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Cross-country divergence in female patenting activity during the XIX century

Effects of the French revolutionary legacy

by

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The present study explores the relevance of the geographical distribution of patenting activity in the context of gender equality in innovation. The present thesis constitutes an extensive investigation, incorporating novel data of a considerably broader scope than before. This study endeavours to ascertain the significance of country-specific variables in elucidating female participation in patenting activity during the nineteenth century. In order to obtain the necessary results, a probit model is employed. The main variable of analysis in this model is a dummy for female participation in patents, while the primary explanatory variable is a dummy for the country in which the patent was granted. Robustness checks are conducted by augmenting the data set with additional information from Italy during a comparable historical period. In conclusion, it is evident that country-specific variables play a pivotal role in the analysis of women's participation in the domain of patenting. This observation underscores the imperative for effective governance and inclusive institutions to foster gender equality.

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1 Introduction

In the preceding year, a number of publications pertaining to data collection have been made available, providing comprehensive access to all patents in two European countries during the nineteenth century. In the extant literature, Merouani and Perrin (2026) are notable for their pioneering use of a comprehensive dataset, encompassing all patents granted in France during the nineteenth century (specifically between 1791 and 1899). This innovative approach enabled a rigorous examination of gender equality within the system. In contrast, the work conducted by Berkes et al. (2026) involved the collation of all patents granted in British history into a unified database. For the first time, it is possible to work with the entire population of patents for two countries during the nineteenth century. This represents a significant opportunity that should not be overlooked.

1.1 Research Problem

In light of the recent work for data access, and the availability of such data from two distinct nations, it is pertinent to inquire into the disparities in their respective patent systems. The present study will analyse the disparities in legal patent systems with regard to gender equality and women's access to these systems, as evidenced by this particular thesis.

The question posed here is of considerable interest, particularly when one considers the circumstances under which the nineteenth century commenced for these two nations. Firstly, France experienced one of the most significant periods in its history, which also had a profound impact on the rest of the world. The French Revolution led to a series of unprecedented institutional reforms centred around the principles of equality and freedom, thereby initiating the development of modern feminism (Rose, 1995). Secondly, the United Kingdom assumed a leadership role in opposition to the French during the Coalition Wars, with the objective of containing and halting the French Revolution and the subsequent establishment of the French Empire. This position would enable the country to adopt a more sustained and less revolutionary approach to the changes that would occur during the specified period (Kha, 2018). It is evident that no other pair of countries that experienced analogous events at the time proceeded to tackle them in such divergent ways (revolution vs. incrementalism).

However, the topics covered in this thesis are not bound to country specific contexts. A correct understanding of how different institutional contexts have been shown to be more effective in promoting gender equality can facilitate the identification of the key aspects, elements and values that underpin such effectiveness. This, in turn, can inform the design of new institutions in future, ensuring that they are based on the principles of good and inclusive governance.

Finally, it is important to emphasise the primary strength and value of this study, which is predicated on the scope and innovation of the data utilised. This is one of the first instances in which we are not required to rely on samples of patents. Conversely, the present study employs the complete list of patents, encompassing the same characteristics for all subjects over an extended period of time (108 years). The findings of this study could potentially be interpreted in two distinct directions. Firstly, it could serve to reinforce the extant literature in this field, thereby further solidifying the prevailing stance, that being that country-specific institutional contexts are relevant for the inclusiveness of institutions, specifically for gender in this case. Secondly, and perhaps more intriguingly, it could present a range of divergent results, thus offering a more nuanced perspective on the mechanisms that could potentially explain the observed phenomena.

1.2 Aim and Scope

The integration of novel data sets has enabled the finalisation of a significant gap in the extant literature, as the prevailing state of the art has been confined to the utilisation of samples for cross-country comparisons in the analysis of female patenting activity during the nineteenth century. It is imperative that this opportunity is not overlooked.

The central objective of this thesis is to utilise the available data, employing an econometric model to demonstrate the significance and relevance of country-specific information in understanding the participation of women in the field of patenting. In an ideal scenario, the methodology presented here is sufficiently robust to demonstrate the significance of a country-specific variable. In the worst case scenario, the present analysis is merely a descriptive one, with the potential to complement or question certain statements of the current state of the art on the topic. Notwithstanding, the fundamental strength of this thesis (namely, the analysis of more recent data with a considerably greater scope than heretofore) remains unchanged.

The primary research question that this study seeks to address is the extent to which the national context influenced female patenting activity in France and the United Kingdom during the nineteenth century. The primary contribution of this study to the extant literature is the utilisation of all available patents at the time of writing for the purpose of a cross-country comparison.

In order to achieve the stated aim, a comprehensive review of the extant literature has been conducted, drawing upon a range of sources including, but not limited to, studies of innovation economics, gender equality and institutional context in both countries (Khan, 2024; Merouani & Perrin, 2026), standard macroeconomic proceedings for data management and analysis (Greene, 2019; Wooldridge, 2019) and additional data from the geographical areas of interest (specifically Italy), the latter being used for robustness checks (Martinez, 2025).

Moreover, the analysis of the data was conducted utilising Stata, encompassing all patents granted within both the United Kingdom and France between the years 1791 and 1899, in addition to all patents granted in Italy following its Reunification in 1861 and prior to 1900.

1.3 Outline of the Thesis

The present thesis is divided into five chapters. The initial chapter is dedicated to the introduction of the subject matter, the central inquiry to be addressed, and the pertinence of the topic. Secondly, the most recent literature pertinent to this topic is reviewed. This is done in order to provide a clearer picture of the topic, its historical context, and to compare previous work with the work presented here. Thirdly, the data that will be utilised, the variables obtained, and the model designed are presented, with the different choices made during the process being justified. Subsequently, a comprehensive and meticulous examination of all the results obtained is conducted, with a focus on establishing connections with the extant literature that has been previously examined. Continuously, robustness checks are made with the inclusion of data of a similar historical period in Italy. In conclusion, a summary of the primary conclusions of this thesis, in addition to discussions of such results and further expansions in this direction, is presented.

2 On female patenting activity during the nineteenth century

In this section, an evaluation of the current state of the art of female equality in innovation economics is conducted, with a subsequent correlation to the broader topic of development economics and growth – the primary subject of the master's programme on which this final thesis is based.

2.1 Innovation and gender in the long-run

The relevance of gender in relation to economic growth and development is a subject that merits closer examination. As posited by Merouani and Perrin (2026), innovation, being a crucial factor in the long-term economic growth and development of a nation, is not necessarily accompanied by the recognition of the contributions made by women, who, despite their significance, remain largely unacknowledged. To provide an illustration, during the nineteenth century, patents pertaining exclusively to women constituted a mere 1.8% of all patents issued in France, 1% in the United Kingdom, and less than 0.5% in the United States (Merouani & Perrin, 2026).

The central objective of this thesis is to build upon the findings of the PhD "Pins and Pistons" (Merouani, 2026a) and to examine the manner in which women contributed to innovation. The specific aim is to identify the institutional actions that facilitated their formal integration into the system. This will be achieved by conducting a comparative analysis of France and the UK during the nineteenth century. Firstly, it is necessary to present the current state of the art and respond to certain previous questions.

2.2 Why gender equality matters

Notwithstanding the presence of certain valid criticisms (Nielsen, 2013), the Unified Growth Theory, as proposed by Weil and Galor (2000), remains a pre-eminent theoretical framework that synthesises gender equality, technological advancements, and economic growth. According to this theory, the transition from high to low fertility, which is an integral part of the demographic transition, is a key component of the long-term growth process.

The fundamental mechanism underpinning this theoretical framework (Weil & Galor, 2000) pertains to the opportunity cost of children. As the ratio of capital per worker escalates, the salaries concomitantly increase, thereby amplifying the financial burden associated with child-bearing. This encompasses factors such as foregone salary, educational expenditures, and the time devoted to childrearing, nurturing, and providing for the family. Consequently, women tend to prioritise "quality over quantity" in their fertility decisions, thereby attenuating popula-

tion growth. This reinforces the efficacy of the aforementioned loop.

However, the question remains: how can this theoretical framework be applied to the pursuit of gender equality in the domain of innovation? In order to comprehend this issue, it is necessary to engage in a discourse on the masculinisation of technology (Oldenziel, 1999). Throughout the nineteenth century, there was a shift in the perception of knowledge and innovation in the Western world. The focus shifted towards industrial technology and civil engineering, and there was a "gendering" towards the masculine gender. This was due to the fact that many of the new inventions were better suited to the male body, due to the higher torso strength that was preferred (Weil & Galor, 2000). Consequently, women were systematically marginalised from research and innovation, due to the prevailing assumption that they lacked the requisite "experience" in these domains. Moreover, the specific fields in which they had accumulated experience were no longer regarded as being aligned with technological pursuits (Oldenziel, 1999). Despite its potential shortcomings (Mellström, 2009), this theoretical explanation remains a robust one for the gender disparity observed in the data, particularly within the Western context in which this thesis is situated.

2.3 Institutional evolution

In this section, the various cases for research in this thesis will be examined, and the rationale for their compelling pairing for comparison will be elucidated. France and the United Kingdom. It has been posited that the French Revolution is the genesis of modern feminism (Gouges, 1994; Leclère-Gregory, 2024). This assertion is predicated on the political disposition of the respective nations in the subsequent wars that ensued from this historical occurrence (the Coalition Wars). This premise suggests that the nations in question will exhibit disparate relations between gender equality and their institutional contexts (Hauch, 2016).

It is evident that these disparities manifest in the divergent approaches adopted by these nations with regard to their respective patenting systems and the legal framework governing them. France's conception of inventions as a natural human right, as opposed to a state privilege (Marchal, 2009), engendered a system in which individuals, including married women and foreigners, were able to patent with much more ease (Merouani & Perrin, 2026). Notwithstanding the existence of several substantial impediments, particularly those of a financial nature, the implementation of pertinent reforms within the system, most notably the one enacted in 1844 (Merouani & Perrin, 2026), has rendered the patent process more flexible (an initial payment equivalent to a fraction of the fee, with the remaining amount payable annually), thereby facilitating its accessibility.

The United Kingdom is another pertinent case study. Initially, it had implemented a registration system that imposed exorbitant fees, but with a lengthy period of protection comprising 14 years. This fee was significantly reduced down to £4 with a reform in legislation in 1883 (Khan, 2024), same reform that eliminated coverture laws from patenting, being directly linked with a

spike of more than 750% in patents with participating women in the country. The initial policy would result in the establishment of a "tax on innovation" that would be financially prohibitive for a significant proportion of the population, particularly those lacking financial resources, a group which was disproportionately comprised of women. About the period of protection, it was reduced to 4 in 1852, with the possibility of expanding it with further yearly payments. (Khan, 2024).

Nevertheless, it is imperative to acknowledge the pronounced disparities in gender equality that have been observed among these nations during the present century. For instance, France experienced the onset of its demographic transition at the conclusion of the eighteenth century, a period preceding the advent of industrialisation (Perrin, 2013). Conversely, in the UK, the phenomenon of demographic transition occurred in the opposite sequence.

Furthermore, it is necessary to consider the significant dates throughout the century that may exert a substantial influence on gender equality and patenting in both countries. As demonstrated by Khan (2024), the United Kingdom experienced a period of stability and peace, known as Pax Britannica, over the course of a century. In contrast, France underwent revolutionary periods (Merouani, 2026a), such as that of 1848, and periods of war, including the Franco-Prussian War of 1871.

2.4 Patterns of women's patenting

The following discussion will examine the literature on the main patterns for female participation in patenting. As Khan (2020) and Merouani and Perrin (2026) have demonstrated, women patent holders were predominantly active in the clothing, textiles and domestic economy sectors. However, it should be noted that there are also instances of women patent holders operating in more male-dominated fields, such as machinery and road transport.

A salient disparity exists between the two nations with regard to the social and economic classes of the inventors. In France, a more egalitarian distribution of patents across all social classes has been observed (Galvez-Behar, 2019; Merouani & Perrin, 2026). Conversely, in the UK, a more elitist pattern has been noted, which may be attributed to the systematic high fees that had to be paid (Khan, 2024).

A further salient discrepancy between these two nations pertains to the life-cycle profile of female inventors. In the United Kingdom, married women were subject to coverture, which vested their legal property rights in their husbands (Khan, 2024). Consequently, women who patented property at the time ranged over the entire life cycle, and there are even some cases of married women patenting by concealing their status within family names (Khan, 2024). Meanwhile, in France, the median age of a married woman who has patented is 41 (Merouani, 2026c), which lends support to the "empty nest" theory, given that a significant proportion of women patent only after their last childbirth (Merouani, 2026c).

The observed discrepancies between the two nations can be ascribed to the divergent patenting processes for women in these countries. Nevertheless, a comparable pattern was observed in both regions, as collaboration between inventors was uncommon in the nineteenth century (Merouani, 2026b).

However, when women did collaborate with other inventors, institutional factors once again served to delineate the differences between the two countries. As Merouani (2026b) have demonstrated, a significant proportion of French women engaged in collaborative efforts with the objective of achieving technological diversification, frequently with men, whereas men would collaborate in most cases with other men. It is evident that British women frequently engaged in collaborative endeavours due to financial or legal imperatives (Khan, 2024). However, it is noteworthy that these women concurrently upheld a predilection for familial connections among their collaborators (Khan, 2024).

2.5 On the structural differences between France and the UK

It is imperative to acknowledge that the structural contexts in both countries were not entirely congruent. Firstly, the demographic characteristics and the demographic transition of the two countries are in stark contrast due to the differing temporal alignment between the industrial revolution and the demographic transition. France witnessed the initial phases of the Industrial Revolution during the 18th century, preceding the advent of the Industrial Revolution (Merouani, 2026a). In contrast, the United Kingdom underwent the majority of the First Industrial Revolution before the emergence of the first indications of the Demographic Transition (Spolaore & Wacziarg, 2019).

A consideration of the patterns of industrialisation reveals significant disparities between the two countries. In the context of the UK's industrial history, the early 20th century was characterised by the rapid development of mass manufacturing using coal as a primary energy source (Nuvolari et al., 2023). In contrast, France experienced a more gradual process of specialisation, with a focus on the production of quality goods, luxury items and niche textiles. This specialisation occurred in smaller workshops rather than in large-scale factories (Merouani, 2026a). Furthermore, disparities in the energy sources utilised are evident. This discrepancy is primarily attributable to the fact that the UK had access to coal domestically, whereas France did not. Consequently, France opted for hydraulic engineering (Nuvolari et al., 2023).

A further salient discrepancy between the two nations pertains to the domains of knowledge and education. The United Kingdom has historically focused on the transmission of tacit knowledge (Nuvolari et al., 2023), utilising apprenticeships within the workplace and informal craft networks to facilitate this process. France, conversely, opted for the route of codified knowledge transmission and theoretical understanding through state-led institutions, such as *Grandes Écoles* and *Écoles d'Arts et Métiers* (Nuvolari et al., 2023). The aforementioned factors also had a significant impact on women's access to education during that period. In France, the imple-

mentation of state-led educational reforms resulted in the establishment of primary education for girls, leading to a near-parity in literacy by the end of the century (Diebolt et al., 2021). In contrast, the UK did not achieve a similar level of literacy among women until much later in the following century. Nevertheless, formal scientific and engineering education remained predominantly male in both countries for the majority of the century (Merouani, 2026a).

Still, it is evident that both countries exhibited a high degree of similarity in their societal norms surrounding gender and technology, adhering to almost identical patterns for the majority of the century. As engineering became more professionalised, it became increasingly associated with mechanics and civil engineering, which were often perceived as masculine domains, while textiles and household production were often regarded as feminine (Merouani & Perrin, 2026; Oldenziel, 1999). The division into "spheres" is evident in the realm of patenting, wherein a significant proportion of patents filed by women pertain to clothing, textiles, and domestic economy (Khan, 2020; Merouani & Perrin, 2026).

3 Data and Methodology

Following a thorough examination of the extant literature on the subject, the subsequent section will delineate the strategy of this thesis. The primary research question guiding this study is as follows: was the country in which the patenting activity occurred significant for the female participation in it through the nineteenth century? The objective of this study is to ascertain the relevance and significance of a variable that can be utilised to control for the country in which patenting activity occurred, with a particular focus on its impact on female participation in this field.

3.1 Data construction and variable definition

The data employed in this thesis derives from three primary sources, of which two are utilised for the primary analysis (Berkes et al., 2026; Merouani & Perrin, 2026). The third source is employed solely for the purpose of conducting robustness checks (Martinez, 2025). The three articles under consideration encompass the patenting records of their respective countries. In the case of France, Merouani and Perrin (2026) provide a comprehensive overview of the period between 1791 and 1899, while Berkes et al. (2026) offer an extensive analysis of all British patenting activity recorded to date. Martinez (2025), meanwhile, focuses on Italian records from 1861 to 1939. A fundamental consideration is the marked differences between the projects in terms of the manner in which data is collected and presented. Nevertheless, a consistent dataset framework has been developed for all three countries, thereby enabling the analysis presented herein. The dataset was constructed such that each row corresponds to a patent, with the columns designated for the various variables incorporated.

The primary dependent variable in this project is a dummy variable that assumes the value of 1 if any women have participated in the specific patent. It is indeed possible to count the number of women participating in each patent for our dependent variable. However, employing a binary outcome in our model would in turn facilitate the implementation of a probabilistic approach when analysing the results. In the context of the present model, a set of controls is available for consideration, such as some pertinent to the patent characteristics (the number of participants, the length of the protection granted with it), significant and aforementioned reforms (1844 in France, 1883 in the UK), controls for the marital status of participating women (whether they were married, widowed, or none of the above, in other words, a spinster), and, finally, the main variable of analysis of our study, whether women were involved in the patent or not.

The linear values represent the total number of participating individuals in each patent. A dummy variable assumes a value of 1 if the patent was granted with a protection duration equal

to or greater than a decade, and 0 otherwise. The reason for the design of this specific variable derives from limitations in the data collection from the UK, where the initial protection granted was at the beginning of the century for 14 years, later reduced to below a decade in 1852, with the possibility of expanding it with further payments (Khan, 2024). The information regarding whether the UK patents expanded that initial protection or not is not available (Berkes et al., 2026). Dummy variables have been utilised to manage the marital status of female participants in each patent, whilst dummy variables have been implemented to control specific years in select countries when pertinent reforms to the patenting system were implemented. For instance, in France, these years span from 1844 onward (Merouani & Perrin, 2026), and in the United Kingdom, they begin in 1883 (Khan, 2024). Year fixed effects variables have also been incorporated into the model. The primary independent variable under analysis, and therefore the primary subject of analysis, is a dummy variable controlling for the country in which the patent was registered. This dummy variable takes a value of 1 for France and 0 for the United Kingdom. As illustrated in Table 3.1, 3.2, and 3.3, the reader will find a series of descriptive statistics relating to the variables for both the French and UK data sets.

	N	Mean	SD	Min	Median	Max
Female participation dummy	308385	0.018	0.131	0	0	1
Number of participants	308385	1.159	0.426	1	1	12
Patent duration dummy	308385	0.974	0.160	0	1	1
French reform of 1844	308385	0.957	0.203	0	1	1
Widow dummy	308385	0.005	0.069	0	0	1
Married dummy	308385	0.008	0.090	0	0	1
Spinster dummy	308385	0.005	0.069	0	0	1

Table 3.1: Descriptive statistics of the data used for the French analysis

Source: Merouani & Perrin (2026)

	N	Mean	SD	Min	Median	Max
Female participation dummy	318136	0.011	0.105	0	0	1
Number of participants	318136	1.237	0.525	1	1	15
Patent duration dummy	318136	0.038	0.191	0	0	1
UK reform of 1883	318136	0.566	0.496	0	1	1
Widow dummy	318136	0.001	0.024	0	0	1
Married dummy	318136	0.001	0.028	0	0	1
Spinster dummy	318136	0.010	0.098	0	0	1

Table 3.2: Descriptive statistics of the data used for the British analysis

Source: Berkes et al. (2026)

Variable name	N	Mean	SD	Min	Median	Max
Female participation dummy	626521	0.014	0.119	0	0	1
French dummy	626521	0.492	0.500	0	0	1
Number of participants	626521	1.199	0.481	1	1	15
Patent duration dummy	626521	0.498	0.500	0	0	1
French reform of 1844	626521	0.473	0.499	0	0	1
UK reform of 1883	626521	0.297	0.457	0	0	1
Widow dummy	626521	0.003	0.051	0	0	1
Married dummy	626521	0.004	0.066	0	0	1
Spinster dummy	626521	0.005	0.069	0	0	1

Table 3.3: Descriptive statistics of the data used for the French and British analysis

Sources: Berkes et al. (2026) and Merouani & Perrin (2026)

3.2 Baseline probit model definition

Following the presentation of the available data for this thesis, and the sources thereof, the subsequent stage is to define the manner in which this data will be utilised in a model, with a view to answering the thesis's fundamental question: namely, did the country of patenting activity significantly affect female participation in patenting? The rationale underpinning this particular model is attributable to three distinct factors. Firstly, Greene (2019) states that the utilisation of either a probit or a logit model does not affect substantially the main results and interpretations in circumstances analogous to the present one. Secondly, it is argued by authors such as Allison (1999) that the primary results are highly comparable to those obtained from logit models, which are another robust contender given the data available and the objectives of this analysis. Conversely, the utilisation of a probit model would entail a more direct alignment with the research conducted by Merouani and Perrin (2026). Their employment of a probit model, utilising exclusively French data, facilitated the interpretation of results and the subsequent comparison with existing literature.

Therefore, following a thorough review of the extant literature, the model employed in this thesis is specified as follows:

$$Pr(Female_{it} = 1) = \Phi(\beta_0 + \beta_1 French_i + \beta_2(French_i \times nParticipants_{it}) + \beta_3 nParticipants_{it} + \beta_4 Duration_{it} + \beta_5 FReform_{it} + \beta_6 UKReform_{it} + \varepsilon_{it}) \quad (3.1)$$

Figure 3.1: Main specification of the model

Sources: Allison (1999), Greene (2019), Merouani & Perrin (2026), and Wooldridge (2019)

French stands for our country dummy. *nParticipants* stands for our control of the number of participants. *Duration* stands for our dummy on the duration of the protection. *FReform* stands for our dummy on the French reform of 1844. *UKReform* stands for our UK reform of 1883.

$$\widehat{AME}_k = \frac{1}{N} \sum_{i=1}^N \phi \left(\hat{\alpha} + \hat{\beta} X_{it} + \hat{\gamma} Z_t \right) \hat{\beta}_k \quad (3.2)$$

Figure 3.2: Average Marginal Effects (AME) definition

Sources: Greene (2019) and Wooldridge (2019)

In words, the Average Marginal Effect ($\widehat{AME}_k$) of a coefficient ($\hat{\beta}_k$) is the average change (ϕ) in the predicted outcome ($\hat{\alpha} + \hat{\beta} X_{it} + \hat{\gamma} Z_t$) when an explanatory variable increases by one unit.

As seen in Equation 3.1, it is comprised of a dependent variable (female participation dummy), a primary independent variable (French dummy), a series of controls, and year fixed effects. There is one interaction between the control for the number of participants and the primary regressor. This is in order to observe any differences between countries and the necessity for collaboration. This is because, as evidenced in the literature (Khan, 2024; Merouani & Perrin, 2026), in France patents were considerably more economical and flexible than in the UK for the majority of the period under consideration. Furthermore, there are concerns that women would be more reliant on collaboration to cover the cost of patenting.

In conclusion, it is imperative to address the fact that raw probit coefficients are devoid of any direct quantitative meaning (Greene, 2019; Wooldridge, 2019). This is a crucial aspect to consider when finalizing the description of the methodology employed in this project. The necessity for addressing this issue will be determined by the employment of Average Marginal Effects (AME), a statistical method employed to demonstrate the average percentage point change in probability. The precise definition of AME can be located in Equation 3.2.

4 Empirical Analysis: the egalitarian effect of the French patenting system

Following a thorough examination of the data pertinent to this thesis, the subsequent analysis will commence with a descriptive evaluation of the data set. This will be followed by a transition to a more detailed investigation of the data, focusing on the specific information that is deemed to be pertinent to the analysis. Subsequent to this, the results for the various models will be presented.

Prior to undertaking an analysis of the aforementioned interpretations, it is imperative to acknowledge the multifaceted nature of contemporary France and the UK. The two nations exhibit divergent characteristics across a range of simultaneous dimensions, including but not limited to industry, education, and urbanisation (Nuvolari et al., 2023). It is evident that the aforementioned disparities fall outside the ambit of the present analysis. Consequently, the findings must be interpreted as descriptive correlations that are in alignment with the institutional narrative delineated in this thesis.

4.1 Descriptive evidence: the landscape of XIX century innovation

In this section, a range of figures will be presented to provide a clear descriptive overview of the data available for this thesis. This will allow for the development of a vision for future regression and modelling.

As demonstrated in Figure 4.1, it is evident that throughout the examined century, female patent holders constituted a minority. The results presented in the pie charts are in close alignment with the extant literature (Khan, 2024; Merouani, 2026a). Through mathematical calculation, it can be determined that 1.76% of all patents in France during this period were filed by women, while this figure for Britain stands at 1.11%.

The subsequent stage of the research will be to observe the evolution of female patenting over time. As demonstrated in Figures 4.2, 4.3 and 4.4. The present century may be divided into three distinct periods with regard to female patenting. Initially, the period between 1791 and 1844 is observed, a time in which patents featuring women are rare. This results in significant fluctuations in growth rates and gender gap calculations. However, it is evident that female patenting is marginally higher in France compared to the UK. This disparity can be attributed to the more egalitarian approach to patenting that was adopted by France during the French Revolution (Merouani & Perrin, 2026). In the period spanning from the French reform of 1844 to the English reform of 1883, there was a notable increase in the number of patents filed by women in France. This period is characterised by a substantial gender disparity, both in terms

of the absolute number of patents filed and the gender gap in patenting. However, this disparity is not as evident in the growth rates of patenting activity. Finally, the period following 1883, which was characterised by a British boom in female patenting (Khan, 2024), resulted in France being overtaken in the absolute count and gender gap. Furthermore, there was a stabilisation of the growth rates for both countries.

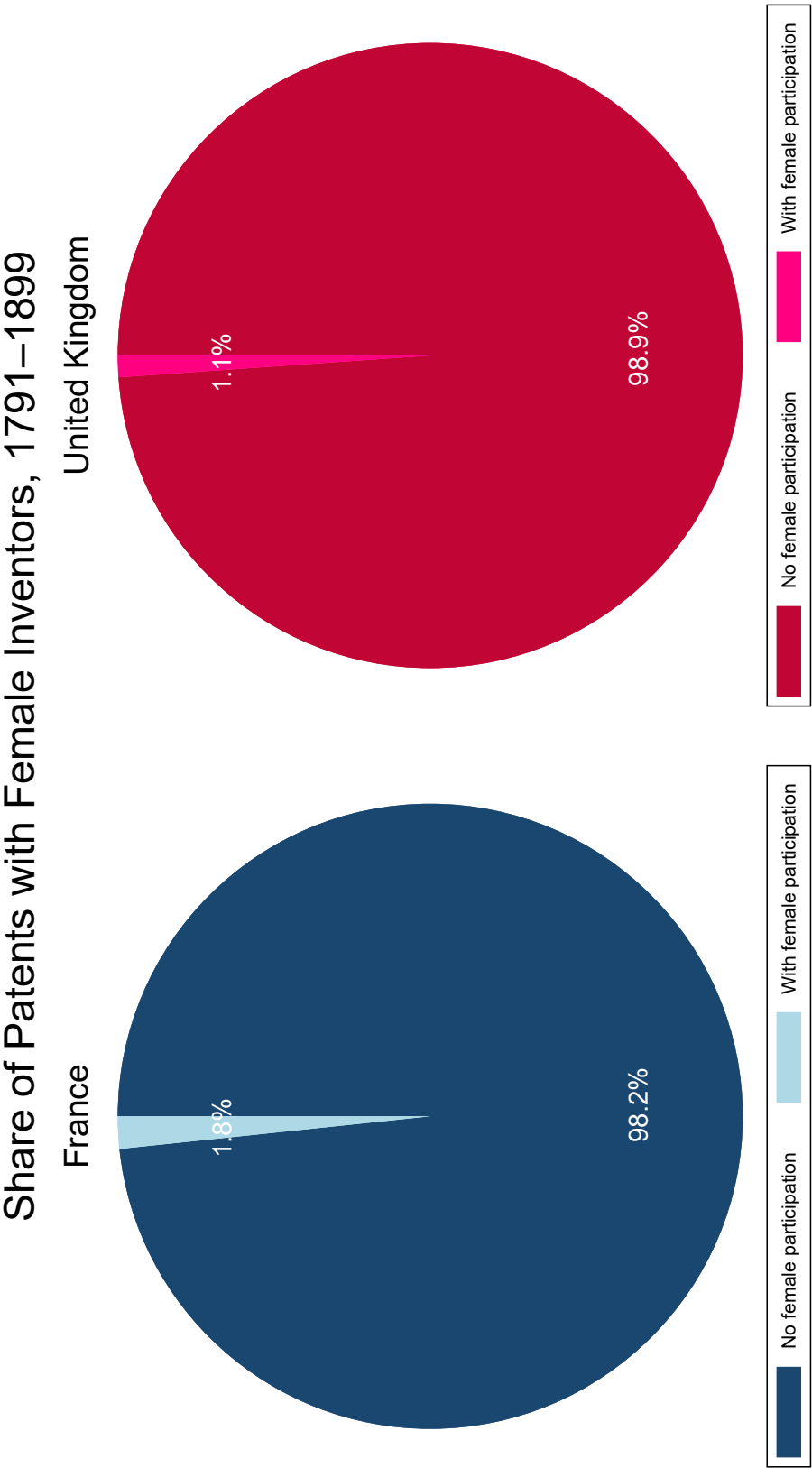


Figure 4.1: Share of patents with women on the total of patents between 1791 and 1899 in both France and the UK
Sources: Berkes et al. (2026) and Merouani & Perrin (2026)

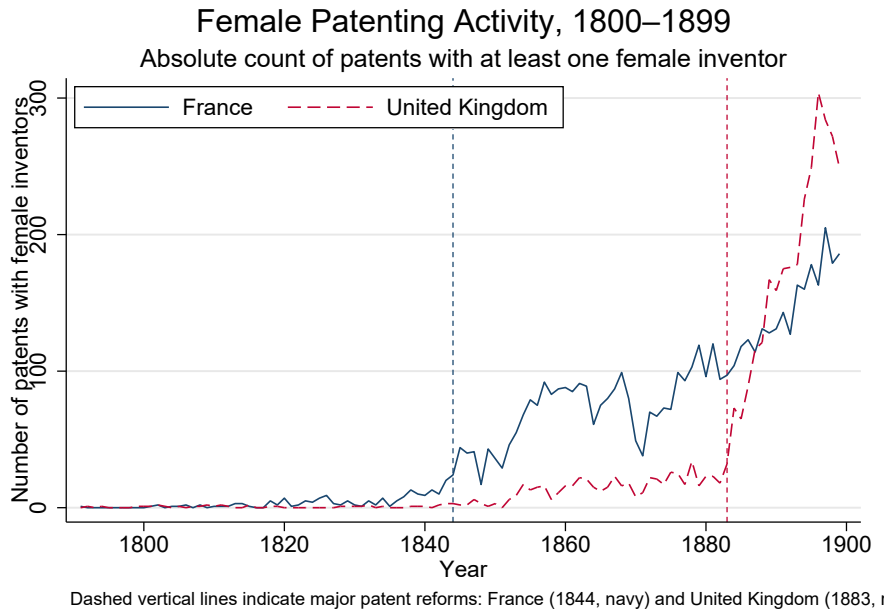


Figure 4.2: Evolution of the absolute number of patents with at least one woman mentioned between 1791 and 1899 in both France and the UK

Sources: Berkes et al. (2026) and Merouani & Perrin (2026)

Firstly, as illustrated in Figure 4.5, the relationship between patent duration, country of patenting, and female patenting is demonstrated through time. The construction of the graph was limited by constraints imposed by the available data, as mentioned in the methodology section. The graph was thus formulated by means of the annual means of the values for the patent duration dummy. We can obtain two conclusions. Firstly, it is evident that each country has adopted a distinct approach with regard to the temporal length of protection (Khan, 2024; Merouani & Perrin, 2026). Finally, it is possible to extrapolate a complementary hypothesis based on French data from before 1844. This data shows that the average duration of women's patents was shorter before 1844. This is consistent with the financial constraints documented in the existing state of the art (Merouani & Perrin, 2026). However, the model cannot isolate this channel independently.

Another dimension to explore is the civil status of the female patentees. This is especially relevant in the UK case (Khan, 2024), where married women were subject to coverture. This suggests that there may be distinct patterns in this case, at least in comparison with France. As illustrated in Figures 4.6, 4.7 and 4.8, the evidence appears to be consistent with the anticipations that were previously outlined. An examination of the proportion of married women reveals that they did not patent in the UK prior to the 1883 reforms (Khan, 2024). However, the data does not provide direct evidence to substantiate this hypothesis. In consideration of the limitations imposed by the context, the sole civil status that merits examination is that of widowed women, as observations pertaining to them are more equally distributed throughout the entire period. These women, typically endowed with sufficient means to pursue patenting,

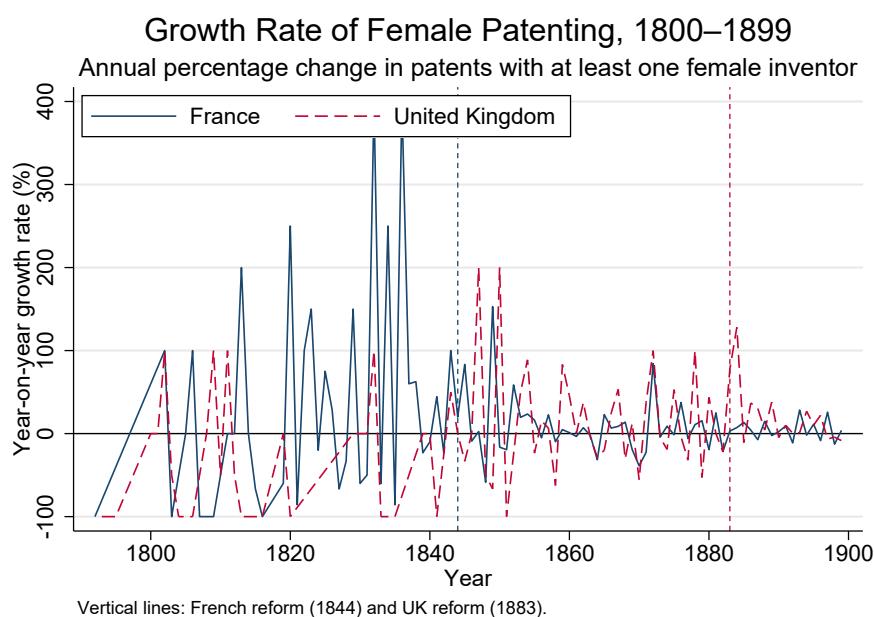


Figure 4.3: Evolution of the growth rate of patents with at least one woman mentioned between 1791 and 1899 in both France and the UK

Sources: Berkes et al. (2026) and Merouani & Perrin (2026)

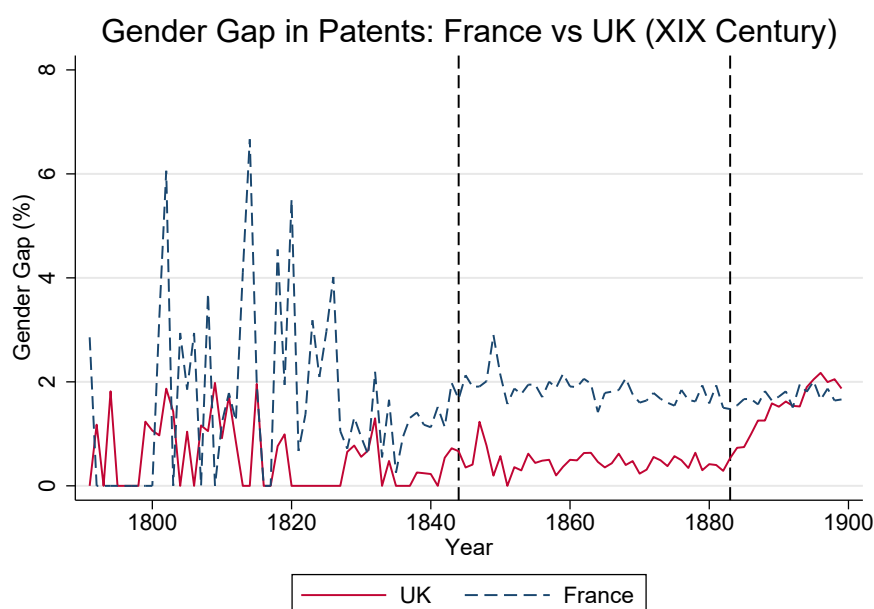


Figure 4.4: Evolution of the gender gap in patenting between 1791 and 1899 for both France and the UK

Sources: Berkes et al. (2026) and Merouani & Perrin (2026)

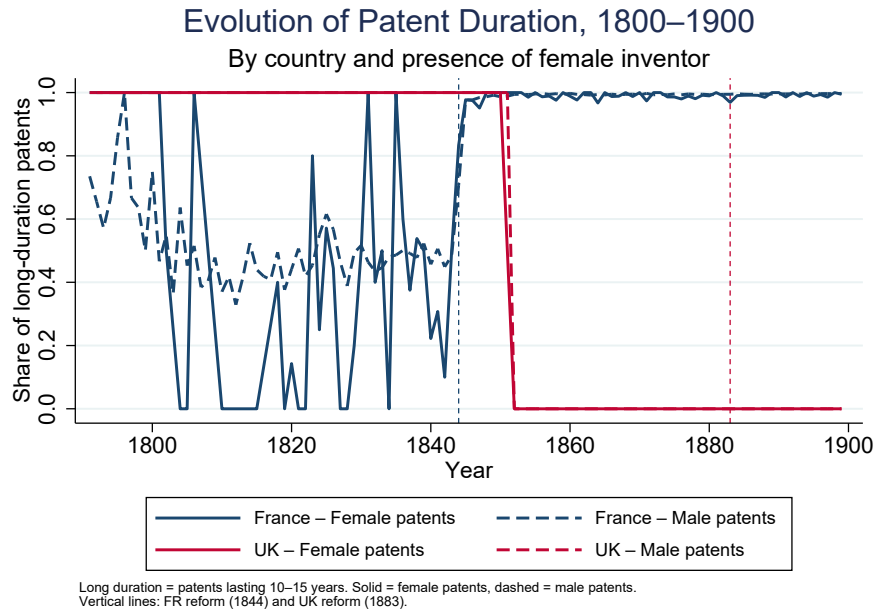


Figure 4.5: Evolution of patent duration chosen between 1791 and 1899, depending on country of patenting and whether women are mentioned or not

Sources: Berkes et al. (2026) and Merouani & Perrin (2026)

The values for this graph represent the mean value assumed by the patent duration dummy on an annual basis, contingent on geographical location and the inclusion of women.

are no longer subject to the legal constraints of coverture in the UK, having experienced the demise of their spouses.

It is finally possible to observe the mean number of participants in relation to female participation and country over time. This is due to the expectation that women collaborate more in order to afford the price of the patent (Merouani, 2026b). As demonstrated in Figure 4.9, despite the disturbance introduced by the limited sample size, it can be contended that the mean team size is elevated when the team is from the UK, and when the team comprises women, the findings are consistent with the extant literature.

4.2 Within country regressions: Predictors of female participation in patenting

In this section, the regressions and modelling will be conducted on a country-by-country basis. This approach will facilitate a more robust comparison when the two datasets are subsequently amalgamated. The primary function of these regressions is to provide a basis for exploratory analysis, with a view to informing the specification choices in the pooled model.

As illustrated in Table 4.1, the outcomes of the regressions, which are based exclusively on data from the French source (Merouani & Perrin, 2026), appear to be less robust than anticipated. Evidence suggests that the number of inventors and the duration of the patent are significant predictors of female participation in France, particularly in the initial iterations. However, once the full list of controls for marital status is included, these factors no longer prove relevant. The



Figure 4.6: Evolution of female patents with at least one married woman in both France and the UK between 1791 and 1899

Sources: *Berkes et al. (2026)* and *Merouani & Perrin (2026)*

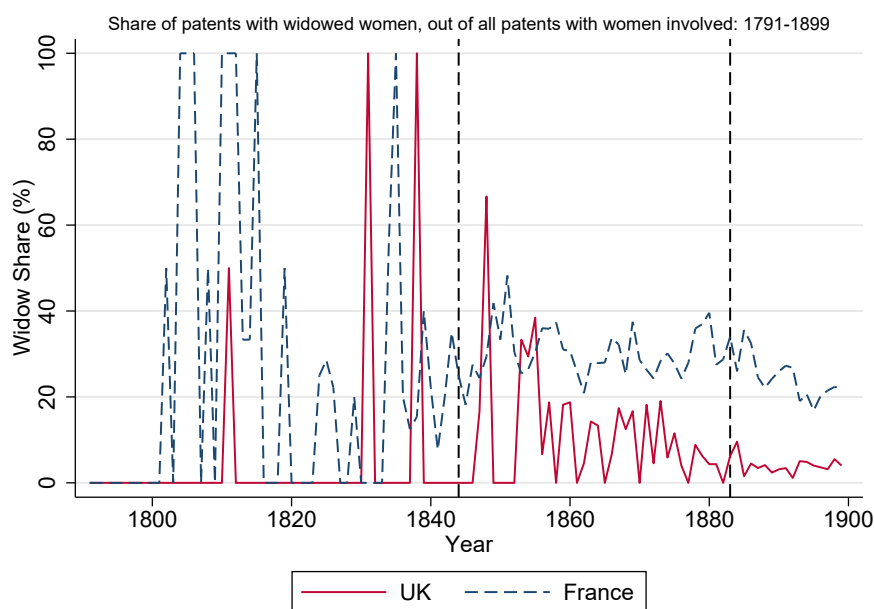


Figure 4.7: Evolution of female patents with at least one widow in both France and the UK between 1791 and 1899

Sources: *Berkes et al. (2026)* and *Merouani & Perrin (2026)*

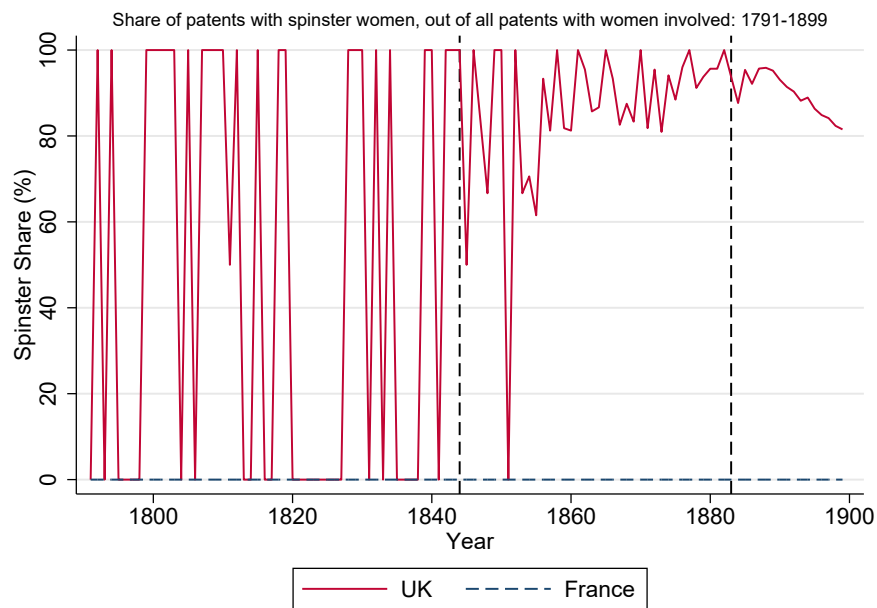


Figure 4.8: Evolution of female patents with at least one spinster in both France and the UK between 1791 and 1899

Sources: *Berkes et al. (2026)* and *Merouani & Perrin (2026)*

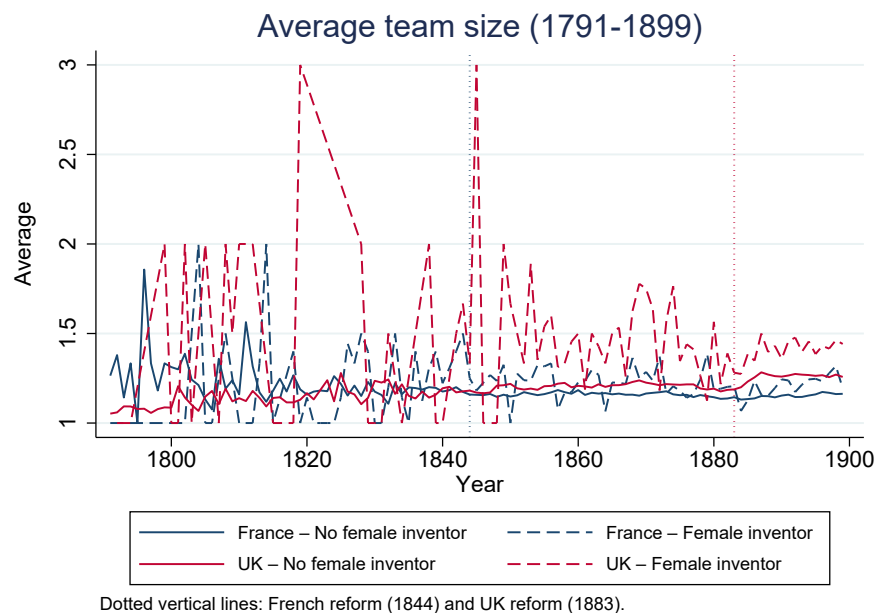


Figure 4.9: Average number of patentees between 1791 and 1899 in each country, whether a woman is involved or not

Sources: *Berkes et al. (2026)* and *Merouani & Perrin (2026)*

observed pattern is indicative of severe multicollinearity among the marital status controls. This hypothesis is supported by the near-perfect overlap observed in Figures 4.6, 4.7 and 4.8.

With regard to the results, it should be noted that these values are not AMEs, thus their interpretation is extremely limited, and it is only possible to use the sign of the coefficients and their significance. The primary analysis of this thesis, namely the pooled probit, is accompanied by AMEs (see Table 4.4). Upon examination of Table 4.1, four conclusions can be deduced. Firstly, a substantial and favourable correlation has been identified between the number of participants and the involvement of women. Despite the model's inability to provide a direct explanation for the phenomenon, an argument can be made from the literature, that financial constraints are a contributing factor to the observed relationship (Merouani, 2026b).

Secondly, a significant and negative correlation is evident between the duration of the patent and the female participation rate. The result can be explained by two different factors. First, patents granted prior to 1844 would entail a one-time payment, with the amount increasing in proportion to the duration of protection. The correlation between the limited financial resources of women, as evidenced by the literature (see Merouani (2026b)), and their underrepresentation in the field of innovation, is a salient factor in understanding this phenomenon. For patents granted after 1844, a reduced fee could be paid at the time of registration, with the remaining balance payable in annual instalments. Whilst this does afford greater flexibility with regard to the patenting process, there is an absence of data concerning whether the yearly payments were made in full. It is evident that the limitations imposed during the subsequent period have a detrimental effect on the initial period, thereby resulting in a negative outcome. However, the model does not provide any evidence to support this claim.

Thirdly, the Reform Act of 1844 is not significant, and it appears to have a negative effect. The insignificance of the phenomenon under discussion could be explained by Figure 4.2, which illustrates the negligible growth caused by it in comparison with the subsequent British boom. It is possible that, even with our specifications, the issue will remain insignificant. With regard to the negative value, this phenomenon can be elucidated by the observations presented in Figure 4.4. The war of 1848 is evidenced to have induced a decline in the growth of female participation in patenting. This factor subsequently collided with our dummy, thereby engendering this unanticipated outcome, at least in comparison with the extant literature (Merouani & Perrin, 2026). In summary, the phenomenon under investigation appears to be the result of the construction of the variable, and external factors not included in the analysis, which, once the data from the UK has been incorporated, should dissipate.

It is evident that the marital status dummies are not available for the final analysis due to their erratic nature at the beginning of the century, as evidenced by Figures 4.6, 4.7 and 4.8. Consequently, it is not feasible to report values in this model without incorporating British data.

	(1) Female inventor dummy	(2) Female dummy	(3) Female dummy	(4) Female dummy	(5) Female dummy
Number of participants		0.125*** (0.011)	0.125*** (0.011)	0.111*** (0.013)	0.086*** (0.018)
Patent duration dummy		-0.199*** (0.043)	-0.199*** (0.043)	-0.196*** (0.049)	-0.179*** (0.064)
French reform of 1844			-0.170 (0.440)	-0.268 (0.440)	0.086 (0.167)
Widow dummy				0.000 (.)	0.000 (.)
Married dummy					0.000 (.)
Constant	-1.902*** (0.431)	-1.910*** (0.439)	-1.910*** (0.439)	-1.894*** (0.439)	-2.600*** (0.158)
Country	France	France	France	France	France
Pseudo R ²	0.002	0.005	0.005	0.005	0.008
Wald Chi ²	117.941	261.923	261.923	216.223	157.247
N	307910	307910	307910	305619	300810

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ **Table 4.1:** Results of the regressions using exclusively the French dataset*Source: Merouani & Perrin (2026)*

The first column is just the constant. Then, I add the controls on number of participants and patent duration for the second column. On the third, I add the control for the reform of 1844. Finally on the last two columns, I add the marital status dummies. All specifications include year fixed effects.

	(1) Female dummy	(2) Female dummy	(3) Female dummy	(4) Female dummy	(5) Female dummy
Number of participants		0.174*** (0.010)	0.174*** (0.010)	0.169*** (0.010)	0.175*** (0.010)
Patent duration dummy		-0.447** (0.204)	0.220 (0.217)	0.221 (0.217)	0.220 (0.217)
UK reform of 1883			0.667*** (0.081)	0.652*** (0.081)	0.584***
Widowed dummy				4.688*** (0.280)	4.700*** (0.279)
Marri dummy					4.222*** (0.184)
Constant	-2.081*** (0.026)	-2.312*** (0.029)	-2.979*** (0.078)	-2.972*** (0.078)	-2.980*** (0.078)
Country	UK	UK	UK	UK	UK
Observations	314148.000	314148.000	314148.000	314148.000	314148.000
Pseudo R ²	0.034	0.042	0.042	0.082	0.132
WaLd Chi ²	1142.563	1497.935	1497.935	1719.598	2099.846
Standard errors in parentheses					

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.2: Results of the regression using exclusively the British dataset

Source: *Berkes et al. (2026)*

The first column is just the constant. Then, I add the controls on number of participants and patent duration for the second column. On the third, I add the control for the reform of 1883. Finally on the last two columns, I add the marital status dummies. All specifications include year fixed effects.

As illustrated in Table 4.2, which presents the outcomes of the regressions employing exclusively the data from the English dataset (Berkes et al., 2026), the results appear more promising. This is due to the presence of significant variables in all iterations, with the exception of the control for the duration of patents. The explanation for this phenomenon is twofold. Firstly, the evolution of the grant system in the UK is a contributing factor (Khan, 2024). Secondly, the limitations of the available data must be considered.

With regard to the results, it is imperative to reiterate that these are not AMEs; consequently, the signs and significance of the values are the only elements that are taken into consideration. Upon examination of Table 4.2, four conclusions can be deduced. Firstly, the number of participants is once again positive and significant, perhaps explained by the same mechanisms as previously outlined (see reference below). However, it should be noted that the model does not provide any evidence to support this hypothesis.

Secondly, the patent duration is found to be insignificant. This finding is substantiated by the evidence presented in Figure 4.5, which illustrates the alteration in the length of the patent in a separate reform not involving a reduction in the fee price (Khan, 2024). When this is considered in conjunction with the dearth of information regarding the extent to which they were involved, the result is unsurprising.

In the topic of reforms, the 1883 reform is particular significant and positive. This outcome is anticipated upon examination of Figure 4.2, which demonstrates the increase in patents with women in the country (Khan, 2024). Finally, it appears that the marital status dummies are significant and positive. However, given the sudden rise in the pseudo R^2 and Wald χ^2 values, there is sufficient reason to suspect multicollinearity in the model. Consequently, it would be prudent to refrain from interpreting these results.

Upon examination of both tables, it becomes evident that the multicollinearity issues posed by the civil status controls are of such a nature that their inclusion in the final specification of the model for the pooled model is deemed unwarranted. As illustrated in Table 4.1, the situation is of particular concern, as it displays instances of absolute 0s, which are indicative of perfect alignment.

4.3 Main pooled probit: cross country heterogeneity and revolutionary legacy

The following section outlines the principal results of the thesis. It should be noted that these are the only results in which cross-country divergence is controlled for, thereby providing the necessary information to answer the thesis's fundamental question: namely, the relevance of the country of patenting in terms of female participation in such activities.

As illustrated in Tables 4.3 and 4.4, both datasets (Berkes et al., 2026; Merouani & Perrin, 2026) have been amalgamated, with the cross-country heterogeneity being utilised to provide a definitive response to the primary research question. Initially, the examination of multicollinearity

across columns 6 and 7, introduced to ascertain the potential for cross-country heterogeneity to resolve the issue, unequivocally substantiates the persistence of the problem.

A comparison of the data from the other columns reveals that patent activity in France appears to have been more inclusive of gender during the nineteenth century, at least in comparison with the UK. The significance of the variable remains consistent, with an increasing positive coefficient observed across all five specifications. The present study finds further corroboration in the interaction terms with the control for the number of inventors (indicating a reduced need for multiple individuals to collectively meet the financial obligations). This finding aligns with historical evidence suggesting that UK patenting fees were considerably higher and more prohibitive for women (Khan, 2024). However, it should be noted that the model is unable to independently identify a financial constraint channel.

The discrepancy in values is primarily attributable to the fees. Despite the positive and significant nature of both coefficients, a notable disparity in the values of the reform controls is observed. As demonstrated in Figure 4.2, there is a clear indication of a significant increase in female patenting, which is consistent with the documented reduction in fees to £4 following the 1883 reform (Khan, 2024). This reduction is hypothesised to have contributed to the observed rise in female patenting, given that the UK coefficient is double the value of the French one.

Finally, we have the only negative coefficient, the dummy controlling patent duration. This result is consistent with two distinct factors documented in the literature, as illustrated in Figure 4.5. On the one hand, the evolution of legislation and data limitations (Berkes et al., 2026; Khan, 2024; Merouani & Perrin, 2026) have been shown to shorten the initial length of the patent over time, with subsequent extensions being offered. However, due to data limitations, the initial lengths of patents cannot be determined with certainty. In the other case, it is evident that, when the data permit a clearer perspective, women exhibit a propensity for shorter patent durations. This phenomenon is consistent with the elevated costs associated with extended protection, although this pathway is not directly identified in the model.

In conclusion, the results provide consistent support for the main hypothesis. That is to say, the country of patenting activity has a significant and positive association with female participation across all specifications. This remains the case even after controlling for secular trends, patent duration, legal reforms, and team size. The role of civil status in predicting female patenting participation remains unresolved due to multicollinearity. This represents a significant area for future research.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Female inventor dummy	Female inventor dummy	Female inventor dummy	Female inventor dummy	Female inventor dummy	Female inventor dummy	Female inventor dummy
French dummy	0.181*** (0.008)	0.206*** (0.008)	0.429*** (0.028)	0.443*** (0.070)	0.510*** (0.072)	0.431*** (0.075)	0.093 (0.084)
Number of participants			0.156*** (0.007)	0.152*** (0.007)			
Patent duration dummy			-0.216*** (0.028)	-0.155*** (0.041)	-0.153*** (0.041)	-0.149*** (0.046)	-0.115** (0.057)
French Reform of 1844				0.235** (0.093)	0.232** (0.092)	0.216** (0.099)	0.211* (0.113)
UK reform of 1883				0.465*** (0.020)	0.465*** (0.020)	0.456*** (0.021)	0.452*** (0.025)
French dummy=0 × Number of participants					0.175*** (0.010)	0.170*** (0.010)	0.175*** (0.010)
French dummy=1 × Number of participants					0.123*** (0.011)	0.109*** (0.013)	0.084*** (0.018)
Widow dummy						5.330*** (0.219)	5.629*** (0.221)
Married dummy							5.468*** (0.146)
Constant	-2.288*** (0.006)	-2.397*** (0.376)	-2.532*** (0.388)	-2.586*** (0.388)	-2.616*** (0.387)	-2.553*** (0.384)	-3.636*** (0.207)
Year FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	626521	625715	625715	625715	625715	625715	625715
Pseudo R ²	0.005	0.012	0.017	0.023	0.024	0.172	0.446
Wald Chi ²	466.843	1485.635	2006.638	1968.602	1948.293	2278.337	4009.629

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ **Table 4.3:** Main results for all specifications of the pooled probit model*Sources: Berkes et al. (2026) and Merouani & Perrin (2026)*

The first column is just the main explanatory variable. For column 2, I add the year fixed effects, for the third column I add controls on the patent duration and the number of participants, for column 4 I add reform controls, for the fifth column I iterate the number of participants with the main explanatory variable, for column 6 I add controls for widowed women, and for the seventh column I add controls for married women.

	(1)	(2)	(3)	(4)	(6)	(7)
French dummy	0.006*** (0.000)	0.007*** (0.000)	0.016*** (0.001)	0.016*** (0.003)	0.011*** (0.003)	-0.001 (0.002)
Number of inventors			0.006*** (0.000)	0.005*** (0.000)	0.004*** (0.000)	0.003*** (0.000)
Patent duration dummy			-0.008*** (0.001)	-0.006*** (0.002)	-0.005*** (0.001)	-0.002** (0.001)
French reform of 1884				0.008** (0.003)	0.007** (0.003)	0.005* (0.003)
UK reform of 1883				0.022*** (0.001)	0.017*** (0.001)	0.010*** (0.001)
Widow dummy					0.987*** (0.001)	0.987*** (0.001)
Married dummy						0.988*** (0.001)
Year FE	No	Yes	Yes	Yes	Yes	Yes
Observations	626521	625715	625715	625715	625715	625715

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.4: Average Marginal Effects of the coefficients of the pooled probit model

Sources: *Berkes et al. (2026)* and *Merouani & Perrin (2026)*

The first column is just the main explanatory variable. For column 2, I add the year fixed effects, for the third column I add controls on the patent duration and the number of participants, for column 4 I add reform controls, for column 6 I add controls for widowed women, and for the seventh column I add controls for married women. The fifth column is omitted, since AMEs are not obtained for iterations.

5 Robustness check: the relevance of country dummies

Following the attainment of the primary results of the analysis, it is imperative to undertake a robustness check to substantiate the central hypothesis of the thesis, namely that the countries in which patenting activity occurred exerted a substantial and pertinent influence on the participation of females in this domain. The following forecasting exercise is presented, utilising the available data for Italy (Martinez, 2025), encompassing the period from 1861 to 1899, a time frame shared by all of the datasets. However, the initial question to be addressed is how the Italian data would fit into the existing data set.

Firstly, the use of Italy as a robustness check needs to be argued. Despite the fact that its creation occurred subsequently due to the re-unification of Italy in 1861, the Italians utilised the French patenting system as a template (Nuvolari & Vasta, 2020), yet ultimately, the system proved to be more open and accessible in comparison to that of France. In a similar manner, Italy is equally distinct from Britain with regard to patenting, as were the French, if not to a greater extent (Nuvolari & Vasta, 2020). In consideration of the configuration of the model under scrutiny, and the primary variable of analysis (which assumes a value of 0 in the event of a British patent and 1 in the event of a French patent), the recently incorporated data may be regarded as exhibiting a divergence from the established patterns.

For the description of the Italian data available, and thus, the state of gender equality and female patenting activity in Italy between 1861 and 1939, it is available in Appendix B.

5.1 Pooled probit with Italian data (1861-1899)

One potential methodology for answering this question would be to run the model twice. The present study utilised all available data from Italy (Martinez, 2025), incorporating all analogous variables, with the addition of a control for the year 1924 onwards, based on the context occurring in the country (Martinez, 2025) and previous descriptive analysis (Figures B.1 and B.2). The second approach involves the utilisation of a model that incorporates data from all three countries (Berkes et al., 2026; Martinez, 2025; Merouani & Perrin, 2026) during the period of commonality, specifically from 1861 to 1899. This suggests a relinquishment of authority, reminiscent of the French Reform of 1844, as it transpired previously.

As illustrated in Table 5.1, which presents the model applied exclusively to Italian data, the observed patterns bear a resemblance to the primary findings, wherein women are associated with shorter patents and larger inventor teams. This observation aligns with the financial constraints documented in the extant literature (Khan, 2024; Merouani, 2026a). However, it should be noted that the graph is unable to independently substantiate this hypothesis.

	(1) At least one female patentee	(2) Female participation dummy	(3) Female participation dummy	(4) Female participation dummy	(5) Female participation dummy	(6) Female participation dummy	(7) Female participation dummy
Italian reform of 1924		0.058 (0.354)		0.100 (0.358)	0.059 (0.358)	0.049 (0.359)	-0.218** (0.102)
Number of participants			0.260*** (0.022)	0.260*** (0.022)	0.243*** (0.023)	0.242*** (0.025)	0.269*** (0.036)
Patent duration dummy			-0.038 (0.046)	-0.038 (0.046)	-0.030 (0.048)	-0.054 (0.050)	0.008 (0.080)
Widow dummy					4.485*** (0.291)		
Married dummy						5.111*** (0.343)	
Spinster dummy							0.000 (.)
Constant	-2.322*** (0.009)	-2.511*** (0.352)	-2.810*** (0.356)	-2.810*** (0.356)	-2.791*** (0.356)	-2.786*** (0.356)	-3.017*** (0.122)
Year FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R2	4.44089209850e-16	0.009	0.016	0.016	0.076	0.174	0.023
Wald Chi2	.	148.873	283.873	283.873	489.718	441.032	141.411
Observations	156291	152991	152991	152991	152991	152991	144963

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ **Table 5.1:** Results of the regression using exclusively the Italian data*Source: Martinez (2025)*

The following step will involve the comparison of all three cases within a single model, with the objective of ascertaining whether the results remain consistent following the incorporation of the Italian data. Whilst it is true that the temporal scope is more limited, extending only between 1861 and 1900, it should be noted that these are the years for which data are more abundant.

As illustrated in Table 5.2, the results demonstrate a high degree of consistency with those of the primary pooled model. This provides further validation of the central finding within a third institutional context. The multicollinearity issues that have been observed in the marital status control remain unresolved. The Italian dummy exhibits intermediate values between the French coefficient and the UK baseline, a pattern consistent with Italy occupying a distinct but intermediate institutional position, as suggested by the extant literature (Khan, 2024; Martinez, 2025; Merouani, 2026a). However, cross-country coefficient comparisons of this kind should be interpreted with caution.

	(1) At least one female patentee	(2) At least one female patentee	(3) At least one female patentee	(4) At least one female patentee	(5) At least one female patentee	(6) At least one female patentee	(7) At least one female patentee
French dummy	0.145*** (0.009)	0.166*** (0.009)	0.332*** (0.059)	0.655*** (0.060)	0.713*** (0.063)	0.582*** (0.068)	0.226*** (0.071)
Italian dummy	-0.113*** (0.025)	-0.118*** (0.025)	-0.073*** (0.025)	0.281*** (0.031)	0.283*** (0.031)	0.239*** (0.033)	0.210*** (0.035)
Number of participants			0.157*** (0.008)	0.154*** (0.008)			
Patent duration dummy			-0.148** (0.058)	-0.138** (0.058)	-0.137** (0.057)	-0.115* (0.061)	-0.084 (0.062)
UK reform of 1883				0.458*** (0.022)	0.457*** (0.022)	0.441*** (0.023)	0.413*** (0.027)
French dummy × Number of participants					0.172*** (0.010)	0.166*** (0.010)	0.170*** (0.010)
French dummy × Number of participants					0.125*** (0.013)	0.118*** (0.014)	0.087*** (0.021)
Widow dummy						5.437*** (0.293)	5.752*** (0.297)
Married dummy							5.407*** (0.147)
Constant	-2.258*** (0.007)	-2.332*** (0.038)	-2.535*** (0.040)	-2.778*** (0.043)	-2.802*** (0.044)	-2.800*** (0.047)	-2.778*** (0.056)
Year FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	555427	555427	555427	555427	555427	555427	555427
Pseudo R2	0.004	0.010	0.015	0.021	0.021	0.155	0.415
Wald Chi2	324.445	1064.145	1501.412	1542.715	1529.646	1653.964	3188.337

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ **Table 5.2:** Main results for all specifications of the pooled probit model, including the Italian data. Years between 1861 and 1900*Sources: Berkes et al. (2026), Martinez (2025), and Merouani & Perrin (2026)*

The first column is with the country controls. For column 2, I add the year fixed effects, for the third column I add controls on the patent duration and the number of participants, for column 4 I add reform controls, for the fifth column I iterate the number of participants with the main explanatory variable, for column 6 I add controls for widowed women, and for the seventh column I add controls for married women.

5.2 Out-of-sample forecasting exercise (Italy, 1861-1899)

Following the analysis of the proximity of the Italian data to the pre-existing data utilised for the primary analysis, it is recommended that the principal model, which is based on French and UK data (Berkes et al., 2026; Merouani & Perrin, 2026), be employed for the purpose of forecasting Italian data (Martinez, 2025). This approach will preclude the utilisation of country-specific variables, such as the French dummy or the reform controls. It should be noted that there is a single caveat to this study. The period that all three datasets cover simultaneously is not the same as the one used up until now (1791-1899). Instead, it is shorter (1861-1899). However, this is still a valuable undertaking, given that these are the years with the most entries and the highest quality in our main analysis (Berkes et al., 2026; Merouani & Perrin, 2026).

Perusal of Table 5.3 reveals the presence of missing variables, a fact that is worthy of note. The aforementioned variables were excluded from the forecasting process on the grounds of multicollinearity issues (in relation to our controls for marital status) or due to their country-specific nature (with regard to the French dummy and the country reform dummies). Furthermore, it was imperative to reduce the sample to encompass exclusively the years between 1861 and 1899, inclusive. Nevertheless, the relevance of this forecasting exercise can be argued, as well as the association between the absence of country-specific institutional controls and reduced predictive accuracy.

One of the initial conclusions that can be drawn from this exercise is that the model systematically predicts a low probability of female participation for all Italian patents. This is consistent with the absence of country-specific institutional controls, as evidenced in Table 5.2, where our predicted variable does not exceed the 0.5 threshold. This suggests that the model forecasts a higher chance of no female participation in all patents.

As illustrated by Figures 5.1 and 5.2, the histogram provides evidence consistent with that presented in Tables 5.3 and 5.4. This indicates that the absence of country-specific controls is associated with the model's reduced predictive accuracy for Italy. It is evident from the time series graph that both variables exhibit a comparable average evolution during the initial period. This is in accordance with the anticipated outcome, characterised by reduced deviations in the forecasts. However, following the second half of the period, a substantial divergence emerges, resulting in our expected values significantly exceeding the actual ones. In conclusion, the present forecasting exercise provides further suggestive evidence that the country-specific institutional context is associated with female involvement in patenting, consistent with the central argument of this thesis.

	(1) Female participation dummy
Number of participants	0.155*** (0.008)
Patent duration dummy	0.180*** (0.009)
Constant	−2.527*** (0.040)
Year FE	Yes
Observations	528026
Pseudo R2	0.014
Wald Chi2	1400.403

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5.3: Specification of the model used for forecasting
Sources: Berkes et al. (2026) and Merouani & Perrin (2026)

	Actual	
Predicted	No women	With women
No women	27,158	243
With women	0	0
Total	27,158	243

Table 5.4: Predicted vs Actual Female Inventor – Italy 1861–1900.
Sources: Berkes et al. (2026), Martinez (2025), and Merouani & Perrin (2026)

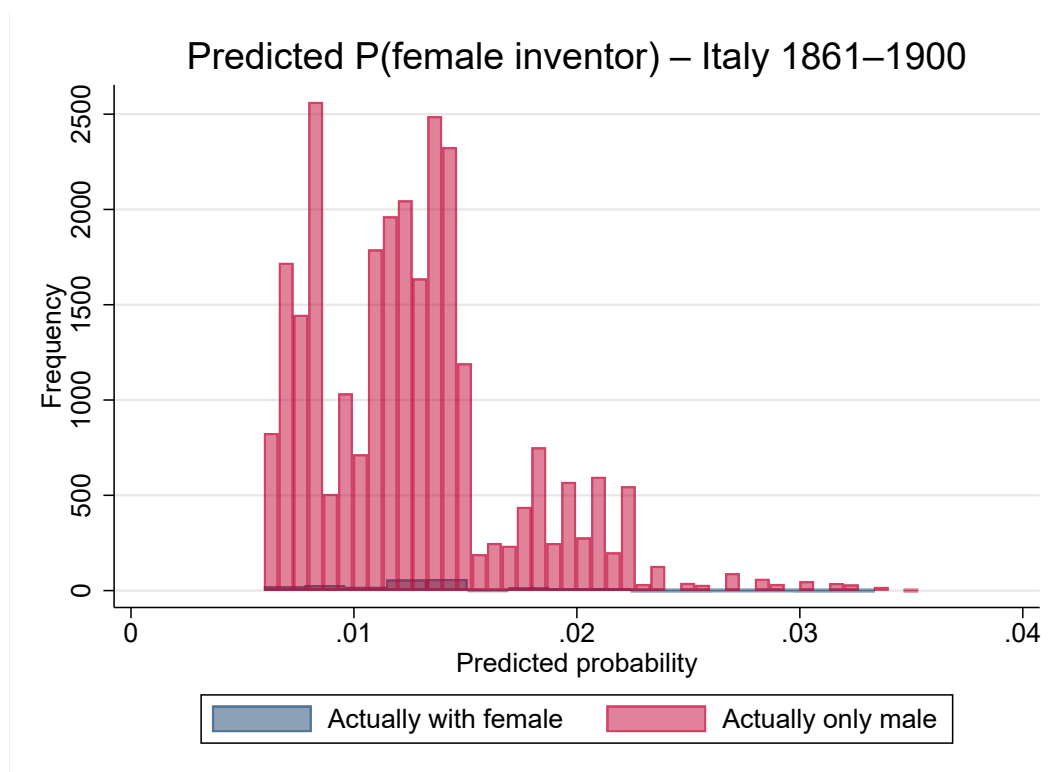


Figure 5.1: Histogram comparing actual data with the estimations of this forecast

Sources: Berkes et al. (2026), Martinez (2025), and Merouani & Perrin (2026)

Since the forecasted values are not binary, this graph indicates vertically the number of patents within each segment of forecasted value (indicated horizontally). Red columns are the ones where we know only men participated, grey for the ones where we know women participated.

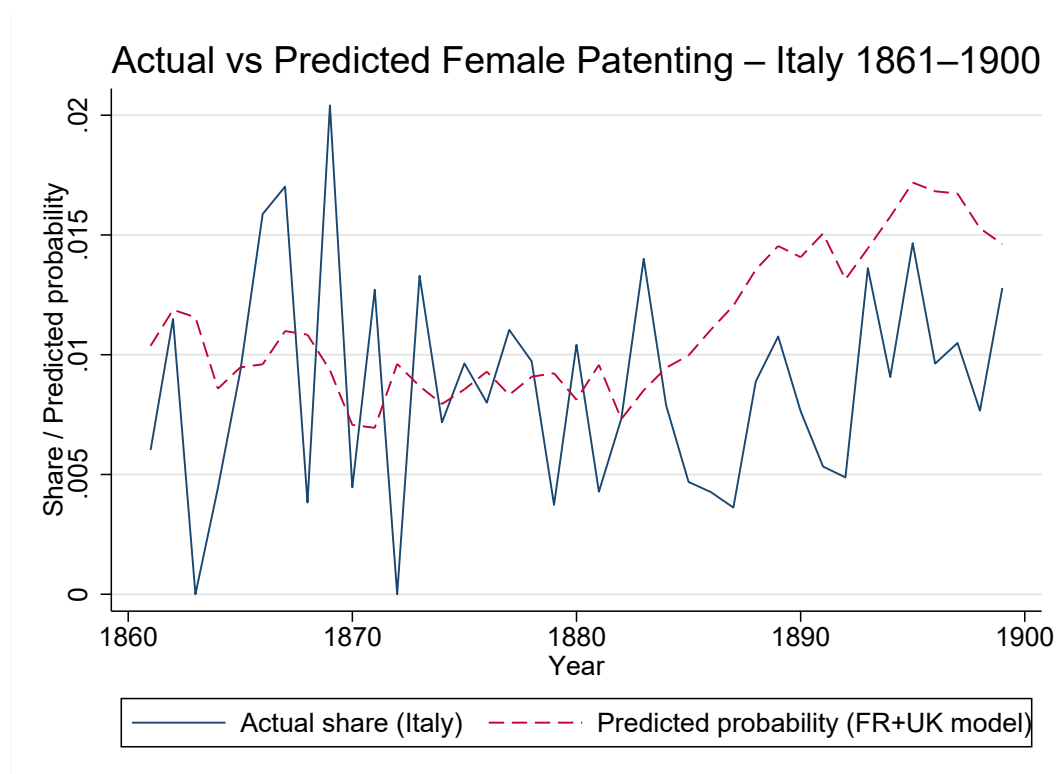


Figure 5.2: Evolution of the average value per year of the actual data and the estimated one in Italy between 1861 and 1899

Sources: Berkes et al. (2026), Martinez (2025), and Merouani & Perrin (2026)

6 Discussion, conclusions and expansions

This section offers a discussion of the results, a concise overview of the primary conclusions and key insights derived from this thesis. Additionally, it provides a modest investigation into the potential directions for future research in this area, drawing upon the findings documented in this thesis.

6.1 Discussion of the results

The primary conclusions of this thesis are presented in Table 4.4, specifically in column 4, where the following concepts are outlined. Firstly, the probability of an average patent encompassing a female inventor is augmented by 1.6% in the event of its patenting in France as opposed to the United Kingdom. Whilst the value may appear negligible, it is nevertheless significant, with a 99% level of confidence. Indeed, upon excluding this variable from the model in order to forecast in Italy, it becomes evident that the model is incapable of incorporating any patent that includes women (see Table 5.4). The limited scope of the present study is due to the fact that, in general, patents incorporating women were a rarity in both countries throughout the entire century (see Figure 4.3). This suggests that the probability of a patent including a woman in the nineteenth is inherently low.

The remaining values are largely consistent with the extant literature (Khan, 2024; Merouani, 2026a). The impact of both reforms on the inclusion of women was positive, albeit with modest gains. The French reform of 1844 resulted in an increase of 0.8%, while the UK reform of 1883 led to an average rise of 2.2%. A negative and significant correlation has been observed between the length of protection afforded by a patent (which diminishes by 0.6% on average if the patent is protected for a minimum of ten years) and the size of the team, with the inclusion of women (which increases by 0.5% on average for each new member). The literature has identified a link between these phenomena and the systematic financial constraints faced by women at the time in both countries.

The primary contribution of this paper to the current state of the art is the estimation of a 1.6% increase in the average probability of a patent including a female inventor, should such an occurrence take place in France. The findings aligns with the prevailing literature on the subject, thereby providing further substantiation of the existing body of knowledge. However, it should be noted that this value also serves to substantiate the hypothesis that, within the context of systematic inequality, the French patenting system exhibited a greater degree of inclusiveness to female patenting compared to its British counterpart during the nineteenth century. It is argued by the literature that the French Revolution, by reforming the system in 1791 to make

it more open and inclusive, has had a significant impact on the present situation (Merouani & Perrin, 2026). Furthermore, it is noted that in the UK, prior to the 1883 reform, married women were unable to patent their own work, as seen in Figure 4.6 (Khan, 2024).

The main contribution of this paper for the current state of the art is that value of 1,6% increase in average of the chances of a patent to include women if it happened in France. Overall, we get further confirmation of what the literature says at the moment, but that value is proof that, given the context of systematic inequality, the French patenting system was a bit more open to women patenting than the British during the nineteenth century. This higher degree of inclusiveness is being linked by the literature (Merouani, 2026a) with the values and spirit of the French Revolution, that already reformed the system to make it more open and inclusive in 1791, and by the fact that until the reform of 1883, married women could not patent on their own in the UK (Khan, 2024), as seen in Figure 4.6.

6.2 Main conclusions

In conclusion, the primary research question of this thesis has been addressed. The central question of this study is whether the country-specific context was relevant and significant for the participation of women in patenting during the nineteenth century. Indeed, both of these factors have a significant impact on the issue. It is acknowledged that, given the recent and notable nature of the data utilised in this thesis (in all three countries, data accounts for all patents registered during the period covered), the findings may not fully align with the current state of the art on the topic (previously, reliance was placed on samples rather than comprehensive data). However, it is crucial to note that the data is entirely consistent with the assertions made in extant literature, thereby serving to reinforce these claims.

Given the context that the nineteenth century is a period of systematic gender inequality, a more detailed analysis of the results reveals that the United Kingdom exhibits substandard performance relatively to France with regard to gender equality in patenting activity, despite the presence of a more conducive industrial environment for innovation. Previous studies have attributed this discrepancy to the influence of coverture laws and the higher costs associated with patent protection. This interpretation of the results is consistent with the outcomes of the reforms implemented in France (1844) and Britain (1883). The data and models demonstrate a surge in female participation in patenting following the reduction of the patent fee and the relaxation of the coverage laws in Britain, which is more pronounced than the gradual and incremental evolution observed in France.

Finally, in the context of the present study, it is important to acknowledge the position of Italy in relation to the two primary areas of analysis. The literature suggests that Italy's position is attributable to the higher level of decentralisation that characterises its legal system for patenting. Nevertheless, the primary conclusion that can be drawn from the out-of-sample forecasting exercise is that country-level information and controls are indispensable for the explanation,

analysis and forecasting of the participation of women in the field of patenting.

6.3 Possible expansions

In the context of future expansions of this research, numerous possibilities exist. The novelty and recent character of the data utilised in this thesis affords it the potential to serve as a foundation for future research that is both more advanced and precise. It is evident that the incorporation of controls for industrial sectors in which patents have been issued is a primary expansion that can be pursued without the necessity of additional data. In their current state, all three datasets employ wholly distinct classifications of the industrial sector of the patent, thus rendering cross-country comparison and analysis of this matter impossible without the adoption of a single standard. The selection of a standard is already the subject of a lengthy debate, as one methodology of sector classification is not suitable for all possible dimensions and considerations. This is the main reason why this was not done in this thesis. Furthermore, if a classification is chosen, it would involve lengthy and time-consuming work, which would exceed the time available for the writing of this thesis. However, once the debate and work have been surmounted, this addition could be achieved in two distinct ways. Firstly, a categorical variable could be employed, which would imply a discussion around the design of it. Secondly, fixed effects could be utilised to control for it.

It would be a fascinating exercise to explore the extent to which the current state of the art (Khan, 2024; Martinez, 2025; Merouani, 2026a) corresponds with the full data set. The most probable scenario is likely to be a close alignment. Moreover, further analysis is warranted into the manner in which the various sectors operated in disparate countries. This would likely necessitate the incorporation of country-specific controls.

In light of the potential for expansion of the data that could be included, it is proposed that this be undertaken within two distinct dimensions. It is conceivable that the data may be from the same time period, but simply from different countries. Spain (Saiz, 2001) is a noteworthy case in point. A nation with a long-standing tradition, it was in existence long before the French Revolution, and it had its own patenting system since the eighteen century, under the reign of Charles III. Its legal system for patenting was established at the beginning of the eighteenth century, and the Industrial Revolution took longer to reach the country than it did in other regions. Additionally, the gender rules of the time can be situated between those of France and Britain. The primary concern pertains to the procurement of the requisite resources for this undertaking, followed by their collection and subsequent purification to ensure their presentation and functionality. It is evident, from a personal standpoint, that the nature of the fieldwork is such that it is time-consuming.

Conversely, there is a possibility that data from the same countries, but from a later period or earlier in time, may be included. In the case of the United Kingdom, the task has been completed (Berkes et al., 2026). The primary challenge now lies with other countries. In the event of an

endeavour to provide additional recent data, the task at hand would be considerably less onerous than the inverse. This is due to the fact that a significant number of countries only initiated the establishment of regulations pertaining to the protection of inventions and patents during the Modern Era. Consequently, any data predating this period is considered lost to history.

In conclusion, this thesis represents merely the initial step in a protracted investigation. By incorporating additional variables and data from diverse geographical and temporal perspectives, a more precise depiction of gender equality in innovation can be formulated.

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A AI Contribution Statement

For the creation of this thesis, Claude was used with the purpose of fixing coding issues in Stata and Latex.

B The Italian situation

A significant distinction emerges in the temporal scope of the data emanating from Italy, as a result of the seminal contributions of Martinez (2025). The unification of Italy was not achieved until 1861, which is to say that the process was not completed until after the halfway point of the nineteenth century. Prior to the establishment of a centralised patent office in the peninsula, the management of intellectual property was more challenging due to the absence of a unified organisational structure. It is important to note that when examining Italian data in isolation, the full scope provided by Martinez (2025) can be utilised. This encompasses the period between 1861 and 1939. However, when comparing this data with the broader dataset (Berkes et al., 2026; Martinez, 2025), the analysis is limited to the specified timeframe between 1861 and 1939.

The following question must be posed: what lessons can be learned from the extant literature concerning Italian data? Despite the process of reunification, the government of Italy opted to perpetuate a system characterised by significant decentralisation. This decision entailed the maintenance of offices responsible for the administration of patenting activities at the level of the prefettura (Martinez, 2025). This approach stands in contrast to the approach adopted in the United Kingdom (Khan, 2024) and France (Merouani & Perrin, 2026), where central national offices have been established. The Italian system is characterised by its capacity to generate precise geographical data concerning the patenting system. An analysis of this data reveals a geographical concentration of patenting activity in the northern regions of the country, particularly within the industrial triangle composed of Milan, Turin, and Genoa. These regions exhibit a pronounced emphasis on manufacturing productivity and are distinguished by higher levels of human capital compared to the southern regions (Martinez, 2025).

An examination of the data per se (a descriptive summary of the variables is available at Table B.1), commencing with Figure B.1, reveals a congruent scenario with that observed in our primary countries, wherein patents with female involvement constitute a minuscule proportion. In this instance, they represent a mere 1.02% of all patents. Upon examination of Figures B.2 and B.1, it can be posited that the trajectory exhibited by these figures is analogous to that of the original data during the common period of observation. As demonstrated in Figure B.2, a notable peak in female patenting activity in Italy is observed in 1924. However, this peak does not extend further in time, a phenomenon that can be attributed to the timing of reforms implemented by the incumbent fascist government in Italy (Martinez, 2025).

As illustrated by Figures B.5 and B.6, the Italian data demonstrates a pattern that is consistent with the primary findings. Specifically, patents involving women are associated with shorter

	N	Mean	SD	Min	Median	Max
Female participation dummy	156291	0.010	0.100	0	0	1
Number of participants	156291	1.119	0.340	1	1	4
Patent duration dummy	156291	0.537	0.499	0	1	1
Italian reform of 1924	156291	0.088	0.284	0	0	1
Widow dummy	156291	0.001	0.028	0	0	1
Married dummy	156291	0.002	0.044	0	0	1
Spinster dummy	156291	0.008	0.086	0	0	1

Table B.1: Descriptive statistics of the data used for the Italian analysis

Source: Martinez (2025)

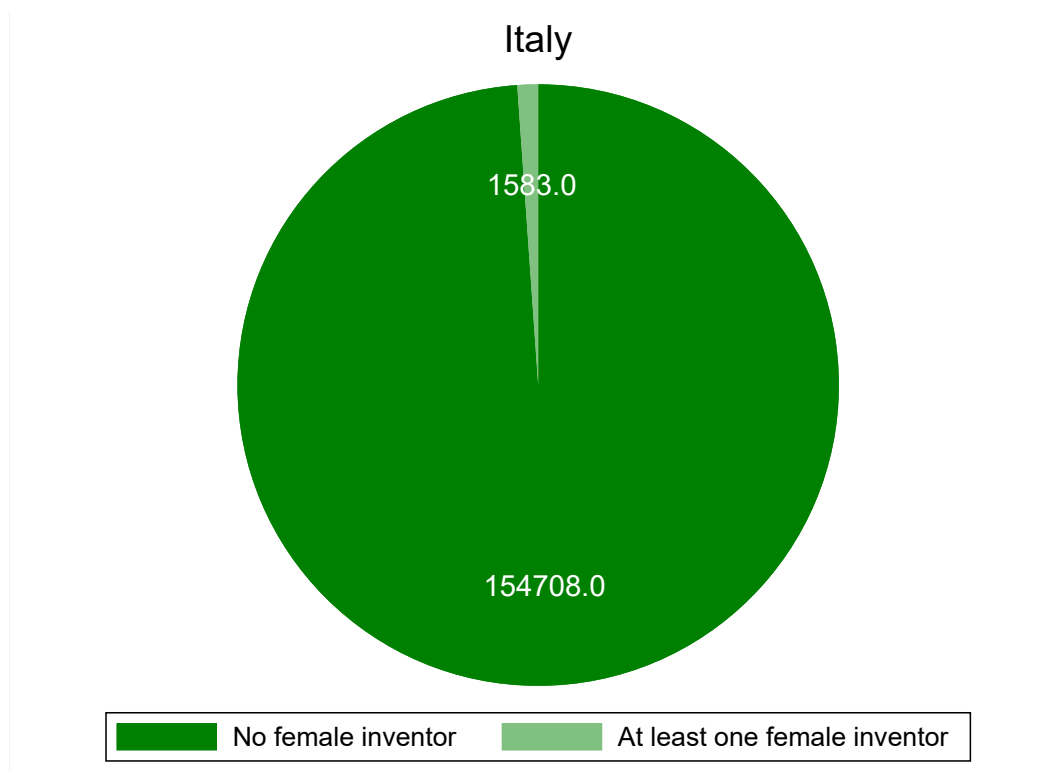


Figure B.1: Share of patents with women on the total of patents between 1861 and 1939 in Italy

Source: Martinez (2025)

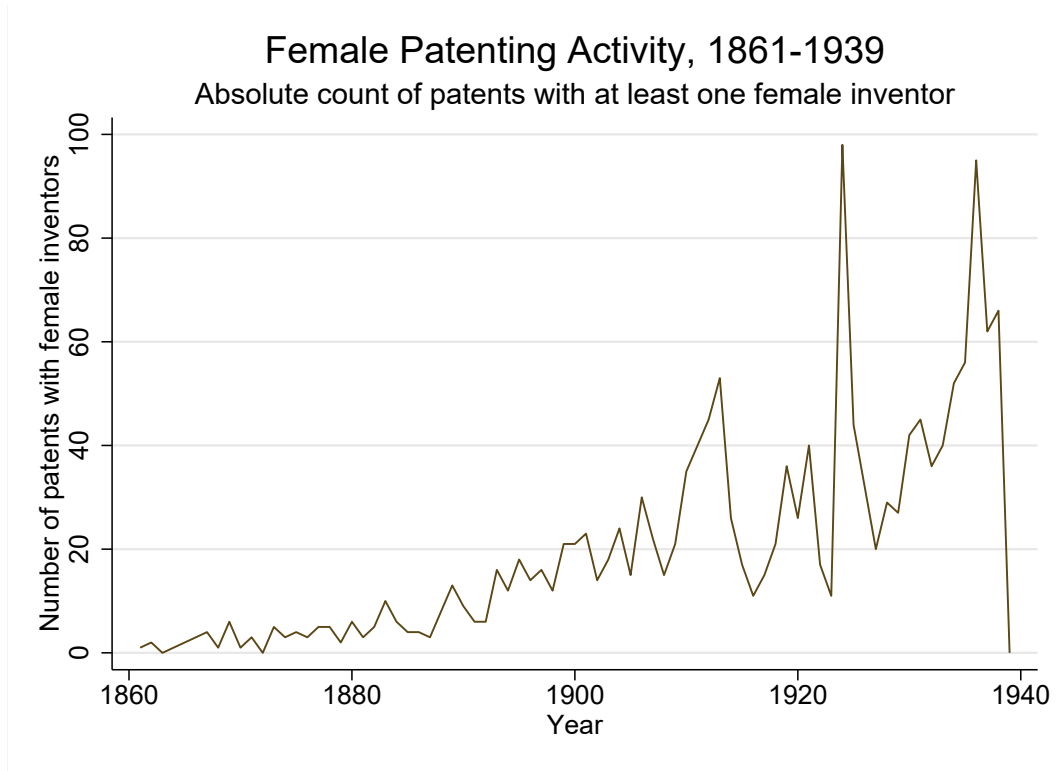


Figure B.2: Evolution of the absolute number of patents with at least one woman mentioned between 1861 and 1939 in Italy

Source: Martinez (2025)

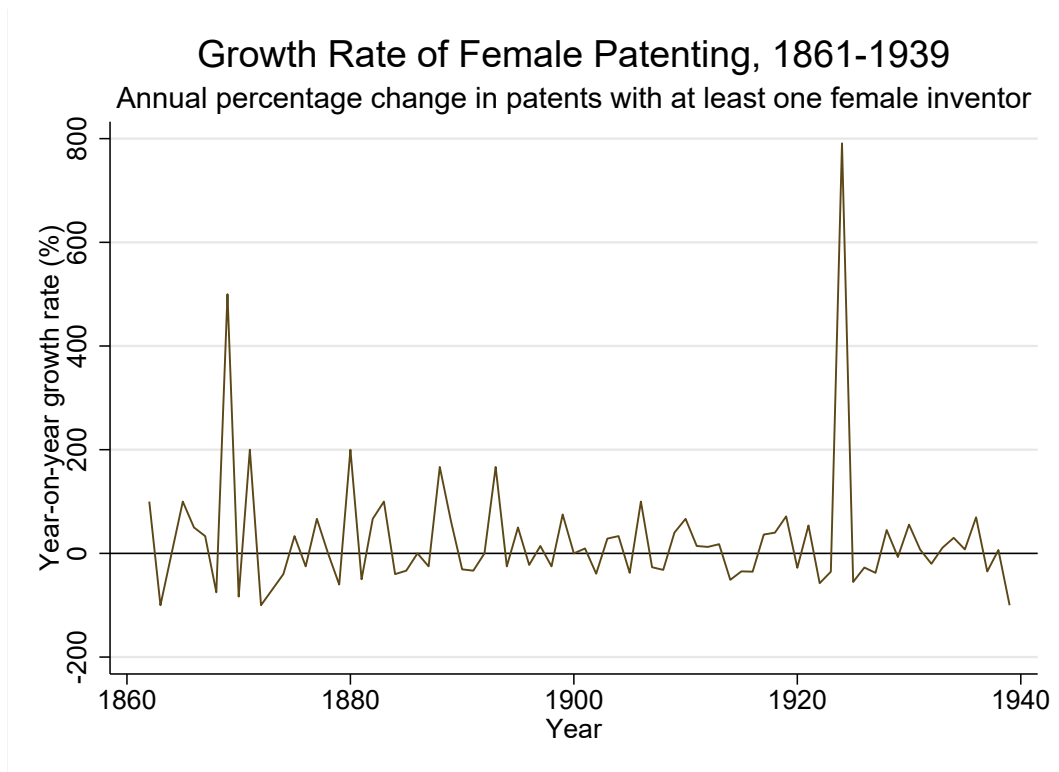


Figure B.3: Evolution of the growth rate of patents with at least one woman mentioned between 1861 and 1939 in Italy

Source: Martinez (2025)

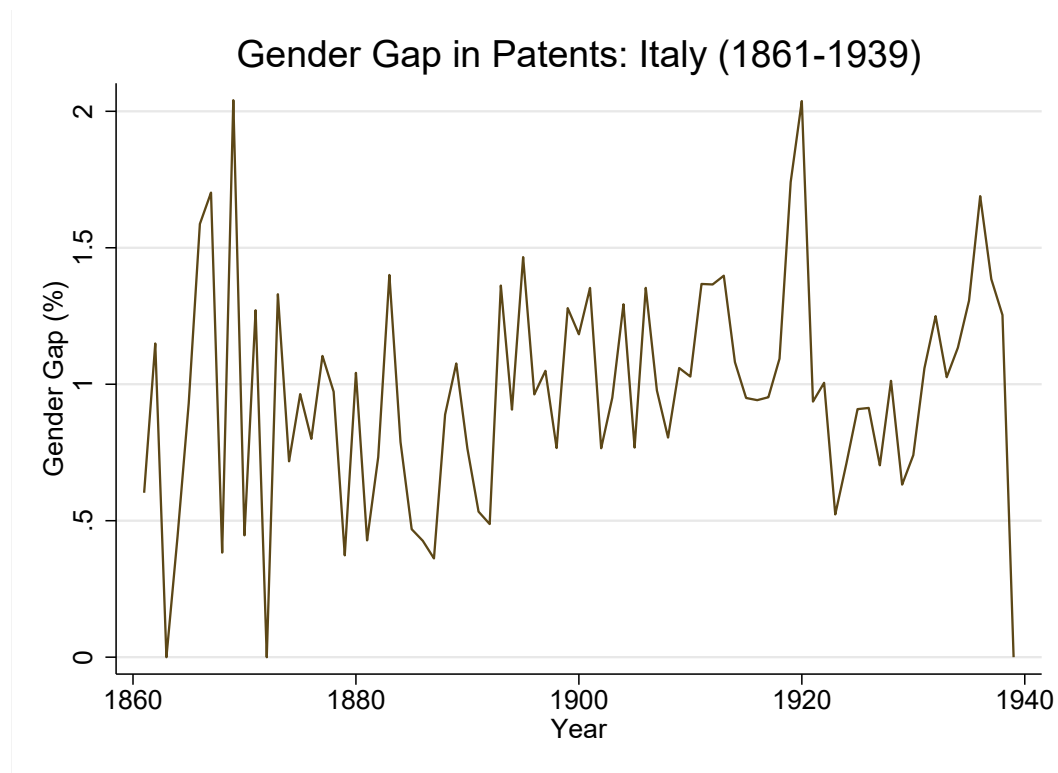


Figure B.4: Evolution of the gender gap patenting between 1861 and 1939 in Italy

Source: Martinez (2025)

average durations. The intriguing scenario is attributable to the marital status. In this section, the quality of the information has been enhanced, thus indicating that the majority of the women involved were neither married nor widowed. This finding is consistent with the legal constraints on married women's property rights that have been documented by Martinez (2025), and it is analogous to the coverture system in the UK (Khan, 2024). However, the data does not allow for the identification of this mechanism.

It can be argued that, in general, the situation in Italy during the late 19th century is comparable to that observed in both France and the UK within the same time period. It has been demonstrated that, as Martinez (2025) asserts, subsequent analysis reveals the presence of notable patterns that are in alignment with the political and institutional disruptions that characterised the specified period.

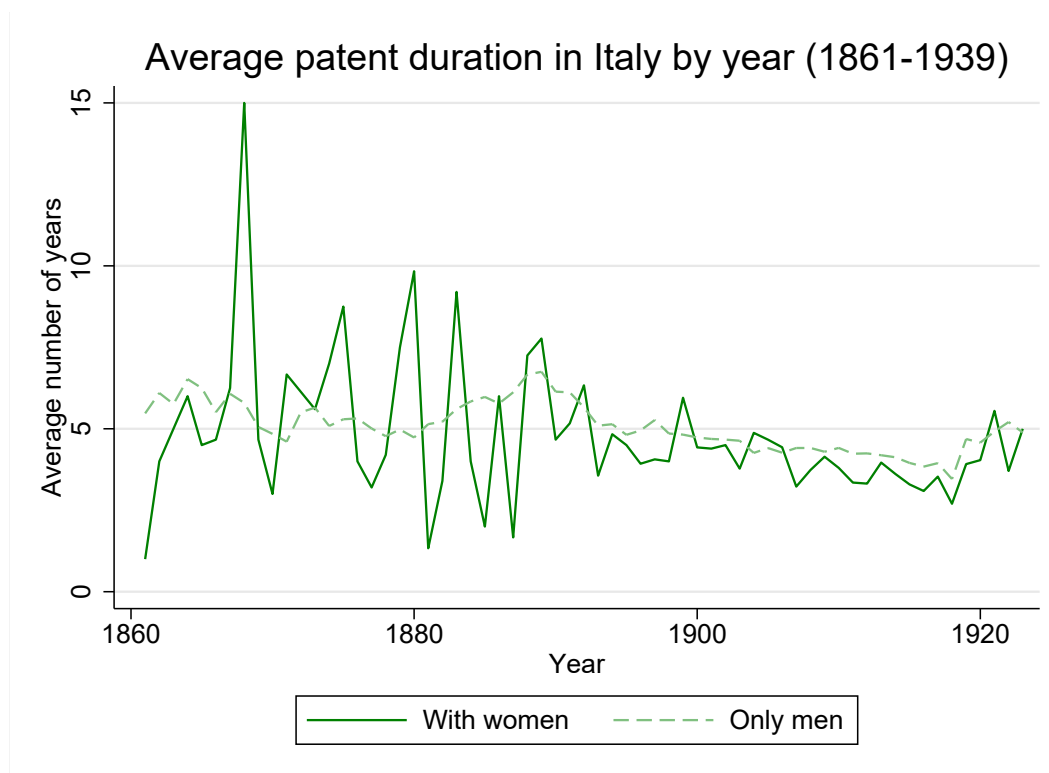


Figure B.5: Evolution of the patent duration between 1861 and 1939 in Italy

Source: Martinez (2025)

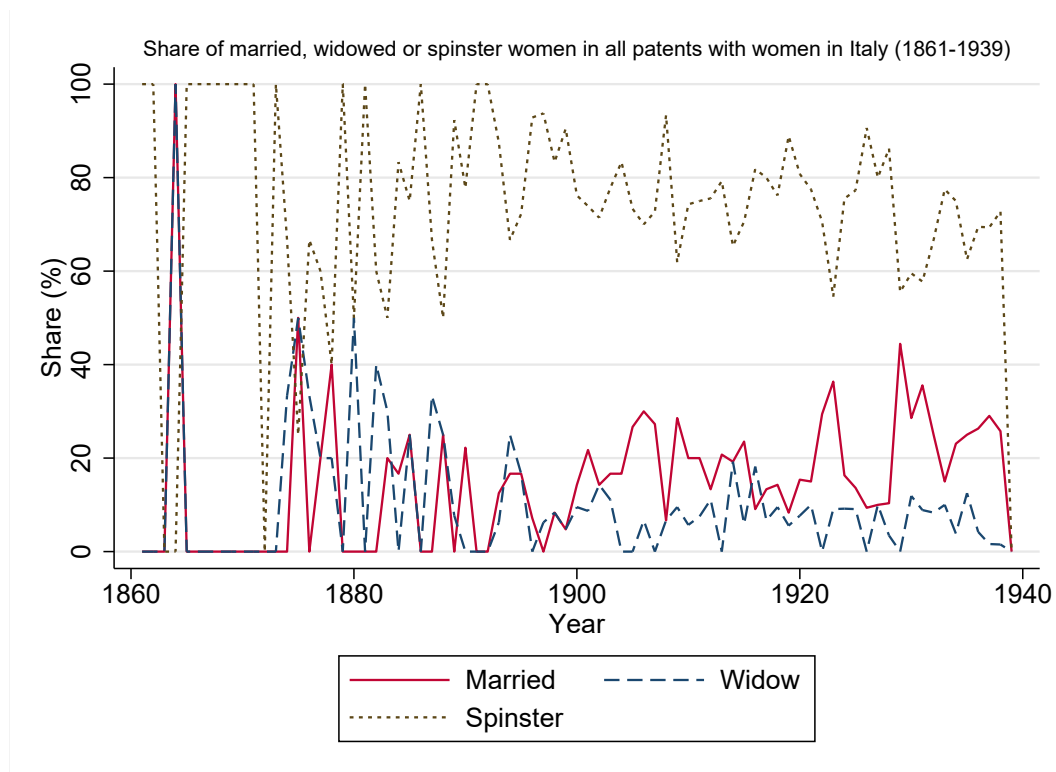


Figure B.6: Evolution of the marital status of women patenting between 1861 and 1939 in Italy

Source: Martinez (2025)