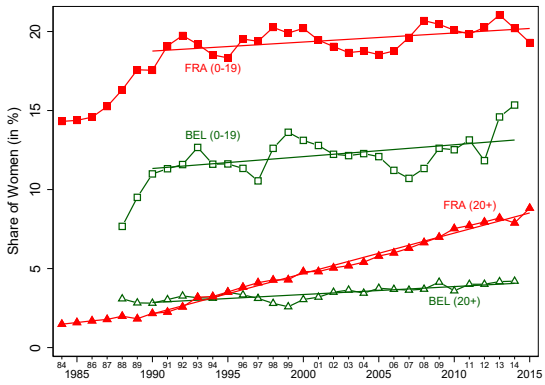
[77] Of the 25,180 active players in Belgium from 1988 to 2014, the year of birth is missing for 225 players.

Figure 9: Chess Players in France and Belgium

A: Number of Women



B: Share of Women



Notes: For each year, the number and share of female players in Belgium (from 1988 to 2014) and the share of female players in France (from 1986 to 2015); see Figure 6 of the numbers in France.

youth players than Belgium has, the increase since 1990 is similar and small in both countries.[78] In contrast, the large increase in the number and share of women among adult players in France significantly outstrips the lack of change in Belgium.[79]

The comparison to Belgium strongly suggests that the rise in adult female chess players in France is not driven by forces that affect female chess players in France and Belgium but rather seems a French phenomenon.

6.2 EU-15 FIDE Players and Employment Data

To show that France is special compared to the average EU-15 country and not just to Belgium, we use FIDE data. However, before the new millennium, we only have access to

[78] We run an OLS regresion $\widehat{\text{Share}} = -138.0\ (62.6) + .075\ (.031)\ \text{year} \times \text{Dummy}_{BEL} + .066\ (.018)\ \text{year} \times \text{Dummy}_{FRA} + 25.08\ (72.55)\ \text{Dummy}_{FRA}; n = 50, R^2 = .95$, where *Share* is the share of young players (0-19) in Belgium (BEL) and in France (FRA), and *year* is a yearly trend from 1990 to 2014. Robust standard errors are in parentheses. While the annual trends of the share of young players in Belgium, 0.075 ($p < 0.05$), and in France, 0.066 ($p < 0.01$), are both significant, they are not significantly different from one another (F(1,46) = 0.06, Prob > F = 0.807).

[79] We run an OLS regresion $\widehat{\text{Share}} = -97.6\ (11.3) + .050\ (.006)\ \text{year} \times \text{Dummy}_{BEL} + .253\ (.006)\ \text{year} \times \text{Dummy}_{FRA} - 402.89\ (16.42)\ \text{Dummy}_{FRA}; n = 50, R^2 = .98$, where *Share* is the share of adult players (20+) in Belgium (BEL) and in France (FRA), and *year* is a yearly trend from 1990 to 2014. Robust standard errors are in parentheses. The annual trends of the share of adult players in Belgium, 0.050 ($p < 0.01$), and in France, 0.253 ($p < 0.01$), are both significant, but the trend in France is significantly larger than the one in Belgium (F(1,46) = 607.0, Prob > F = 0.00).

elite players, roughly players with an Elo rating of at least 1805 and 2205 for women and men, respectively.[80] Recall from Section 2.5 that we have a total of 90,508 chess players from 1984 to 2015 of which 12,499 are elite players.

Figure 10A shows among all EU-15 elite female FIDE players the fraction who are French (see Appendix Figure 18 with only homegrown players). We also show the fraction of the EU-15 population that lives in France.[81] We find an increase in the proportion of the French, especially since 1990.[82] Before 1990, French women were quite underrepresented among elite female players given the size of France (5.55% in 1989, versus roughly 15%). Since 1990, the introduction of the quota, the French representation has dramatically increased, such that, since 2005, they are proportionally overrepresented within the EU-15. When we consider all FIDE players in Panel B, not only those who are elite, the results are even more impressive. French female players represent about 30% of all female EU-15 FIDE players, about twice the expected representation given the size of France.

Figures 10A and B prove that the rise of elite female chess players in France is not an EU-15 wide phenomenon. It is therefore likely the result of the introduction of the Club Championship quota in 1990.

In Figure 10C we show the representation of elite women of all EU-15 countries.[83] No country other than France had or has policies that result in a similarly expansive quota.[84]

Figures 10C and D confirm that France is quite unique. Only two EU-15 countries exhibit a steady and persistent increase in their representation among elite women: France and Spain. A third country, Germany, experienced an increase until the mid-nineties, followed by a continuous decline. We have no explanation for what happened in Ger-

[80] See Appendix K.1 for details on the FIDE requirements and how they have been relaxed over time.

[81] The two definitions differ slightly: For FIDE players, we require the person to have an EU-15 country code, for population data, the person only has to live in an EU-15 country.

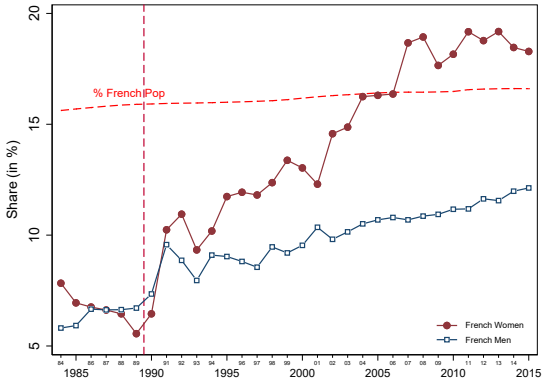
[82] An OLS regression on the fraction of EU-15 elite female chess players who are French from 1990 to 2015 on a yearly trend delivers a coefficient of 0.458 (robust s.e. = 0.036, $p < 0.01$, R^2 = 0.91). This is significantly different from the trend before 1990, where we have a coefficient of -0.371 (robust s.e. = 0.070, $p < 0.01$, R^2 = 0.89), an F-test of the difference equals to 136.5 ($Prob > F = 0.00$).

[83] Appendix Figure 59 reproduces Panels C to E of Figure 10 for men only.

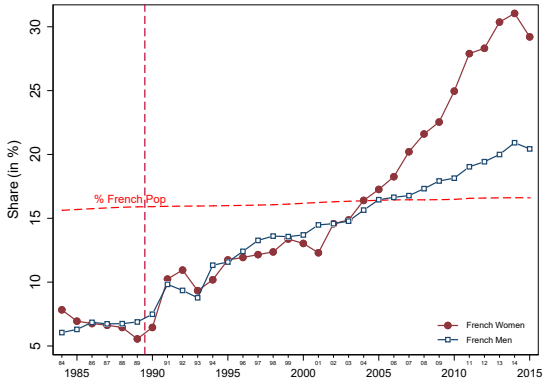
[84] One exception is England which had a quota, though a much less expansive one. In 1993 the English federation created a one-division championship and applied a quota such that each team – of 8 players – must have at least one woman and one man. In 1997, a second division was created with the same gender rule. In 2011, the rule in division 2 was changed requiring each team to have any two of a male, a female or a junior player. No gender rule was applied in the other two divisions created in 2000. There are two important differences between the English quota and the French quota. The French quota was applied to 220 up to almost 300 teams between 2000 and 2013, and is still applied to 118 teams in 2015. While we do not have all the English data, in 2015 only the 16 teams in division 1 had a strict and the 16 teams in division 2 had a very soft quota.

Figure 10: FIDE players in the EU-15

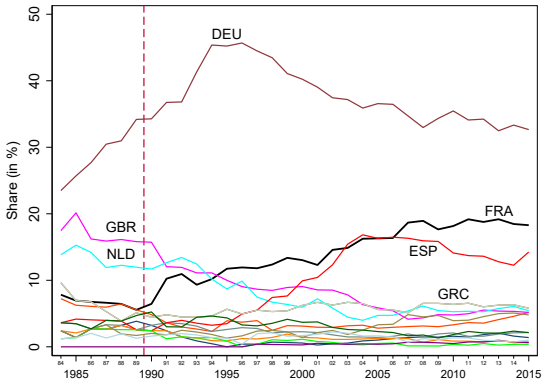
A: Elite French Women and Men



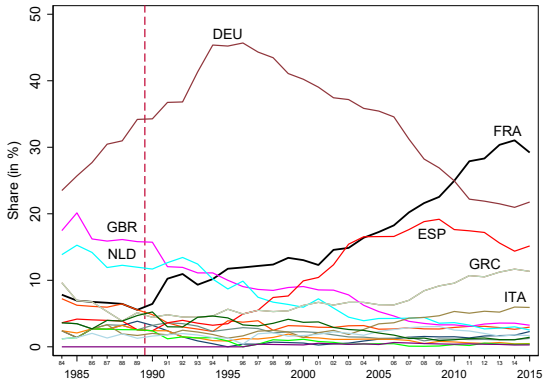
B: French Women and Men



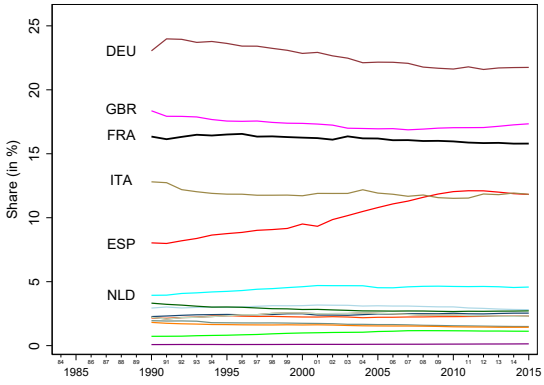
C: Elite EU-15 Women



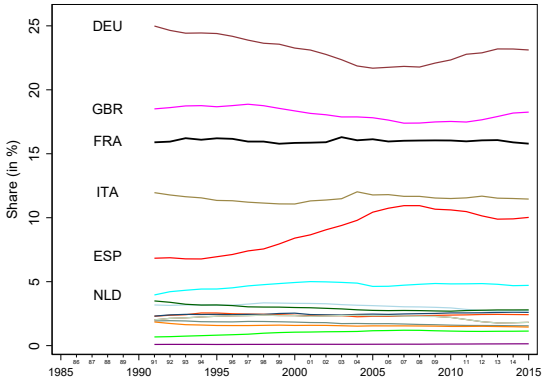
D: EU-15 Women



E: EU-15 Female Labor Force Participation



F: EU-15 Female Employment



Notes: The share of French among active male and female chess players in the EU-15 who are FIDE-rated (Panel B) and who, in addition, are elite players (Panel A). The horizontal line indicates the share of French among the EU-15 population in 2015. The share of each EU-15 country among all (Panel D) or elite (Panel C) female FIDE players. The share of each EU-15 country among women who participate in the labor force (Panel E) and who are employed (Panel F) using International Labour Organization data.

many.[85] All these aforementioned patterns are even more pronounced when we consider all active FIDE women, rather than only elite chess players.

To address to what extent the changes we observe in France and Spain, and perhaps even Germany, are restricted to chess or apply to women in all aspects of their lives, we use ILO (International Labour Organization) data on the EU-15 wide labor force participation (1990 to 2015) and employment (1991 to 2015) of women. We show in Figures 10E and F the representation by country of women in the labor force and employment, respectively. These two Figures confirm that the rise of French female chess players is not accompanied by a similar rise in the representation of French women among EU-15 women in the labor force or among the employed. A second observation concerns Spain, the other country for which we found a prolonged and sustained boom in their representation of women among EU-15 (elite) female players. For Spain, in contrast to France, a similar boom is evident when we consider their representation among the EU-15 female labor force participation and employment. This suggests that the Spanish result is driven by a growth in the female representation in all economic aspects, including chess.

Overall, the FIDE data as well as the labor market outcomes confirm that the rise of the French women in chess is exceptional within Europe. It is not reflected in the general workforce. This confirms that the female chess boom in France is a French specific phenomenon. The increased representation of French women is restricted to chess, specifically, it is not evident in labor market outcomes. International comparisons hence confirm the role of the quota in the boom of French female chess players.

6.3 The Impact of the Quota on Men

There are many ways for the CC quota to have a negative externality on men. Foremost, men might have a taste against women, and as such prefer chess to be a "male" activity. Another set of externalities concerns zero-sum aspects. For example, players could receive a private benefit from being a Top X player (for $X = 1000$, 2000, etc.). In that case, policies that result in more female players being highly ranked have a direct negative impact on men. In this paper, we focus on aspects concerning the pool of male chess players.

[85] Since we always include the former East Germany in the German data, the localized increase in the mid 90's cannot be explained mechanically by the reunification in 1990. However, increased travel possibilities and joint training between the superior former East German players and their West German colleagues could be responsible for the boom in the late 90's.

The quota may well have had a negative impact on the pool of male players. First, this could be a direct effect through playing in the CC. While in 1990 a slot was added to the match-team to accommodate the requirement of a female player, teams were reduced back to 8 players in 2006. Hence, since 2006, the female player replaces a man on the team. Table 1 shows that the worst male player whose position was cut from the team in 2006 was significantly less likely to keep participating in the CC than the worst male player in any other year. However, those men were not less likely to keep being active chess players, neither in the short, nor in the long term, see Section 5.2.

Nonetheless, the quota may have had an impact on men who have not yet played in the Club Championship (or who play in divisions better than division 4), as well as on the performance ability of all men. In addition, the quota may have resulted in clubs investing limited resources on helping improve female players. This could take the form of coaching or even just paying for female bathroom facilities. Hence the quota may have resulted in fewer male players, and perhaps especially in fewer high performing ones.

On the other hand, the quota could have a positive impact on men, and be it just that the presence of women encouraged more men to play chess. Furthermore, some measures implemented by clubs for female players may be beneficial to some men. For example, clubs could have changed their culture, perhaps by emphasizing learning from each other instead of competing against one another.

Comparisons to EU-15 countries allow us to address whether the quota negatively impacted the number of elite French male players. In Figure 10A we show among elite EU-15 male chess players the proportion who are French. This share has significantly increased since 1990.[86] Similar results obtain when we consider the fraction among all EU-15 rated FIDE chess players, elite or not. Therefore, there is no clear evidence that the quota had a negative effect on the number of elite male French players.

7 Discussion and Applications beyond Chess

The implementation of the affirmative action quota in chess in France had many features that may have contributed to its success. First, as is common in quota settings, clubs needed to have female players. Second, the performance of clubs depended on the performance of their female players. Clubs therefore had an incentive to attract good female

[86] This increase is, however, less pronounced than the one of the French among elite female players.

players and to invest in them and help them improve. Moreover, a club who decides where to spend resources to improve their performance in the Club Championship, may opt to invest in the lower rated female players.[87]

Third, a win by a female player is as valuable as a win by a male player for the Club Championship. This could make men feel solidarity with "their" female player and, even if resources are directed towards women, reduce potential backlash.[88] In addition, by directly contributing to Club Championship points, women may feel important and know that they have a place in the club and contribute, rather than worrying whether they really belong. This could reduce the risk of women suffering from the imposter syndrome.[89]

Fourth, a few women in a club (due to the quota requirement) may attract and retain other women. These women in turn could serve as mentors or role models and inspire other women to become or stay being active chess players, creating a snowball effect.[90]

Finally, the quota could have been effective because of the unique feature of the Elo rating in chess. A clear performance measure could reduce the prevalence or the magnitude of an imposter syndrome. Of course, in contrast, it could serve to highlight that women are performing at a lower level than men are, re-enforcing feelings of inferiority.

Data restrictions, specifically the lack of club data around the time of the introduction of the quota do not really allow us to assess which of those factors are important. We can, however, speculate how we could replicate the effects of the quota intervention in environments beyond chess. This can also serve as a way to highlight the difference between the intervention in chess to more standard quota settings.

7.1 Applications beyond Chess

To highlight the difference to standard affirmative action quotas, consider universities and specifically economics departments. One way affirmative action measures are often thought of and implemented is by encouraging or providing incentives based on the rep-

[87] This relies on the fact that increasing the Elo rating by a given number of points is easier the less points a player has, and that it is not exorbitantly more costly for women than for men.

[88] For work in psychology of when quotas lead to backlash see Harrison et al. (2006), and see Bagues et al. (2017) for evidence of backlash to a gender quota in academia.

[89] The imposter phenomenon was first described by Clance and Imes (1978), and since then has been very popular in the press. For a survey on academic work see Bravata et al. (2020).

[90] For evidence in academia that women have a greater propensity to work with other women see Boschini and Sjögren (2007). Bettinger and Long (2005) and Dee (2007) show the role of a gender match between students and teachers.

resentation of women. For example, one could rank departments based on the number or fraction of their female faculty. Or, more extremely, perhaps the AEA could reward departments who have, say, 20% female faculty.[91] At a first glance, the chess quota in France is one on representation. To see why it is not just that, the following would be a quota on "pure presence:" Require that chess clubs who play in the Club Championship have a certain fraction of female members – though women need not play in their teams.

Consider an output rather than a representation-based affirmative action policy for economics departments via rankings or other incentives. Suppose to rank departments we use, besides total research output, not just their number of female faculty, but explicitly the research output of their female faculty, be it publications, citations, prizes, etc. Such "output" rather than "pure representation" rules affect the incentives departments and universities have towards their female faculty.

A department seeking a female faculty member has, ceteris paribus, always an interest to hire the best one. However, under an output affirmative action regime or subsidy the department has an additional incentive to invest in and promote their female researchers. If the returns to a publication by a female faculty member are larger than that of a male member, and the increase in the chance to produce and publish such a paper are not much lower for a given woman than her male colleague with additional resources (time and money), then the department has an incentive to channel resources to the woman. At the very least, it affects incentives for the organization to ensure that women are not inundated with non-promotable tasks (Babcock et al., 2017).

One problem with affirmative action quotas on gender is that, while they are quite prevalent around the world, they have fallen out of favor and are likely illegal in the US.[92]

[91]Such a subsidy could be done via reduced conference fees or library subscription prices. Furthermore, according to the 2020 CSWEP annual report on the Status of Women in the Economics Profession, the fraction of female tenure track faculty in PhD granting economics departments is 21.9%. It is only 15.5% in the Top 10 schools and 16.3% in the Top 20 schools. Note that in this report there are actually 11 departments in the Top 10: Harvard, MIT, Princeton, U. of Chicago, Stanford, UC Berkeley, Yale, Northwestern, UPenn, Columbia and U. of Minnesota. There are 10 more in the "Top 20", namely, NYU, U. of Michigan, CalTech, UCLA, UCSD, U. of Wisconsin, Cornell, Brown, CMU and Duke (see the 2010 CSWEP report of the Committee on the Status of Women in the Economics Profession (see the 2010 CSWEP report of the Committee on the Status of Women in the Economics Profession.)

[92]The US supreme court, starting with *Regents of the University of California v. Bakke* 438 U.S. 265 (1978) and up to *Gratz v. Bollinger* 539 U.S. 244 (2003) deemed that the automatic use of race in college admission violates the Equal Protection Clause of the Fourteenth Amendment. However, *Grutter v. Bollinger* 539 U.S. 306 (2003) upheld the legality of the use of race as *a* factor in college admissions. While the Supreme Court has made it clear that quotas are inherently constitutionally suspect, within the context of American constitutional jurisprudence, race and gender are treated differently (see Okafor, 2019). More recently,

In contrast, a subsidy is less problematic. It seems not *yet* illegal to provide resources or recognition based on the performance of female faculty.

8 Conclusion

The affirmative action quota introduced in 1990 in the French chess Club Championship allows us to study effects of such a quota on three levels. First, like other work on gender quotas, we find that there were high performing women who were only selected once the quota was introduced. Furthermore, we unequivocally find that selected women became more qualified through channels beyond the opportunities directly provided by the quota. The quite unique feature of chess allows us to prove that a gender quota can have significant trickle down and spillover effects, the second level of quota effects. There are not only more, but especially also more high performing French female chess players. We use evidence from France to show that this boom is not just driven by changes in attitudes by and towards female players. Results from EU-15 countries confirm that the boom is a French rather than a general western European phenomenon, and as such likely the result of the quota. For the third level of quota effects, EU-15 data show that there is no evidence of a negative effect of the quota on the pool of elite French male chess players.

We speculate that one reason for the success of the French chess quota was due to the fact that it was an "output" rather than a "pure representation" quota. At least one ninth of the performance of teams in the Club Championship was determined by the performance of female players. Such an "output" based quota provides organization with different incentives than a pure representation quota does. We use economic departments to discuss the different gender quotas and how each of them might be implemented. We hope that future work will provide theoretical properties of various quotas as well as find other areas where output quotas are already, or could be, implemented.

References

Avoyan, Ala, Robizon Khubulashvili, and Giorgi Mekerishvili, "Behavioral Market Design For Online Gaming Platforms," *Available at SSRN 3690620*, 2021.

Schuette v. Coalition to Defend Affirmative Action, 572 U.S. 291 (2014) ruled that states can enact bans on affirmative action in education, which leads Jenkins and Moses (2014) to speculate that affirmative action will not be around for much longer in education in the US.

Babcock, Linda, Maria P Recalde, Lise Vesterlund, and Laurie Weingart, "Gender differences in accepting and receiving requests for tasks with low promotability," *American Economic Review*, 2017, *107* (3), 714–47.

Backus, Peter, Maria Cubel, Matej Guid, Santiago Sanchez-Pages, and Enrique Mañas, "Gender, Competition and Performance: Evidence from Real Tournaments," *Quantitative Economics*, 2022, *Forthcoming*.

Bagde, Surendrakumar, Dennis Epple, and Lowell Taylor, "Does Affirmative Action Work? Caste, Gender, College Quality, and Academic Success in India," *American Economic Review*, 2016, *106* (6), 1495–1521.

Bagues, Manuel and Pamela Campa, "Can Gender Quotas in Candidate Lists Empower Women? Evidence from a Regression Discontinuity Design," *Journal of Public Economics*, 2021, *194*, 104315.

_ , Mauro Sylos-Labini, and Natalia Zinovyeva, "Does the Gender Composition of Scientific Committees Matter?," *American Economic Review*, 2017, *107* (4), 1207–38.

Baltrunaite, Audinga, Piera Bello, Alessandra Casarico, and Paola Profeta, "Gender quotas and the quality of politicians," *Journal of Public Economics*, 2014, *118*, 62–74.

Beaman, Lori, Raghabendra Chattopadhyay, Esther Duflo, Rohini Pande, and Petia Topalova, "Powerful Women: Does Exposure Reduce Bias?," *Quarterly Journal of Economics*, 2009, *124* (4), 1497–1540.

Bertoni, Marco, Giorgio Brunello, and Lorenzo Rocco, "Selection and the Age–Productivity Profile. Evidence from Chess Players," *Journal of Economic Behavior & Organization*, 2015, *110*, 45–58.

Bertrand, Marianne, Sandra E. Black, Sissel Jensen, and Adriana Lleras-Muney, "Breaking the Glass Ceiling? The Effect of Board Quotas on Female Labour Market Outcomes in Norway," *Review of Economic Studies*, 2018, *86* (1), 191–239.

Besley, Timothy, Olle Folke, Torsten Persson, and Johanna Rickne, "Gender Quotas and the Crisis of the Mediocre Man: Theory and Evidence from Sweden," *American Economic Review*, 2017, *107* (8), 2204–2242.

Bettinger, Eric P and Bridget Terry Long, "Do Faculty Serve as Role Models? The Impact of Instructor Gender on Female Students," *American Economic Review*, 2005, *95* (2), 152–157.

Boschini, Anne and Anna Sjögren, "Is Team Formation Gender Neutral? Evidence from Coauthorship Patterns," *Journal of Labor Economics*, 2007, *25* (2), 325–365.

Bravata, Dena M, Sharon A Watts, Autumn L Keefer, Divya K Madhusudhan, Katie T Taylor, Dani M Clark, Ross S Nelson, Kevin O Cokley, and Heather K Hagg, "Prevalence, predictors, and treatment of impostor syndrome: a systematic review," *Journal of General Internal Medicine*, 2020, *35* (4), 1252–1275.

Broockman, David E. and Evan J. Soltas, "A natural experiment on discrimination in elections," *Journal of Public Economics*, 2020, *188*, 104201.

Bühren, Christoph, Björn Frank, Stefan Krabel, and Alexander Werner, "Decision-Making in Competitive Framings – Strategic Behavior of Chess Players in Mini-Ultimatum Game Chess Puzzles," *Economics Letters*, 2012, *115* (3), 356–358.

Chattopadhyay, Raghabendra and Esther Duflo, "Women as Policy Makers: Evidence from a Randomized Policy Experiment in India," *Econometrica*, 2004, *72* (5), 1409–1443.

Clance, Pauline Rose and Suzanne Ament Imes, "The imposter phenomenon in high achieving women: Dynamics and therapeutic intervention.," *Psychotherapy: Theory, Research & Practice*, 1978, *15* (3), 241.

Coate, Stepehn and Glenn C. Loury, "Will Affirmative-Action Policies Eliminate Negative Stereotypes?," *American Economic Review*, 1993, *83* (5), 1220–1240.

De Paola, Maria, Vincenzo Scoppa, and Rosetta Lombardo, "Can Gender Quotas Break Down Negative Stereotypes? Evidence from Changes in Electoral Rules," *Journal of Public Economics*, 2010, *94* (5-6), 344–353.

De Sousa, Jose and Guillaume Hollard, "Gender Differences: Evidence from Field Tournaments," *CEPREMAP Working Paper*, 2015, *1506*.

Dee, Thomas S, "Teachers and the Gender Gaps in Student Achievement," *Journal of Human resources*, 2007, *42* (3), 528–554.

Deschamps, Pierre, "Gender Quotas in Hiring Committees: A Boon or a Bane for Women," *Sciences Po LIEPP Working Paper*, 2018, *82*.

Elo, Arpad E, *The Rating of Chessplayers, Past and Present*, Arco Pub., 1978.

Fang, Hanming and Andrea Moro, "Theories of Statistical Discrimination and Affirmative Action: A Survey," in Jess Benhabib, Alberto Bisin, and Matthew O. Jackson, eds., *Handbook of Social Economics*, Vol. 1 2011, pp. 133–200.

Franceschet, Susan and Jennifer M Piscopo, "Gender Quotas and Wwomen's Substantive Representation: Lessons from Argentina," *Politics & Gender*, 2008, *4* (3), 393–425.

Gneezy, Uri, Muriel Niederle, and Aldo Rustichini, "Performance in Competitive Environments: Gender Differences," *Quarterly Journal of Economics*, 2003, *118* (3), 1049–1074.

González-Díaz, Julio and Ignacio Palacios-Huerta, "Cognitive Performance in Competitive Environments: Evidence from a Natural Experiment," *Journal of Public Economics*, 2016, *139*, 40–52.

Gränsmark, Patrik, "Masters of Our Time: Impatience and Self-Control in High-Level Chess Games," *Journal of Economic Behavior & Organization*, 2012, *82* (1), 179–191.

Harrison, David A, David A Kravitz, David M Mayer, Lisa M Leslie, and Dalit Lev-Arey, "Understanding Attitudes Toward Affirmative Action Programs in Employment: Summary and Meta-Analysis of 35 Years of Research.," *Journal of Applied Psychology*, 2006, *91* (5), 1013.

Ibanez, Marcela and Gerhard Riener, "Sorting through Affirmative Action: Three Field Experiments in Colombia," *Journal of Labor Economics*, 2018, *36* (2), 437–478.

Jenkins, Laura Dudley and Michele S. Moses, "Affirmative action initiatives around the world," *International Higher Education*, 2014, *Fall* (77), 5–6.

Künn, Steffen, Christian Seel, and Dainis Zegners, "Cognitive Performance in the Home Office - Evidence from Professional Chess," *Economic Journal*, 2022, *132* (643), 1218–1232.

Levitt, Steven D., John A. List, and Sally E. Sadoff, "Checkmate: Exploring Backward Induction among Chess Players," *American Economic Review*, 2011, *101* (2), 975–990.

Linnemer, Laurent and Michael Visser, "Self-selection in Tournaments: The Case of Chess Players," *Journal of Economic Behavior & Organization*, 2016, *126*, 213–234.

Maida, Agata and Andrea Weber, "Female Leadership and Gender Gap within Firms: Evidence from an Italian Board Reform," *ILR Review*, 2020, *75* (2), 488–515.

Matros, Alexander, "Lloyd Shapley and Chess with Imperfect Information," *Games and Economic Behavior*, 2018, *108*, 600–613.

Moul, Charles C and John VC Nye, "Did the Soviets collude? A statistical analysis of championship chess 1940–1978," *Journal of Economic Behavior & Organization*, 2009, *70* (1-2), 10–21.

Niederle, Muriel, Carmit Segal, and Lise Vesterlund, "How costly is diversity? Affirmative action in light of gender differences in competitiveness," *Management Science*, 2013, *59* (1), 1–16.

O'brien, Diana Z and Johanna Rickne, "Gender Quotas and Women's Political Leadership," *American Political Science Review*, 2016, *110* (1), 112–126.

Okafor, Gabriella, "California's Gender Board Quota Legislation is Likely Unconstitutional," *Columbia Business Law Review*, 2019, *https://journals.library.columbia.edu/index.php/CBLR/announcement/view/191.*

Otero, Sebastian, Nano Barahona, and Caue Dobbin, "Affirmative Action in Centralized College Admission Systems: Evidence from Brazil," *Mimeo*, 2021.

Palacios-Huerta, Ignacio and Oscar Volij, "Field Centipedes," *American Economic Review*, 2009, *99* (4), 1619–1635.

Salant, Yuval and Jörg L. Spenkuch, "Complexity and Choice," *CESifo Working Papers*, 2021, *9239.*

Strittmatter, Anthony, Uwe Sunde, and Dainis Zegners, "Life Cycle Patterns of Cognitive Performance over the Long Run," *Proceedings of the National Academy of Sciences*, 2020, *117* (44), 27255–27261.

Zonszein, Stephanie and Guy Grossman, "Turnout Turnaround: Ethnic Minority Victories Mobilize White Voters," *Mimeo*, 2022.

Appendices

A Data Sources and Descriptive Statistics

To explore the impact of the gender quota, we use four data sets: the French Club Championship (A.1), the administrative French data (A.2), the administrative Belgian data (A.3) and the FIDE data (A.4).

A.1 The French Club Championship

Our first data set contains information on the French Club Championship (CC). We first present descriptive statistics on the CC (A.1.1) and then detail its organization (A.1.2). Finally, we thank the many people who helped us collect and understand the data (A.1.3).

A.1.1 Descriptive Statistics

In Table 3, we decompose the 10,505 teams per division and year, while in Table 4, we decompose the 42,077 match-ups per division and year. In Table 5, we look how the 29,931 unique players, of which 3,325 are women, break down by division and year, while in Table 6 we break down these players by gender.

Of the 8,757 players participating in the CC in 2015, 468 are foreigners (i.e., they are not playing under the French FIDE country code, FRA). Of the 29,931 players participating in the Club Championship from 1986 to 2015, 1,948 are foreigners. Panel A of Appendix Figure 11 shows participation in the Club Championship by gender in 2015.[93] Panel B shows the same when we restrict attention to the top 3 divisions, which fall under a quota in 2015.

In 2015, CC games represent about half of the official games of CC players (48% for women and 59% for men). When we restrict attention to quota divisions 1 to 3, it is 49% for women and 47% for men.

A.1.2 Organization of the Data

We observe three layers of data: teams, match-ups and games (or boards). A club who plays in a given division in the Club Championship fields a team for a season. The team consists of players for each match-up against another team, and each match-up consists of a given number of boards or games, where each player in a given match-up plays exactly one game. For example, one of the authors played for Paris Caïssa in the season 1992

[93] Appendix Figure 12 shows histograms of all active players by gender and age in 2015. We also report the mean age of all Club Championship and active players from 1986 to 2015 in Appendix Figure 13.

(from September 1992 to August 1993) where the team faced 11 other teams, hence the team had 11 match-ups and brought 9 players to each match-up.

A. Teams

If all the planned games had been played in the divisions and the years we observe, we would have 10,679 teams (see column 1 of Panel A in Table 2).[94] They would have played 42,793 matches for a total of 346,108 games or boards. However, the actual number of teams differs from the planned ones because some teams forfeited the whole season. For instance, in division 1, this is the case in 2009, 2011 and 2013, which explains the odd number of teams in these years (15, 11, and 11 respectively, see column 1 in Table 3). As a result, the number of teams for which we *could* actually capture data is 423 in division 1, and 10,505 in all five divisions. We managed to get some data from any single one of those teams (column 3 in Panel A).

B. Match-ups

The actual number of teams in our sample (10,505) could have lead to 42,793 planned match-ups (column 1 in Panel B). However, some teams forfeited some, though not all, match-ups in a season. For example, in 1991 in division 1, *Montpellier Karpov* forfeited its last 5 matches such that we observe only 61 match-ups instead of the expected 66 ($= 11 * 12/2$) match-ups in that year, see column 1 of Table 4. Other teams in division 1 also forfeited some matches: *Lille* forfeited its last 5 matches in 1993 and its last 4 matches in 1997, and *Marseille Duchamps* forfeited its last four matches in 2007. In addition, in 1987, the match between *Paris Caïssa* and *Strasbourg* was not held for administrative reasons. As a result, the number of actual match-ups for which we could gather data is 2,313 in division 1. When we consider teams from all 5 divisions, only 42,175 of the 42,793 match-ups actually happened (see column 2 in Panel B of Table 2).

However, we are missing some observations, hence the discrepancy between the actual number of match-ups and those in our sample (column 2 vs column 3 of Panel B). In division 1, for instance we miss a total of 11 match-ups. While there is a chance that some of them might not have happened, we simply don't know, therefore we err on the conservative side and declare them as data we could have found, but failed to do so. These 11 match-ups we are missing are: one in 1986, *Toulouse vs Clichy*, one in 1988, *Metz vs Strasbourg*, and 9 in 1989 (*Meudon vs Montpellier* in round 5; *Meudon vs Rennes* in round 6; *Meudon vs Paris Chess XV* and *Rennes vs Toulouse* in round 7; *Montpellier vs Rennes* in round 8; *Paris Chess XV vs Strasbourg* in round 9; *Paris Caïssa vs Lyon*, *Paris Chess XV vs Montpellier*, and *Strasbourg vs Toulouse* in round 11).

In total, over the five divisions, we miss only 98 match-ups. This represents only 0.23 percent of all match-ups we could have observed. Recall that prior to 2001, data were

[94] A team that plays in two different years is labeled as two different teams. Recall also that a club may have more that one team in the Club Championship in a given year.

mainly hand collected from chess magazines, chess forums and the (shockingly incomplete) archives of the French Chess Federation.

C. Boards or Games

Given the actual match-ups that were played (including match-ups for which we miss data and hence we can only speculate that they actually happened), we expect a total of 346,108 games played (see column 1 of Panel C).[95] However, as explained above, we are missing some games because some match-ups have not been played. First, some teams forfeited part of the season so that 5,097 games could not be played. Additionally, three match-ups for a total of 24 games have not been played for unknown administrative reasons due to potential rule violation (e.g., *Paris Caïssa vs Strasbourg* in division 1 in 1987). Overall, 5,121 games have not been played: 166 in division 1, 106 in division 2, 583 in division 3, 1,089 in division 4, and 3,177 in division 5. This explains why the theoretical number of games (346,108) differs from the actual one (340,987; see column 2 of Panel C).

Among the actual 340,987 games, 871 have been played but not observed. Specifically, we miss 88 games in division 1, broken down as follows: 8 games in 1986 (the match-up *Toulouse vs Clichy*), 8 games in 1988 (the match-up *Metz vs Strasbourg*, and 72 games in 1989 (9 match-ups missing). Apart from division 1, we also miss 72 games in division 2 (eight match-ups missed in 2000), and 711 games in division 3 in 2000 and 2001, but none in divisions 4 or 5. Given that prior to 2001 data were mainly hand collected, it is remarkable that we were able to retrieve most of the data in the division and the years we observe. The missing games represent only 0.26% of the total actual games.

Due to the missing match-ups and games, our sample contains 340,036 (= 340,987-871) available games (see column 3 of Panel C in Table 2). These games are split into four different data sets according to the type of information we observe:

1. *Board Data 1*: Both players are listed in the match-up sheet and the game was played. This data set represents 328,592 games out of 340,036 (96.6%) for which we observe the score of the game and the id number of each listed player, her gender and her elo rating.

    - *Board Data 1A*. 328,511 games (out of 328,592) where the player's year of birth is observed. Year of birth is not observed for 27 players and 81 games.[96]

2. *Board Data 2*: Board Data 1 + 4,441 games where both players are listed in the match-up sheet but the score of the game is unknown (80 games) or the game has been forfeited (4,361).

[95] With 2 players each, the 346,108 games deliver hence 692,216 copies of not necessarily distinct players.

[96] The date of birth is mandatory for a player to be registered in the national and FIDE database. Then, only the year of birth is publicly displayed but a player may request that his or her year of birth not be published. See the FIDE privacy policy for more details, https://www.fide.com/privacy.

Note that two cases of forfeits are possible. First, the usual classical forfeit when one player is announced but does not show up or arrives at the chessboard after the default time, set to one hour. Second, the unusual administrative forfeit when a specific rule is broken. In rare circumstances, both players may lose by forfeit. Players declared as forfeits are usually announced in the game sheet, but this is not always the case, as we will see below.

Board Data 2 represents 333,033 games (= 328,592 + 4,361 + 80), i.e., 97.9% out of our sample of 340,036 games.

3. *Board Data 3*: Board Data 2 + 6,634 games where information is missing for one player. The player is listed but unknown (9) or is forfeit and not listed (6,625). This data set represents 339,667 games (=333,033 + 6,634), i.e., 97.9% out of our sample of 340,036 games.

4. *Board Data 4*: Board Data 3 + 369 games where we do not have information for both of the players. They are both listed but unknown (136) or they both forfeited and were not listed (233). Board Data 4 represents our full sample of 340,036 games.

A.1.3 Acknowledgments

We are grateful to many chess players and chess officials of the French Chess Federation (FFE) for their comments, suggestions and sharing some of the French Club Championship data with us. We thank Isabelle Billard (President of the Grenoble chess club and President of the Gender Equality Commission), the FIDE Arbiter Sonia Bogdanovsky, the WIM Mathilde Congiu, the WIM Chritine Flear, the GM Glenn Flear, the CM Marc Kirszenberg, the IM Jean-Rene Koch, the FM Jordi Lopez (FFE's National Technical Manager), the GM David Marciano, the FM Jean-Claude Moingt (former President of the FFE), the National Arbiter Joëlle Mourgues (FFE administration), the IM Jean-Baptiste Mullon (Vice-President of the FFE), Dominique Primel, the FM Emmanuel Neiman, André Rasneur (former President of the Ile-de-France Chess League), Charles-Henri Rouah (FFE's National Elo Rating Director), the IM Daniel Roos, and Aude Soubrier (member of the Gender Equality Commission).

Table 2: Number of Teams, Match-ups and Boards

	(1)	(2)	(3)
	Panel A. Teams		
Division	Planned	Actual	Sample
1	426	423	423
2	536	533	533
3	1,360	1,338	1,338
4	2,779	2,754	2,754
5	5,778	5,457	5,457
Total	10,679	10,505	10,505
	Panel B. Match-ups		
Division	Planned given actual teams	Actual	Sample
1	2,332	2,313	2,302
2	2,915	2,903	2,895
3	6,605	6,540	6,461
4	11,632	11,499	11,499
5	19,309	18,920	18,920
Total	42,793	42,175	42,077
	Panel C. Boards or Games		
Division	Planned given actual matches	Actual	Sample
1	20,030	19,864	19,776
2	24,541	24,435	24,363
3	56,150	55,567	54,856
4	94,487	93,398	93,398
5	150,900	147,723	147,643
Total	346,108	340,987	340,036

Notes: Number of theoretical, actual and sample teams, match-ups, and boards (or individual games) from 1986 to 2015.

Table 3: Number of Teams per Year and Division

	Teams in Division						of which
Year	1	2	3	4	5	Total	under AA
1986	10					10	0
1987	12					12	0
1988	12					12	0
1989	12					12	0
1990	**12**					12	**12**
1991	**12**					12	**12**
1992	**12**					12	**12**
1993	**16**					16	**16**
1994	**16**					16	**16**
1995	**16**					16	**16**
1996	**16**					16	**16**
1997	**16**					16	**16**
1998	**16**					16	**16**
1999	**16**					16	**16**
2000	**16**	**48**	**156**			220	**220**
2001	**16**	**47**	**160**			223	**223**
2002	**16**	**48**	**156**	357	348	925	**220**
2003	**16**	**48**	**158**	376	413	1011	**222**
2004	**16**	**16**	**48**	**160**	391	631	**240**
2005	**16**	**16**	**48**	**159**	382+**8**	629	**247**
2006	**16**	**24**	**48**	**160**	380+**8**	636	**256**
2007	**16**	**24**	**48**	**158**	377+**8**	631	**254**
2008	**16**	**24**	**47**	**157**	363+**8**	615	**252**
2009	**15**	**23**	**48**	**157**	370+**8**	621	**251**
2010	**12**	**36**	**69**	**180**	406	703	**297**
2011	**11**	**36**	**70**	**177**	403	697	**294**
2012	**12**	**36**	**70**	**179**	393	690	**297**
2013	**11**	**36**	**70**	**177**	405	699	**294**
2014	**12**	**35**	**72**	178	396	693	**119**
2015	**12**	**36**	**70**	179	390	687	**118**
Total	423	533	1,338	2,754	5,457	10,505	**3,952**

Notes: For each year and division, the number of teams in the Club Championship. We also indicate in bold the number of teams that fall under the quota. In total, of the 10,505 teams, 3,952 are subject to a gender quota (AA) reported in bold.

Table 4: Number of Match-ups per Year and Division

	Match-ups in Division					
Year	1	2	3	4	5	Total
1986	44					44
1987	65					65
1988	65					65
1989	57					57
1990	66					66
1991	61					61
1992	66					66
1993	115					115
1994	88					88
1995	88					88
1996	88					88
1997	84					84
1998	88					88
1999	88					88
2000	88	256	600			944
2001	88	243	694			1,025
2002	88	264	662	1,229	1,154	3,397
2003	88	264	694	1,336	1,356	3,738
2004	88	88	254	707	1,395	2,532
2005	88	88	264	699	1,396	2,535
2006	88	132	262	718	1,398	2,598
2007	84	132	264	698	1,378	2,556
2008	88	130	253	688	1,300	2,459
2009	77	121	264	686	1,339	2,487
2010	66	198	364	791	1,398	2,817
2011	55	198	374	780	1,368	2,775
2012	66	198	374	800	1,346	2,784
2013	55	198	369	780	1,403	2,805
2014	66	187	396	789	1,361	2,799
2015	66	198	373	798	1,328	2,763
Total	2,302	2,895	6,461	11,499	18,920	42,077

Notes: For each year and division, the number of match-ups in the Club Championship. In total, our sample contains 42,077 match-ups (see Panel B of Table 2).

Table 5: Number of Players per Year in the Club Championship

Year	Number of Players	Number of Men	Number of Women	Share of Women
1986	135	132	3	2.2
1987	147	146	1	0.7
1988	139	137	2	1.4
1989	132	129	3	2.3
1990	156	140	16	10.3
1991	153	133	20	13.1
1992	157	140	17	10.8
1993	223	200	23	10.3
1994	195	173	22	11.3
1995	206	183	23	11.2
1996	212	182	30	14.2
1997	204	178	26	12.7
1998	211	185	26	12.3
1999	226	199	27	11.9
2000	3,074	2,701	373	12.1
2001	3,176	2,794	382	12.0
2002	10,511	9,728	783	7.4
2003	11,350	10,549	801	7.1
2004	8,101	7,500	601	7.4
2005	8,047	7,426	621	7.7
2006	7,958	7,321	637	8.0
2007	7,875	7,232	643	8.2
2008	7,617	6,976	641	8.4
2009	7,780	7,137	643	8.3
2010	8,673	7,904	769	8.9
2011	8,704	7,865	839	9.6
2012	8,616	7,785	831	9.6
2013	8,775	7,950	825	9.4
2014	8,749	8,094	655	7.5
2015	8,757	8,118	639	7.3

Notes: For each year, the number of male and female players in the Club Championship, as well as the share of women. Data are available for division 1 since 1986, for divisions 2 and 3 since 2000 and for divisions 4 and 5 since 2002.

Table 6: Number of Players per Gender and Division

Division	Gender	Number of Players	Share of Gender per Division	Available Period	Introduction of the Quota
1	M	1,275	87.3	1986-2015	1990
	F	185	12.7		
2	M	2,625	84.5	2000-2015	1991
	F	480	15.5		
3	M	6,949	84.4	2000-2015	1992
	F	1,281	15.6		
4	M	13,428	87.8	2002-2015	2004-2013
	F	1,870	12.2		
5	M	22,264	92.3	2002-2015	no quota[a]
	F	1,864	7.7		
Total	M	46,541	89.1		
	F	5,680	10.9		

Notes: Total number of Male (M) and Female (F) players who participate in a division in a given period. Accordingly, we double count a player who participates in one division in one year and another division in another year, as well as a player who participates, with certain restrictions, in two different divisions the same year. Overall, we observe 29,931 unique players of which 3,325 women. [a]In the fifth division the quota has been implemented in only one region (in Basse Normandie) between 2005 and 2009.

A.2 The Administrative French Data

Our second data set is from the French Chess Federation (FFE) and consists of all players registered in France between 1984 and 2015.[97] We only use active players, i.e., who paid their dues to the federation for the season (regardless of the number of games they play). This leaves us with 150,550 players, of which 26,472 (17.6 percent) are female. Of the 150,550 active players, the year of birth is missing for 6,244 players and the gender for 126 players. If we only consider "homegrown" players, that is female and male players who started their chess career in France, we end up with 147,742 players, of which 26,156 (17.7 percent) are female.

Table 7 reports the number of active players in France, as well as the number and share of Club Championship players over the five divisions.

A.3 The Administrative Belgian Data

The Belgian data come from the Belgian Chess Federation.[98] We have data of all chess players registered in Belgium from 1988 to 2014. As for France, we only use active players, i.e., players who paid their dues to the federation for the season (regardless of the number of games they play). This leaves us with 25,180 players, of which 2,287 (9 percent) are female. If we only consider "homegrown" players, that is female and male players who started their chess career in Belgium, we end up with 14,366 players, of which 1,295 (9 percent) are female.

Table 8 reports the number of active players in Belgium, as well as the share of women between 1984 and 2014.

A.4 The FIDE Data

Rating lists are published by FIDE (the Federation Internationale des Echecs) since 1967.[99] Data since January 2001 are available on the FIDE website.[100] Data from June 1967 to July 2000 are from the chess publication *Šahovski Informator*.[101] FIDE provides a unique identifier for each player, as well as her/his year of birth, national federation, rating and gender. The FIDE identification number remains the same throughout a player's chess career. However, when a player dies, FIDE may reassign his or her identification number

[97] We are very grateful to Charles-Henri Rouah, in charge of the French national rating for providing us with the administrative French data.

[98] See https://www.frbe-kbsb-ksb.be/en/.

[99] See the Online Appendix K.1 for a short history.

[100] See https://ratings.fide.com/download.phtm.

[101] See https://sahovski.com/. Šahovski Informator is a publishing house in Belgrade (Serbia) which has been producing periodically, since 1966, a book called Chess Informant. Each issue offers several hundred annotated games, as well as the FIDE rating list until July 2000.

to a new player. We track these changes and reassign identification numbers so that each player receives a unique number.

Active FIDE Player

A FIDE player is rated active by FIDE if she has played a rated game in the last twelve months. This definition differs from that of national federations where a player is active if she has paid her federation dues for the season, regardless of the number of games she has played. In Table 9, we present the number of active FIDE players in the EU-15 countries from 1984 to 2015. Using historical FIDE thresholds, we also report the number of elite players with $Elo \geq 1805$ for women and with $Elo \geq 2205$ for men.

Homegrown FIDE Player

A homegrown FIDE player is defined based on the national Federation of her fist appearance in the FIDE rating list. In the case of France and Belgium, we define the homegrown status of the player a bit more precisely. The reason is that the conditions to obtain a FIDE rating are more stringent (See Online appendix K.1). Thus, most of the time, a player appears sooner in the national rating lists than in the FIDE ones. However, when we compare France and Belgium to the EU-15 countries we focus only on the FIDE rating lists because we don't observe their first appearance in the national rankings. Céline Roos, a French and Canadian chess player who holds the title of Woman International Master since 1985 started her career in France. So, we will consider her as French homegrown in our French Club championship data but not in the FIDE data because she got her first FIDE rating under the Canadian code. On the contrary, the Serbian-French International Master Miodrag Todorcevic, learned chess in ex-Yugoslavia but gained his first FIDE rating under the French code. So, he will be considered as French homegrown in the FIDE data but not in the French Club Championship data.

Table 7: Number of Active Players in France (1984 - 2015)

	Active Players					Share of CC among Active		
	All		Women			All	Women	Men
	#	No Age (#)	#	%	No Age (#)	%	%	%
Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1984	7639	2498	493	6.5	147	.	.	.
1985	8597	2570	531	6.2	141	.	.	.
						Division 1		
1986	9121	2423	523	5.7	108	1.5	.6	1.5
1987	9130	2005	521	5.7	77	1.6	.2	1.7
1988	8710	1515	525	6	51	1.6	.4	1.7
1989	10394	1491	667	6.4	51	1.3	.4	1.3
1990	11750	1191	885	7.5	63	1.3	1.8	1.3
1991	13237	724	1157	8.7	49	1.2	1.7	1.1
1992	15209	34	1463	9.6	1	1	1.2	1
1993	15932	34	1542	9.7	2	1.4	1.5	1.4
1994	16217	43	1525	9.4	4	1.2	1.4	1.2
1995	17154	36	1658	9.7	2	1.2	1.4	1.2
1996	18993	29	2057	10.8	1	1.1	1.5	1.1
1997	20064	26	2262	11.3	0	1	1.1	1
1998	20351	26	2392	11.8	0	1	1.1	1
1999	20788	24	2422	11.7	1	1.1	1.1	1.1
						Divisions 1 to 3		
2000	22148	16	2716	12.3	2	13.9	13.7	13.9
2001	22366	15	2647	11.8	0	14.2	14.4	14.2
						Divisions 1 to 5		
2002	23732	17	2754	11.6	1	44.3	28.4	46.4
2003	24931	21	2893	11.6	0	45.5	27.7	47.9
2004	25631	17	3029	11.8	0	31.6	19.8	33.2
2005	25459	7	3018	11.9	0	31.6	20.6	33.1
2006	25765	4	3145	12.2	1	30.9	20.3	32.4
2007	25000	5	3173	12.7	1	31.5	20.3	33.1
2008	25535	2	3446	13.5	1	29.8	18.6	31.6
2009	26275	2	3592	13.7	0	29.6	17.9	31.5
2010	26749	3	3680	13.8	1	32.4	20.9	34.3
2011	28326	4	4002	14.1	0	30.7	21	32.3
2012	28499	0	4118	14.4	0	30.2	20.2	31.9
2013	29697	1	4486	15.1	0	29.5	18.4	31.5
2014	29310	1	4228	14.4	0	29.8	15.5	32.3
2015	31689	1	4601	14.5	0	27.6	13.9	30

Notes: Columns 1 to 5: Number (#) of active players registered in France. The share of women in percentage (%) in column 4 is computed among all registered players (column 1). "No Age" means that we miss information about the birth year of some players. Columns 6 to 8: share of Club Championship (CC) players among active players.

Table 8: Number of Active Players in Belgium (1988 - 2014)

	All	Women	
Year	#	#	%
1988	5,546	223	4.0
1989	5,565	235	4.2
1990	5,495	256	4.7
1991	5,812	281	4.8
1992	5,660	298	5.3
1993	5,666	304	5.4
1994	5,058	255	5.0
1995	6,014	334	5.6
1996	5,198	267	5.1
1997	5,162	258	5.0
1998	5,084	266	5.2
1999	4,910	263	5.4
2000	5,279	298	5.6
2001	5,769	362	6.3
2002	5,923	384	6.5
2003	5,917	383	6.5
2004	5,821	359	6.2
2005	6,478	422	6.5
2006	5,653	344	6.1
2007	5,479	322	5.9
2008	5,174	312	6.0
2009	5,671	389	6.9
2010	4,517	278	6.2
2011	5,341	370	6.9
2012	5,092	324	6.4
2013	5,142	375	7.3
2014	5,377	421	7.8

Notes: Number (#) of active players in Belgium, and share of women in percentage (%).

Table 9: Number of Active FIDE Players in the EU-15 (1984 - 2015)

	Active Players			Active Elite Players		
	All	Women		All	Women	
Year	#	#	%	#	#	%
1984	1,356	166	12.2	1,319	166	12.6
1985	1,398	144	10.3	1,377	144	10.5
1986	1,549	148	9.6	1,514	148	9.8
1987	1,814	151	8.3	1,780	151	8.5
1988	2,096	155	7.4	2,053	155	7.5
1989	2,849	234	8.2	2,782	234	8.4
1990	3,173	248	7.8	3,093	248	8.0
1991	2,873	166	5.8	2,799	166	5.9
1992	3,452	201	5.8	3,123	201	6.4
1993	4,247	225	5.3	3,380	225	6.7
1994	4,860	216	4.4	3,315	216	6.5
1995	5,793	230	4.0	3,495	230	6.6
1996	6,825	243	3.6	3,704	243	6.6
1997	7,895	255	3.2	3,703	254	6.9
1998	8,478	283	3.3	3,853	283	7.3
1999	9,645	314	3.3	3,989	314	7.9
2000	10,501	353	3.4	4,179	353	8.4
2001	11,097	374	3.4	4,247	374	8.8
2002	13,067	446	3.4	4,390	446	10.2
2003	15,345	538	3.5	4,549	538	11.8
2004	18,608	689	3.7	4,683	677	14.5
2005	22,465	869	3.9	4,892	785	16.0
2006	26,761	1,079	4.0	5,073	886	17.5
2007	23,626	1,044	4.4	4,334	723	16.7
2008	26,254	1,222	4.7	4,335	734	16.9
2009	33,235	1,606	4.8	4,603	827	18.0
2010	36,037	1,787	5.0	4,558	815	17.9
2011	39,185	2,018	5.1	4,463	824	18.5
2012	42,255	2,338	5.5	4,381	815	18.6
2013	43,959	2,493	5.7	4,243	782	18.4
2014	49,033	2,928	6.0	4,304	807	18.8
2015	56,134	3,482	6.2	4,289	793	18.5

Notes: Number (#) of active FIDE players in the EU-15 countries, and share of women in percentage (%). Using historical FIDE thresholds, we define elite players with Elo $\geq$ 1805 *for women and with Elo* $\geq$ 2205 *for men.*

B *Top 12* Data and Descriptive Statistics

Our *Top 12* Data are composed of 12 teams per year from 1987 to 2015 and the best 10 teams in 1986. These teams mainly come from division 1 (see Appendix Table 3). When the number of teams in division 1 is larger than 12, we simply select the 12 best teams among division 1, when it is smaller (11 in 2011 and 2013), we add the best team from division 2. Specifically, for each team in Divisions 1 and 2, we compute the average Elo rating of the team for each match-up, and then average over the number of matches per season. We cannot perform a similar exercise in 1986, since in that season we only have Division 1 data.

The *Top 12* data contain 3,890 match-teams (see column 1 of Table 10), of which 462 are from before the quota (1986-1989). A match-team consists of the players who represented their team (or club, actually) at that particular match-up. From 1986 to 1989, the 462 match-teams consist of 1,712 games and boil down to 284 unique players. The reason we have 1,712 and not 1,848 [=(462 match-teams * 8 boards)/2] games is because 36 match-teams are incomplete in 1989, so we do not observe 136 games (see Appendix A.1 for details). From 1990 to 2015, we have 3,428 match-teams, which represent 14,782 games and 1,102 unique players.

Table 10: Match-Teams in the *Top 12*

				Dropping Individual Forfeits			Dropping All Individual Forfeits		
		How Many Women?			How Many Women?			How Many Women?	
	Total	> 0	$= 1$	Total	> 0	$= 1$	Total	> 0	$= 1$
Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1986	88	9	9	88	9	9	86	9	9
1987	130	2	2	125	2	2	125	2	2
1988	130	20	20	130	20	20	130	20	20
1989	114	20	20	59	12	12	59	12	12
1990	132	132	132	129	129	129	129	129	129
1991	122	122	119	121	121	118	120	120	117
1992	132	132	130	132	132	130	130	130	128
1993	176	176	169	176	176	169	174	174	168
1994	132	131	121	130	130	121	129	129	120
1995	132	132	131	132	132	131	132	132	131
1996	132	132	126	132	132	126	132	132	126
1997	126	126	121	124	124	119	124	124	119
1998	132	132	115	132	132	115	132	132	115
1999	132	132	114	132	132	114	131	131	113
2000	132	132	114	132	132	114	132	132	114
2001	132	132	126	132	132	126	132	132	126
2002	132	132	129	132	132	129	131	131	128
2003	132	128	126	128	128	126	127	127	125
2004	132	132	123	132	132	123	127	127	119
2005	132	132	116	132	132	116	131	131	115
2006	132	132	132	131	131	131	130	130	130
2007	130	130	130	130	130	130	125	125	125
2008	132	132	128	132	132	128	132	132	128
2009	124	124	110	124	124	110	124	124	110
2010	132	131	129	131	131	129	128	128	127
2011	121	121	116	121	121	116	121	121	116
2012	132	132	124	132	132	124	132	132	124
2013	121	121	120	121	121	120	121	121	120
2014	132	132	124	132	132	124	131	131	123
2015	132	132	127	132	132	127	127	127	124
Total									
1986-2015	3,890	3,473	3,303	3,816	3,457	3,288	3,784	3,427	3,263
1990-2015	3,428	3,422	3,252	3,414	3,414	3,245	3,384	3,384	3,220
1990-2005	2,140	2,135	2,012	2,128	2,128	2,006	2,113	2,113	1,993

*Notes: In column 1, we observe 3,890 match-teams in the Top 12 from 1986 to 2015. Per year, the expected number of match-team is 132 (=12*11) because each of the 12 teams play 11 rounds, expect in some occasions. However, some observations are missing as described in section A.1.2. We consider match-teams with at least one woman, and at most one woman in columns 2 and 3, respectively. Columns 4 to 6 consider match-teams where we have discarded individual forfeits in which the player is not listed. Columns 7 to 9 consider match-teams where we have discarded all individual forfeits, independent of whether the player is listed or not. See Appendix Section A.1.2 for details.*

C *Next 208* Data

From 2000 to 2013, we have at least 220 teams under the gender quota (see Appendix Table 3), so that beyond the *Top 12* we can select the *Next 208* best teams. The sample is constructed as described in Table 11. We start with all teams under the quota (excluding the *Top 12* teams and division 5). Then,

- in 2000 and 2002, this selection corresponds exactly to 208 teams;
- in 2001 and 2003, we select the remaining teams from division 1, all teams from division 2, and the best teams from division 3 to complete our *Next 208* teams;
- From 2004 onwards, we select the remaining teams from division 1 (if any), all teams from divisions 2 and 3, and the best teams from division 4 to complete our *Next 208* teams.

For each year, the best teams in division 3 or division 4 are selected based on the average of their best woman in the match-teams (given that teams played at least one-third of their match-ups).

Table 11: *Next 208* Sample: Number of Teams per Year and Division

	Teams in Division					Teams not Selected in Division	
Year	1	2	3	4	Total	3	4
2000	4	48	156		208	0	0
2001	4	47	157		208	3	0
2002	4	48	156		208	0	0
2003	4	48	156		208	2	0
2004	4	16	48	140	208	0	20
2005	4	16	48	140	208	0	19
2006	4	24	48	132	208	0	28
2007	4	24	48	132	208	0	26
2008	4	24	47	133	208	0	24
2009	3	23	48	134	208	0	23
2010	0	36	69	103	208	0	77
2011	0	35	70	103	208	0	74
2012	0	36	70	102	208	0	77
2013	0	35	70	103	208	0	74

Notes: Teams in the Next 208 sample per division and year. In the last 2 columns, we report the number of teams not retained in the Next 208 sample.

Table 12: Number of Match-Teams in the *Next 208* Sample

Same Definition as *Top 12*

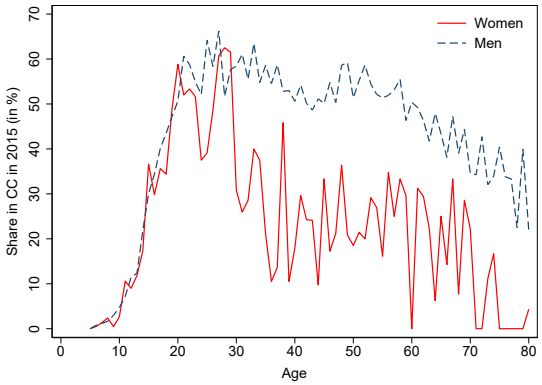
	Including Individual Forfeits			Dropping Individual Forfeits		
		How Many Women?			How Many Women?	
Year	Total	> 0	$= 1$	Total	> 0	$= 1$
	(1)	(2)	(3)	(4)	(5)	(6)
2000	1,756	1,706	1,612	1,647	1,647	1,559
2001	1,892	1,832	1,708	1,761	1,761	1,642
2002	1,896	1,855	1,754	1,787	1,787	1,690
2003	1,943	1,907	1,779	1,843	1,843	1,722
2004	1,965	1,930	1,782	1,862	1,862	1,716
2005	1,985	1,953	1,816	1,896	1,896	1,760
2006	2,016	1,990	1,877	1,950	1,950	1,839
2007	1,997	1,972	1,836	1,927	1,927	1,791
2008	1,977	1,946	1,801	1,904	1,904	1,765
2009	1,969	1,939	1,826	1,890	1,890	1,780
2010	2,039	2,008	1,887	1,970	1,970	1,852
2011	2,041	2,009	1,885	1,974	1,974	1,852
2012	2,056	2,039	1,875	1,999	1,999	1,839
2013	2,028	2,002	1,839	1,976	1,976	1,813
Total	27,560	27,088	25,277	26,386	26,386	24,620

Notes: In column 1, we observe 27,560 match-teams in Next 208 from 2000 to 2013. However, some observations are missing as described in section A.1.2. We consider match-teams with at least one woman, and at most one woman in columns 2 and 3, respectively. Columns 4 to 6 consider match-teams where we discarded individual forfeits in which the player is not listed.

D Age Profile of Players

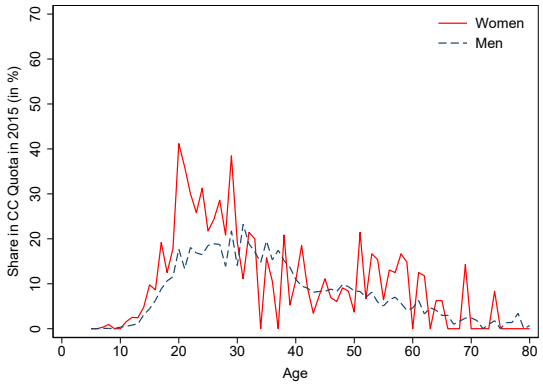
Figure 11: Propensity to Participate by Age and Gender in 2015

A: In Club Championship (Div. 1 - 5)



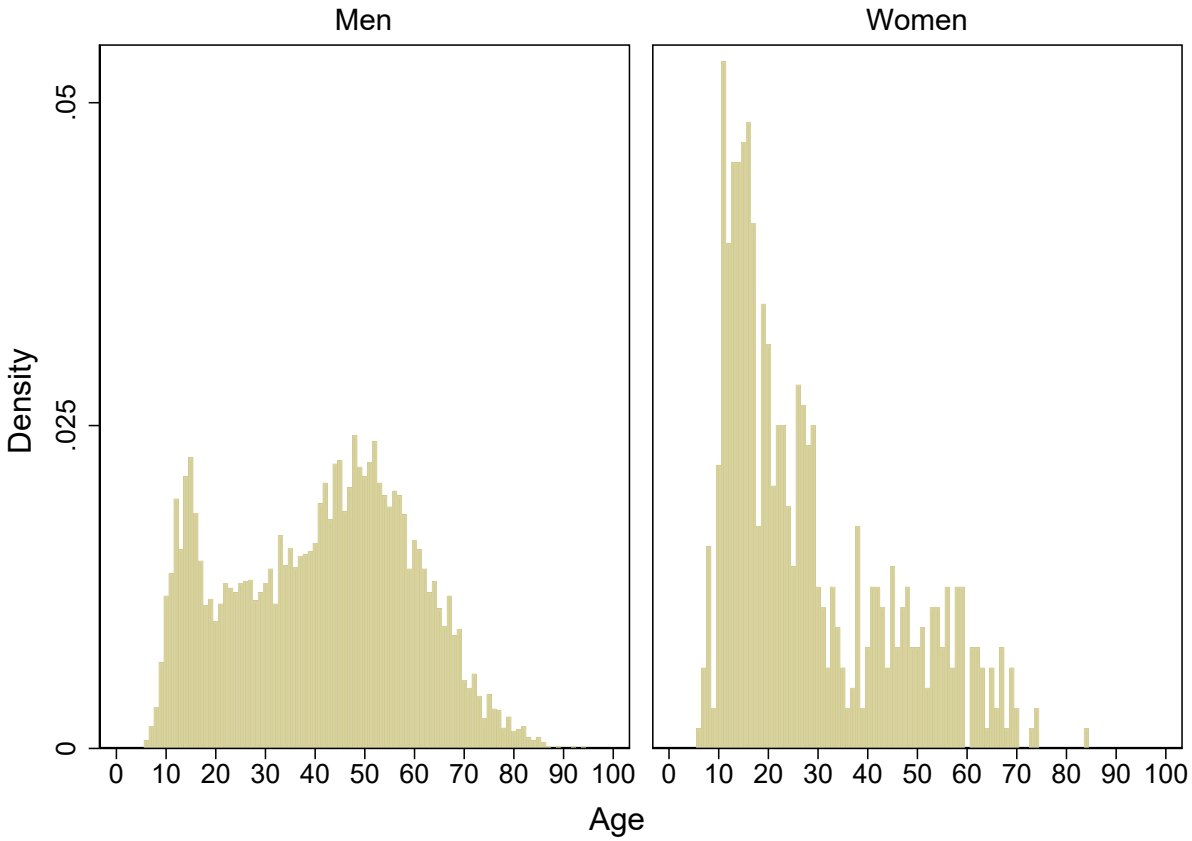
Notes: For each age, the fraction of the 27,088 active men and 4,601 active women who played at least one game in the 2015 French Club Championship. The 48 players under five and the 270 players over 80 are assigned to the five and 80-year bin, respectively.

B: In CC with Quota (Div. 1 - 3)



Notes: For each age, the fraction of the 27,088 and 4,601 active men and women who played at least one game under the quota in the 2015 French CC. The 48 players under five and the 270 players over 80 are assigned to the five and 80-year bin, respectively.

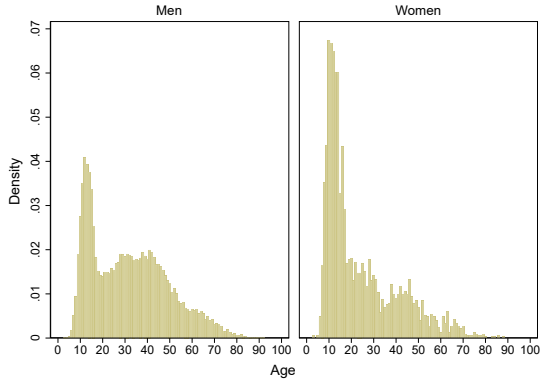
Figure 12: Age of Active Players in 2015



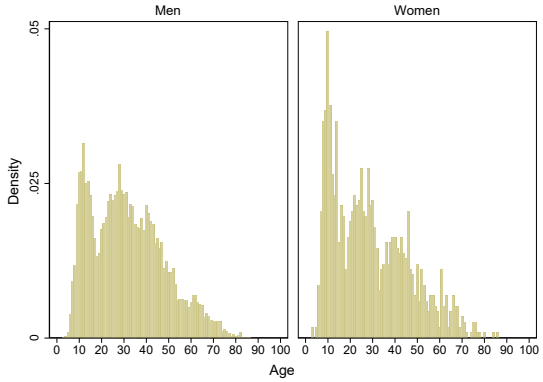
Notes: Age of all active players registered at the French Federation by gender in 2015: 27,088 men and 4,601 women.

Figure 13: Mean Age of Club Championship Players (1986-2015)

A. Club Championship Players



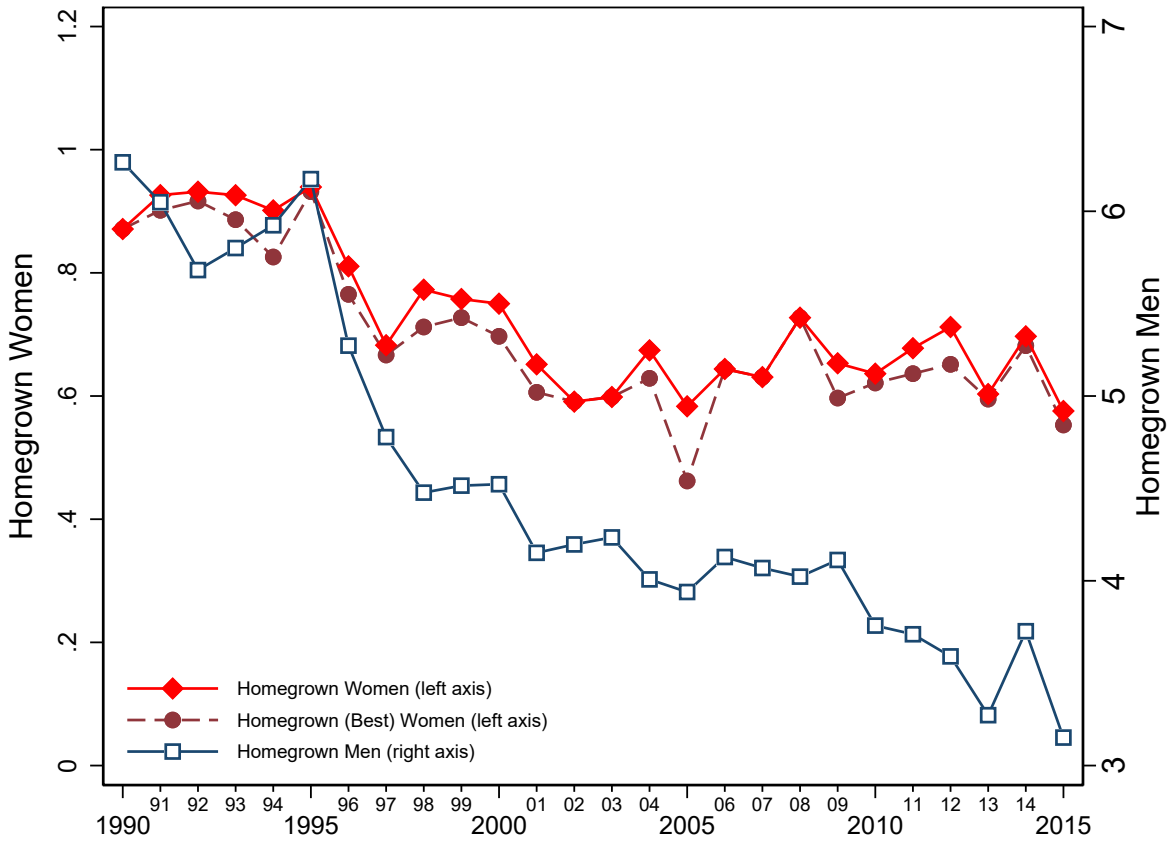
B. Active Players



Notes: Panel A: Since most of the players are participating in the Club Championship more than one season, we report here their mean age by gender from 1986 to 2015: 26,599 unique men and 3,325 unique women. Panel B: Since most of the players are active in more than one season, we report here their mean age by gender from 1986 to 2015: 117,490 unique men and 25,920 unique women. In both panels, the very small proportion of players whose birthday is missing are not taken into account, 0.02% and 0.7% in panel A and B, respectively.

E Average Number of Homegrown Players in the *Top 12*

Figure 14: Number of Homegrown Players per Team-Match

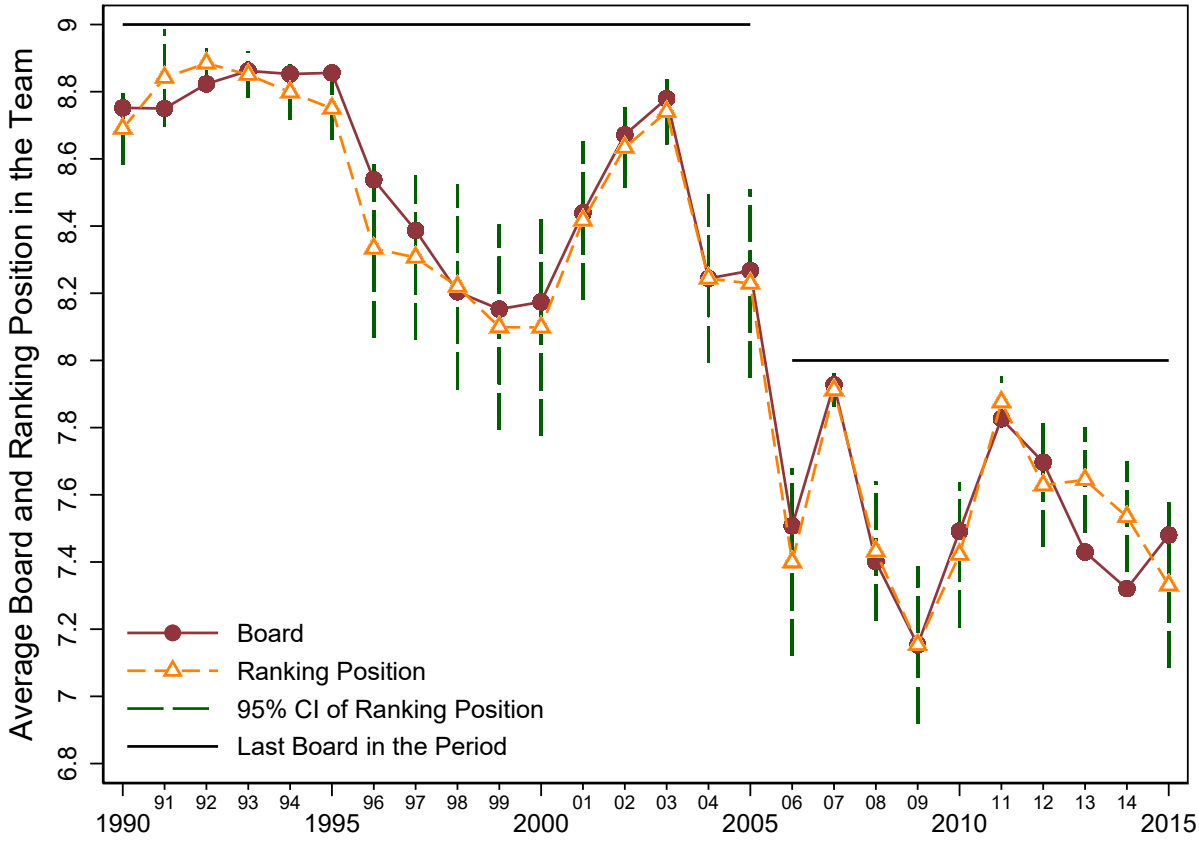


Notes: For each year from 1990 to 2015, the average number of "Homegrown Women" and "Homegrown (Best) Women" and "Homegrown Men" per match-team. Of the 3,428 match-teams (see column 1 in Table 10), 2,467 have a homegrown woman for a total of 119 (111) homegrown (best) women and 566 homegrown men.

We show in Figure 14 the average number of homegrown female players per match-team in the *Top 12*. We report both the average number of all homegrown female players, as well as when restricting attention to the best female player in each match-team. As a comparison, we also show the number of homegrown male players in the *Top 12*, though recall that in 2006 the number of boards and hence players was reduced from 9 to 8. While the number of homegrown female players is below one, and slightly decreasing, this downward trend is also present for men.

F Average Board of the Best Woman in the *Top 12*

Figure 15: Average Board of the Best Woman

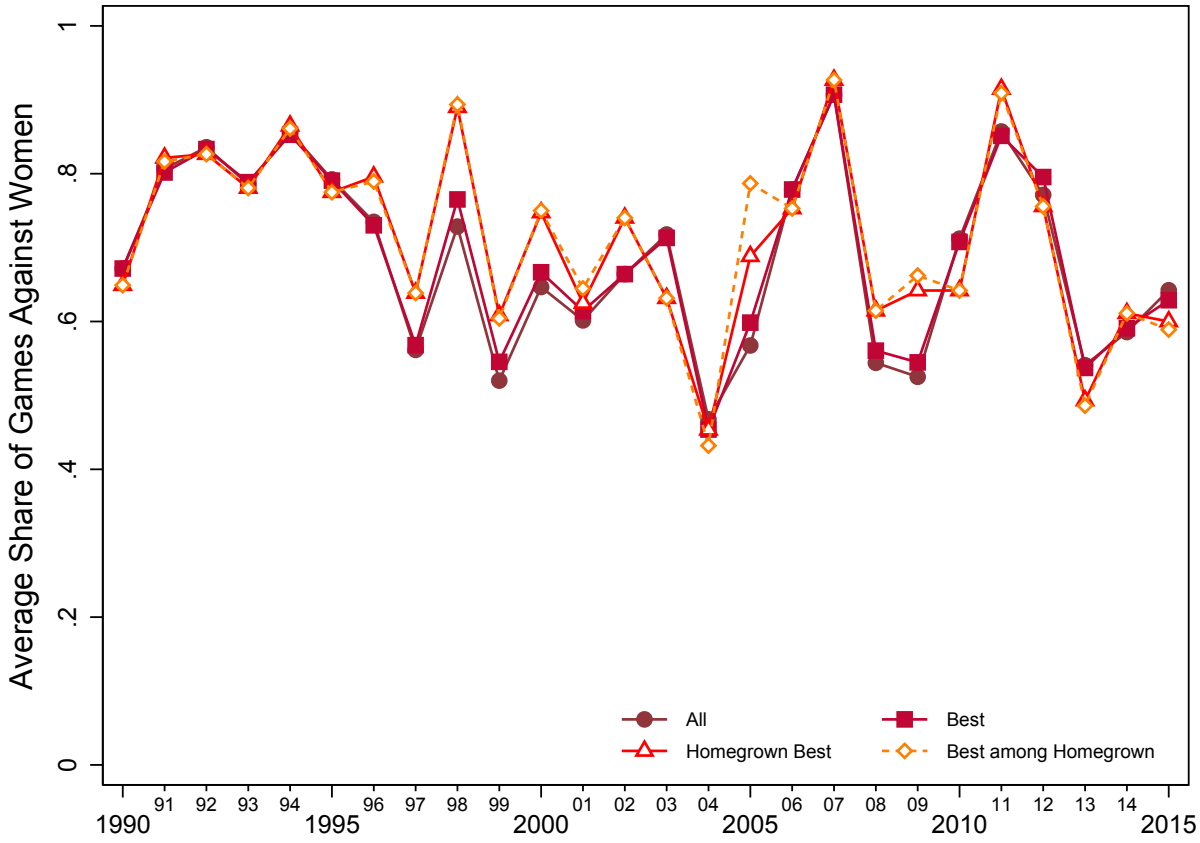


Notes: We focus on Top 12 clubs from 1990 to 2015. We consider 3,398 match-teams to determine the average board of the best female player, and where she "should" have played on average, if the order of play were completely determined by the Elo rating.

We start with showing the average board at which women play, "Board" in Figure 15, as well as the board in which the woman would have played on average if the ordering in the team had strictly reflected the Elo rating, see "Ranking Position."[102] Women largely play on the last board, and hence against the weakest member of the opponent team, and in fact about two thirds of the time against the other woman. Figure 16 shows for each year the chance with which the woman plays against a female player.

[102]We construct Figure 15 based on 3,398 match-teams. We keep the 161 match-teams with two or three female players and consider in each case only the highest rated (best) female player, even if another female player plays on a better board. Recall that the last board was number 9 from 1990 until 2005, and number 8 from 2006 onwards.

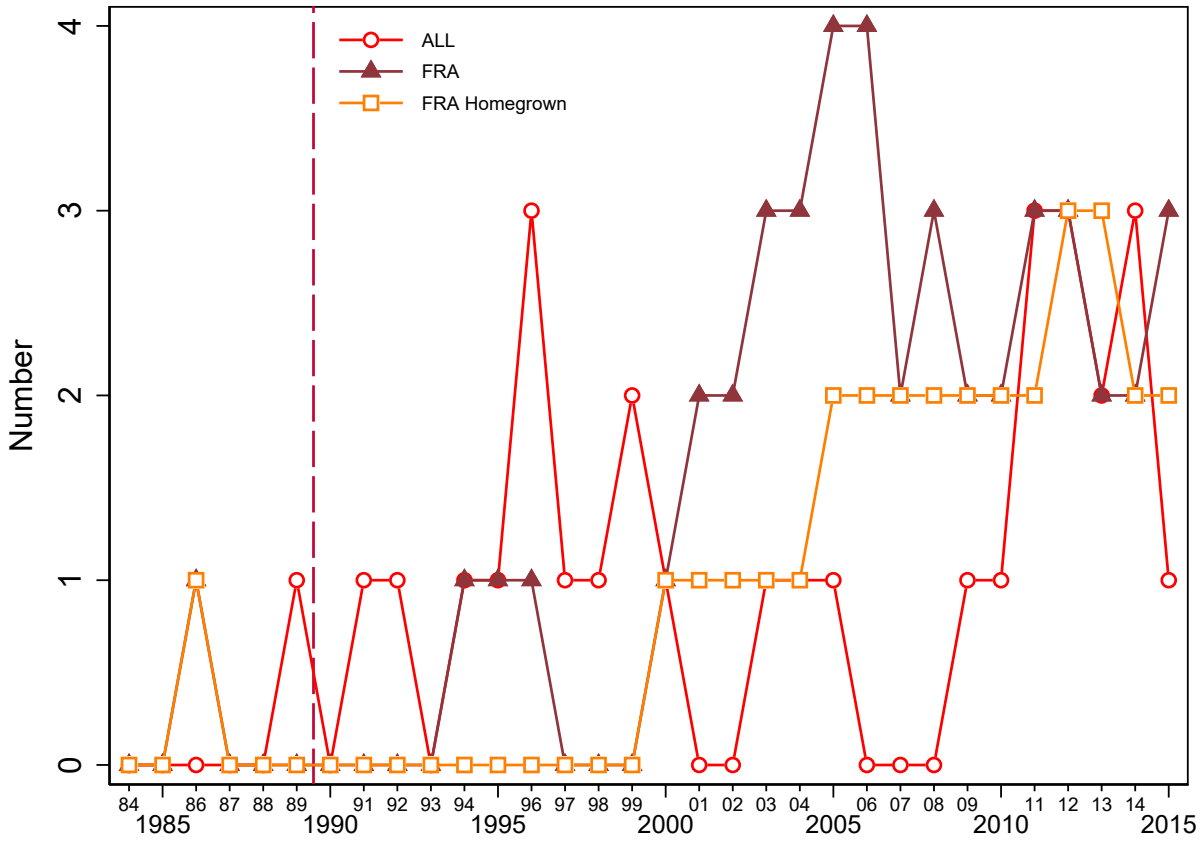
Figure 16: Women's Opponents



Notes: Average share of games between women in Top 12 teams per year.

G Number of Women in France's Top Lists

Figure 17: Number of Women in France's Top 100

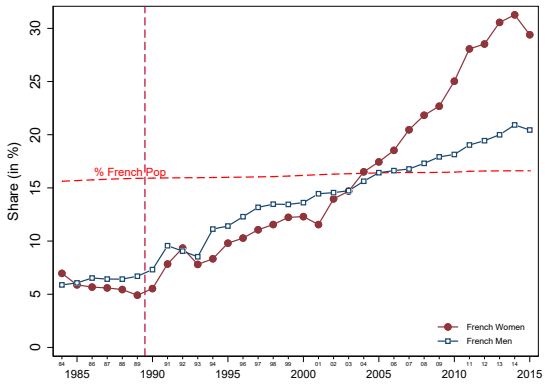


Notes: For each year from 1984 to 2015: share of women among the Top 100 players in France. We consider either all active players registered at the French Federation (All), or restrict attention to those with a French FIDE code (FRA) or to those who in addition are homegrown.

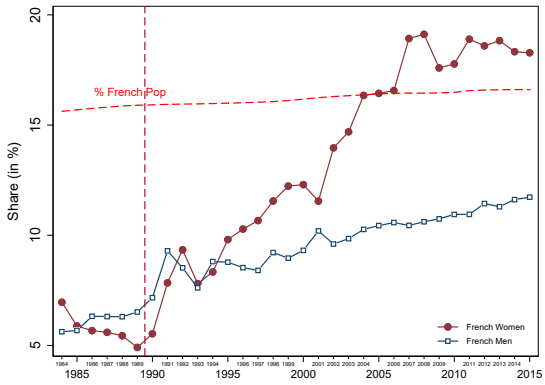
H Share of French among the Homegrown EU-15 Players

Figure 18: EU-15 Homegrown Players

A: Elite French Women and Men



B: French Women and Men



Notes: In Panels A and B, we consider active FIDE homegrown EU-15 players, that is players who paid their dues for the year, who played at least one FIDE-rated game in that year, and who are homegrown players in one of the EU-15 countries. Elite players in Panel A restrict attention to players who, in addition, are elite, that is have an Elo rating such Elo $\geq$ 1805 *for women and Elo* $\geq$ 2205 *for men, respectively.*