Working Paper

Marriage Strategy Among the European Nobility[*]

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Abstract

We use a unique dataset to analyze marriage and union patterns of the European nobility from the 1500s to the 1800s. Historical evidence shows that: nobles tended to marry nobles with identical title; and, German marriages, whose dowry rules were more rigid, were characterized by a higher degree of homogamy in titles than English marriages. Moreover, we show that German data exhibit lower odds of intermarriage than English among high ranked titles, and hence provide evidence of a more stratified society. We propose a matching model that rationalizes our empirical findings: it predicts homogamy in title, and that more stringent constraints on the dowries lead to a higher degree of homogamy.

KEYWORDS: marriage, nobility, class, elite, history, assortative matching.

JEL CODE: C78, J12, J16, N34, Z1.

1. Introduction

The European nobility maintained its supremacy for several centuries (Dewald, 1996). To ensure that political power and wealth remained in a few hands from one generation to another, nobles followed a number of laws and informal rules. Specifically, they endeavoured to marry within the nobility (endogamy) and, whenever possible, only the eldest son was to inherit his parents' estate and title (primogeniture).[1]

Through marriage, there was intense competition to maintain and increase the prestige of the lineage. The reasons are that only a handful of marriageable young mates were available at a given time; participants shared the same preferences over potential partners, that is, the more prestigious, the better; and, prestige was measured by an observable characteristic, that is, the groom's or bride's family title. The payment of the dowry (from the bride's to the groom's family) further fostered the competition for the best partners. Interestingly, the rules that governed the amount of a "proper" dowry differed from one country to another (Hurwich, 1998, 2006; Stone, 1961). While English nobles faced virtually no limitation, the level of dowries were fixed by custom with regards to the bride's family title in Germany.[2] We use this country variation to study the impact of the dowry system on marriage outcomes.

We exploit a unique database of the European nobility which allows us to compare marriage patterns in the English and German nobilities in the Early modern period, from the 16th to the 19th century. The dataset has been constructed from the website of Herbert Stoyan, whose information was not in a format directly usable for our empirical analysis. The website displays records in a "family tree" format: each webpage corresponds to an individual, who is a node connected through hyperlinks to her parents, partners, and children. In addition, it provides demographic information, such as name, person identifier, date of birth and death (in a limited number of cases), person identifiers of father and mother, person identifier of partner(s), and descendants for each of the corresponding partner. In our final dataset, all persons of the European nobility are stored and can be linked to their partners and successors.[3] The availability of the entire

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[1]Primogeniture has long been denunciated as one the main obstacle for the dissemination of wealth. Notably, eminent thinkers like Smith, Tocqueville, Engels or Marx advocated against the law of primogeniture.

[2]Throughout the paper, we will use "Germany" to refer to the Holy Roman Empire.

[3]The construction of our final dataset is detailed in Section 3.

sample of nobles is crucial for our empirical analysis because it avoids selection bias in the estimation of the homogamy degree.

We apply methods for contingency tables in order to estimate the odds of homogamy in titles in the two marriage markets. First, we measure odds of homogamy by computing the ratio of actual to expected marriages between nobles sharing the same title. Second, we use a log-linear model to measure the trend in the odds of homogamy. In general, the log-linear model for contingency tables is appropriate because it provides estimates of the changing association between couples' nobility titles while controlling for shifts in their marginal distributions over time.

We find that: (i) both marriage markets present a high degree of homogamy, and (ii) odds are significantly higher in Germany than in England. In the 1500s English nobles were about 1.7 times as likely to marry someone who shared their same title as they were to marry someone who did not. The same odds were about 3 for German nobles. By the 1800s, the odds had decreased in Germany to approximately 2.5, while it remained quite stable in England. Results also show that the odds of crossing title barrier are fairly constant over time in German marriages. In particular, German data exhibit lower odds of intermarriage (or a lower probability of marrying across titles) than English among high ranked titles, and hence provide evidence of a more stratified society.

In order to explain these patterns and rule out mechanisms driven by preferences and social norms, we implement several robustness checks and add a set of observable characteristics. All these strategies reduce unobserved heterogeneity between countries, leave our results unchanged, and support the role of institutions in explaining the differences in odds of homogamy. In particular, to remove omitted variable bias due to within-country variations over time, we estimate the odds of homogamy controlling for number of siblings, birth order, and country-specific time trends (Appendix D.2). We find odds that are consistent with those computed from the log-linear model.

Another potential threat to our identification is that celibacy among noble women was not a negligible phenomenon (Abramitzky et al., 2011). We therefore consider the sample of married and unmarried women and estimate the marriage probability by birth order, including controls for the number of siblings, time fixed effects, wealth (for English nobles), and enlarging the marriage market to countries other than Germany and England (Appendix D.3). We also extend the analysis to men and find that first born men had

both the highest marriage probability and the highest likelihood to marry a high ranked noble woman. We also make sure that our results carry through when we consider a disaggregated ranking of titles (Appendix D.1).

After having established the robustness of our empirical findings, we provide a theoretical model of assortative mating that rationalizes them. The literature offers two main models to explain assortative mating: one where utility is not transferable (Gale and Shapley, 1962), and another where utility is fully transferable (Becker, 1973, 1991; Shapley and Shubik, 1971). In the former case, assortative mating arises when all participants have the same ordered preferences, that is, when everyone agrees on whom is the most desirable partner, the second one, and so on. In the latter case with transfers, assortative mating arises if there are sufficiently strong complementarities between partners. We encompass these two approaches by proposing a theoretical model in which the degree of transferability is a parameter, also interpreted as an upper bound on the amount of dowries, and we study its impact on matching in the marriage market.[4] We show that more stringent constraints on the amounts of dowries (or, equivalently, a lower degree of transferability) lead to a higher degree of homogamy in title. These findings are consistent with our empirical results which demonstrate that German nobles were more likely to marry partners with the same title than English nobles.

RELATED LITERATURE. Our paper is linked to various strands of literature. We add to existing works on the nobility marriage market. Two recent working papers by Goni (2015) and Gobbi and Goni (2017) investigate assortative matching, fertility, and wealth inequality among nobles in Britain. In particular, Goni (2015) uses the interruption of the London Season occurred in 1861–63 to measure search costs and segregation in the marriage market. Gobbi and Goni (2017) establish the relationship between marriage settlements (as described in Habakkuk, 1950) and childless rate among peers. Hamilton and Siow (2007) show that endogamous marriages were still prevalent among the descendants of the European nobles who emigrated to Quebec in the 1800s. In contrast with these articles, we make a comparative analysis of German and English marriage markets.

Our paper provides a review of the characteristics of nobility marriages. Building on existing works by historians, we document that, although they shared a number of

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[4]See Legros and Newman (2007) for a model that provides sufficient conditions for assortative matching in environments where utility is only partially transferable between partners. An empirical framework is provided by Galichon et al. (2017).

similarities, English and German nobilities had different rules to guarantee the survival of their elites. We rely on works by Schutte (2014), who shows that marriage patterns of women in the English nobility (in terms of endogamy, rate of marriage, fertility, age of marriage, etc.) were stable from the 1500s to the late 2000s. Stone (1961) studies the institutions governing marriages of leading English families on the 16th and 17th centuries. Stone (1977) enlarges his previous work to a broader period. Thomas (1972) extends the analysis of marriages in the British nobility to the 19th century. Hurwich (1998) and Hurwich (2006) study marriage strategies and dowry payments in Germany from the 15th to 17th centuries.

There is a blooming and fast-growing literature on the empirical analysis of matching markets.[5] One main issue encountered by econometricians is that agents' preferences cannot be directly identified from the observed matching: man A may prefer woman B over woman C but still gets married to C because he would have been rejected by B. To circumvent this difficulty, several approaches have been taken in the literature: Choo and Siow (2006) use a structural model of the matching market with transferable utility and impose restrictions on unobserved heterogeneity; Hitsch and Ariely (2010) observe the profiles and the communication of users of an online dating and directly identify preferences; and, Chiappori et al. (2012) assume that multi-dimensional preferences can be summarized by a one-dimensional index.[6]

We take a different approach and argue that the characteristics of nobles' marriage market enable us to bypass most of these concerns: nobles had simple ordered preferences, and there were little to no search frictions. In a sense, we exploit the difference between the institutions that governed marriages in England and Germany as a natural experiment to analyze the impact of the degree of transferability on matching. Close in spirit to our paper is the work by Abramitzky et al. (2011) which uses World War I as a natural experiment to study the impact of a shortage of men on matching and fertility.

Our paper also contributes to the literature on elites as we describe a set of rules and institutions that have successfully helped a small elite to stay in power for centuries. On this topic, Bergstrom (1994) studies the interaction between social stratification, marriage, and fertility decision. Acemoglu and Robinson (2008) explores the interplay be-

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[5]See Chiappori and Salanié (2016), and the many references therein.

[6]Sorting on one dimension has been investigated by a large number of authors. See, among others, Weiss and Willis (1997), Qian (1998), Pencavel (1998), Silventoinen et al. (2003).

tween social stratification and the design of political and economic institutions. Bertocchi (2006) analyzes the link between social stratification, inheritance systems, and technological progress.

Elites, and more specifically reproduction of elites, are an important field of study in sociology. To name only a few, Bourdieu and Passeron (1990) show that elites (the "upper class") maintain their domination through both economic and cultural capital; Elias (1969 [1939]), in his classical study of the European civilization, describes how the aristocracy developed a set of social attitudes and manners to distinguish themselves from the rest of the society.

ORGANIZATION OF THE PAPER. Section 2 details the historical context. Section 3 describes the data. Section 4 contains the empirical analysis. Section 5 provides the theoretical model. Section 6 concludes the paper.

2. Marriages in the English and German Nobilities

In the European nobility, marriage and inheritance were intimately linked: one of the main goal of marriage was to ensure the production of an heir and the continuity of the lineage. Accordingly, marriage strategies should be understood in view of the rules and institutions governing both marriage and inheritance.

TITLE AND INHERITANCE. In the early Medieval Ages, the custom among European aristocracies was that sons were to inherit equally and no privilege was enjoyed by the elder. However, this resulted soon in the fragmentation of families' wealth and estate. In order to maintain social stability and to keep the wealth, power and social standing in the hands of as few people as possible, primogeniture was progressively established by law. The law of primogeniture stipulated that only the eldest son should inherit the title and the family's possessions. Therefore, it guaranteed the continuity of the family name, title, and estate if there was a male heir.

The establishment of primogeniture followed different paths in England and Germany. In England, the origin of primogeniture can be traced back to the reign of William I in the 8th century who imposed it to his vassals. It was then enacted in 1115 by King Henry I, and remained mandatory until 1925.[7,8] The eldest son was considered

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[7] "The ancestral fee of the father is to go to the first-born son", *Leges Henrici Primi*, 1115.

[8] See Stanhope (1878) and Rockley (1895, Chap.2) for further details.

as a nobleman and the sole heir to the paternal estates, while younger sons and their descendants were excluded from inheritance right. To further strengthen primogeniture, special arrangements (known as "strict settlements") were signed at the marriage of the eldest son. Three generations were involved in such settlements: the groom, his father (and current holder of the title), and his future first grandson. They established that family estate remained in the hands of the eldest son by limiting the heir's interest into that of life tenant and entailing it to his first descendant (Habakkuk, 1950).[9]

Primogeniture was established *de jure* or *de facto* in Germany only in later years.[10] The German nobility borrowed from Saxon law an inheritance system that granted equal shares to sons. This custom could result in the fragmentation of the family's wealth and estate in a few generations.[11] German nobles however found ways to circumvent Saxon Law (Hurwich, 1993). For instance, younger sons were often discouraged to marry, or were given the permission to marry only if they found an heiress, that is a bride who was entitled to inherit the wealth of her family. German noble families also had the unique capacity to enact "house" laws that superseded German and Roman laws.[12] A number of noble families made use of this possibility to establish primogeniture and it progressively became the norm in the 16th century. Finally, in order to further consolidate primogeniture, German legalists borrowed the *fideicommissum* from the Roman law, an institution similar to the English strict settlement.

Endogamy and rank of spouses. To preserve the purity of the group and avoid dissemination of wealth, a set of rules limited marriages outside the nobility. This resulted in a high degree of endogamy in the marriage decision.[13] Quoting the German historian Karl-Heinz Spiess, Hurwich (2006) underlines that the duty of a noble family was to "maintain and elevate the lineage" and, consistently, "the social criteria for the choice of marriage candidates aimed at partners who were as equal as possible in rank or even of higher rank". Similarly for England, Stone (1977) noted that "the greatest fear in a

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[9]A strict settlement includes other provisions such as annuities, portions, etc. Take as an example the marriage settlement of William Bentinck, Duke of Portland, with Lady Margaret Cavendish Harley, daughter of the Earl of Oxford and Mortimer. The marriage took place in 1734, and the details are described at www.nottingham.ac.uk/manuscriptsandspecialcollections/researchguidance/deedsindepth/settlements/complex.aspx.

[10]See Rockley (1895, Chap. 5) and Hurwich (2006, Chap. 2).

[11]For instance, Saxony was split up into Saxe-Weimar, Saxe-Eisenach, Saxe-Gotha, Saxe-Meiningen, Saxe-Coburg, Saxe-Römhild, Saxe-Eisenberg, Saxe-Saalfeld, Saxe-Hildburghausen.

[12]See www.heraldica.org/topics/royalty/g_change.htm.

[13]Endogamy is defined as the custom of marrying within one's cultural group or clan.

society so acutely conscious of status and hierarchy was of social derogation in marriage, of alliance with a family of lower estate or degree than one's own."

Based on Hollingsworth (1957), Thomas (1972) and his own calculations, Cannon (1987) found that, in England, from 1650 to 1759, the rate of endogamous marriages varied from 61.8 to 69.9 percent. Hollingsworth (1957) showed that marriages of eldest sons were characterized by a higher degree of endogamy than marriages of younger brothers. Moreover, Schutte (2014) showed that marriage patterns were remarkably stable in England from the 16th to 20th century, despite considerable change in the organization of society. The proportion of women who married within the aristocracy remained in the range of 50 to 60 percent until the 19th century, and started only then to fall down. She also noted that women from the most prestigious families were more likely to marry endogamously.

When social control was not enough to enforce endogamy, legal barriers were imposed to discourage unequal marriages. In Germany, a marriage between spouses of different social origins was considered *unequal* and carried the legal disability of inequality of birth (Harrington, 1993). An unequal marriage could be valid under canon and civil law but the rules governing inheritance were a private matter: each family could decide whether to limit or nullify the rights of inheritance of the lower-ranking spouse and her children. Such rules were often applied to remarriage in order to secure the inheritance right of children from the first marriage. For instance, in 1690, Landgraf Ernst von Hesse-Rheinfels (1623-93) remarried to Alexandrine von Düriczell who was the daughter of an officer. The marriage contract specified that none of the children born from the marriage were to inherit the title.[14] There was no such explicit law or rule in England. Yet the Hardwicke's Marriage Act of 1753 strengthened parental control over spouse choice and its objective was very clear: "[...] we should contribute to a poor lord's being always sure of matching himself with some rich heiress, and thereby restoring the lustre and the independency of his family" (Harth, 1988).

THE QUEST FOR PRESTIGIOUS MARRIAGES. If nobles clearly avoided marrying outside the aristocracy, they also spent considerable effort finding "prestigious" spouses for their offsprings. There was indeed a clear hierarchy between nobles within the aristocracy. In

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[14]See the discussion and the many examples in www.heraldica.org/topics/royalty/g_morganat.htm

England and Germany, titles made this hierarchy explicit.[15] For instance, the title *Duke* was more prestigious than *Earl*, which itself was more prestigious than *Baron*.[16] Since title was hereditary, the only way to improve the family's lineage was for a noble to marry upward, that is, with someone from a more prestigious family.

To account for the fact that the ranking between titles may slightly differ from one period and region to another, and to ease comparison between the English and the German ranking, we regrouped titles into five categories as shown in Table 1. In Appendix A, we provide the extensive ranking of German titles. The first category includes the sovereign and royal titles (King, Emperor, etc). The second category includes the highest titles in the nobility, that is Duke, Marquess and their equivalent in Germany. Nobles in this category had considerable power and privilege. The third category consists of the English and German Count (Earl and Graf respectively). The fourth category includes the lowest titles in the nobility (Baron, etc.). The last category includes the non-titled lower nobility (Lord, Knight, etc.).

RANK	ENGLISH	GERMAN
1	King, Prince, Emperor	König, Prinz(essin), Kronprinz(essin), Kaiser, Erzherzog(in), Grossherzog(in), Kurfürst(in)
2	Duke, Marquess	Herzog(in), Pfalzgraf(in), Markgraf(in), Landgraf(in), Fürst(in)
3	Earl	Graf(in)
4	Viscount, Baron	Freiherr, Freifrau, Freiin, Altgraf(in), Burggraf(in)
5	Lord, Knight, Sir	Edler, Edler Herr, Ritter, Herr, Junker

Note: For more details on the aggregation of titles, see Appendix A.

Table 1 – Ranking of Titles

Historians emphasize that prestige outweighed any other criterion in spouse's choice, including financial motives. Schutte (2014) stressed that in England, though "money was an important factor in the marital decisions of aristocratic women, rank was consistently of greater import". Similarly, Hurwich (2006) explained that "the emphasis on status rather than wealth was true of the German nobility in general". Finally, mutual attraction, or even love, was not disregarded but simply considered largely irrelevant: marriage was primarily about "companionship". Furthermore, it is only in the early 20th century that parents stopped supervising their children spouse's choice.

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[15]This was not necessarily the case in other European countries. In France, for instance, quarters of nobility were of prime importance.

[16]This ranking between titles does not imply that a noble of lower rank should obey a noble of higher rank. Difference in titles reflects almost only difference in terms of prestige or precedence.

Dowry. An important component of marriage was the payment from the bride's family to the groom's family. The rules and traditions governing the size of dowries used to vary from one country to the other.[17] In general, the bride's dowry was paid in cash and also included a *trousseau* in clothing, jewellery, etc. In exchange, the father of the groom had to provide support to the bride in case of widowhood.

In the German system, dowries were fixed by custom within very narrow limits (Hurwich, 2006, Chap. 2). The idea was that the payment of dowries should not burden the family's wealth at the expense of the future male heirs. The range of acceptable dowries was fixed by house regulations and depended on the bride's social rank. For instance, dowries of baron's daughters ranged from 3000 to 5000 gold coins, but from 6000 to 10000 gold coins for daughters of higher nobility (Hurwich, 2006, p. 45). As noticed by Hurwich (2006), this aimed to maintain "strong barriers against intermarriage between different social orders". As a consequence, nobles from the lower nobility did not support upward marriages of their daughters since they could not align on the dowry paid by nobles of higher rank.

In England, the size of dowries suffered of no such limitations: dowries were very sensitive to the "law of supply and demand". Indirect evidence of this fact can be found in Stone (1961, 1965, 1977) and Habakkuk (1950). Stone (1961) stated that "between the second quarter of the 16th and the third quarter of the 17th century, portions given with daughters of the aristocracy increased approximately ten times", keeping pace with the general rise of agricultural prices in the 16th century. For the 17th and 18th centuries, Freed (1995) justified the increase in dowries by a shortage of eligible husbands among the English aristocracy. Moreover, the bride's rank had an impact on the amount of dowry: "a duke's daughter was a good catch for any family while a baron's daughter would need a substantial dowry to make her appealing to a marquess" (Schutte, 2014). Stone (1961) also explained that "the physical and mental defects of a girl" had to be monetary compensated for. At some point in time, it was even possible to buy from the King an "option" on a noble's son (*wardship*).

So far, we have described rules and institutions governing marriages among the English and German nobility. The rest of the paper is devoted to the empirical analysis of

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[17]See Anderson (2007) for a discussion of basic facts about the prevalence and magnitude of marriage payments across countries.

matching patterns. Our main variable of interest is the degree of homogamy in titles, that is the proportion of couples who share the same title.

In Section 3, we describe our sample of marriages, and in Section 4, we estimate the odds of homogamy for the entire English and German populations of nobles from the 16th to the 19th century. We document that more homogamous marriages have taken place in Germany than in England. Differences in marriage odds across countries may be explained by several reasons: historical events (wars, epidemics, etc.), demographic variables (mortality, fertility, etc.), institutions. To reduce any unobserved potential heterogeneity, we enrich our empirical analysis by including time and country fixed effects, and we control for birth order and number of siblings. We show that adding these variables, results are unchanged. This suggests that different institutions are the main source of the observed difference in patterns of marriages. In the traditional understanding of the empirical literature on culture (see Guiso et al., 2008 among others), any remaining variation could indeed be interpreted as evidence that different social norms explain a higher degree of homogamy in marriages among German nobles. This leads us to propose, in Section 5, a theoretical model that rationalizes our empirical findings. We show that restrictions on the amount of dowries make it less likely to observe assortative mating in titles.

3. Data

In this Section we describe the dataset containing records of English and German nobles. The sample has been constructed from the website of Herbert Stoyan.[18] Each webpage corresponds to an individual, who is a node connected through hyperlinks to her parents and children. In Figure 1 we have two entries of the dataset. Panel (a) shows the case of *Friedrich Eberhard Graf v.Hohenlohe-Kirchberg* who was born in 1672 from Heinrich Friedrich v.Hohenlohe-Langerburg and Juliana Dorothea v.Castell-Remlingen, and died in August 1737. He married twice: the first wife was Friederika Albertina v.Erbach-Fursteanu, from whom he had five children; the second marriage was with Augusta Sophia v.Wurttemberg-Neuenstadt from whom he had another child. Each name is an hyperlink to the person's information. Panel (b) reports the case of *Richard*

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[18]Data are available at ww-person.com/cgi-bin/wwp/LANG=engl/?1. The numerous sources of the data are described at ww-person.com/html/literatur.html.

Boyle 2nd Earl of the County of Corke 1st Earl of Burlington who was born in 1612. He married Elizabeth de Clifford and had five children.

(a) German   (b) English

Figure 1 – Website Snapshot

The set of available information includes name, person identifier, date of birth and death (in a limited number of cases), person identifiers of father and mother, person identifier of partner(s), and descendants for each of the corresponding partner. The original dataset contains information of about 700,000 individuals in Europe over nine centuries.

Substantial work has been done to collect the data and render them compatible with standard statistical softwares. We started from a dataset where the information on each individual includes her name, birth/death date and relatives' identifiers. The name of an individual is a chain of characters that may provide, in no particular order, the first and last name, the title(s), etc. From this string, we deduced the gender, the country of origin, and the nobility title. For example, for "Friedrich Eberhard Graf v.Hohenlohe-Kirchberg", we know that *Friedrich* is a male German first name; *Graf* is a male German title; *v.* stands for the German preposition *von*; and *Hohenlohe-Kirchberg* is a German county. However, the identification is not always as simple. For instance, an individual may have multiple first names with different countries of origin. To solve these issues, we developed a simple algorithm that allowed us to determine the most likely country of origin.

In summary, each individual has been identified by combining several sources of information: (i) a list of first names guided us to the identification of her country and gender;[19] (ii) a list of prepositions allowed us to pin down the country (for instance, *zu*

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[19]The list is available at www.lexique.org.

as German indicator); (iii) the list of nobility titles led us to identify country and gender (for instance, *Duke* and *Duchess* are male and female English titles respectively). In case of ambiguity, we checked the information of the individual's family members. For instance, if we found that both parents came from England, we deduced that their children were also English. Other information has been employed, such as the list of the English peerage and a list of German territories. When an individual had more than one title, we opted for the highest one, based on the title ranking. It should be noted that the vast majority of individuals had not title, because only few members of a noble family inherited one (see the discussion in section 2). Moreover, in most cases daughters did not officially hold a title. As we are interested in the assortativeness of marriages in titles, we identified a woman's title with that of her father. Any remaining ambiguous entry in the dataset has been assigned manually.

We have information on years of birth. British nobles were born from 1053 to 1961, with 80 percent of the individuals born after 1600. German nobles were born from 1028 to 1974, with 90 percent of them born after 1600. We restrict the analysis to individuals born from 1500 to the end of 1800 because only few individuals were born before 1500. Lastly, in our main analysis, we exclude nobles from the top tier of the nobility (category 1 in Table 1). As we can see from Tables 6 and 7, less than one (four) percent of the highest ranked English (German) nobles are involved in marriages. In Appendix D.1, we estimate odds of homogamy including all the titles in Table 1, and show that results remain unchanged.

DESCRIPTIVE STATISTICS. Our data exploration begins with Table 5, Appendix B, which summarizes the demographic statistics of our sample. English individuals are on average about ten years older than German nobles; English families have one child less than German families. Hence the size of German families is bigger than the size of English families. The fraction of individuals who got married is higher among English nobles than Germans, but the percentage of nobles who got remarried is higher in Germany. In Appendix D, we establish that differences in demographic characteristics between the two groups of nobles cannot explain significantly different outcomes in the marriage market of the two countries.

We then proceed to compute two measures of resemblance and dissimilarity between spouses using distributions of husband's and (father's) wife's titles from 1500 to the end

of the 1800s (Tables 6 and 7, Appendix B). That is, we determine the proportion of couples who share the same title (homogamous marriages) and the proportion of couples in which the wife has a higher title than the husband (hypergamous couples), among those who do not share the same title (heterogamous couples). The results are depicted in Figures 2 and 3, respectively. Figures 2 shows that the proportion of homogamous marriages is high in both countries and higher for the Germans than for the English. As for the trends, the proportion of homogamous marriages appears to increase for the first century, stabilize for the Germans, and slightly decrease for the English thereafter.
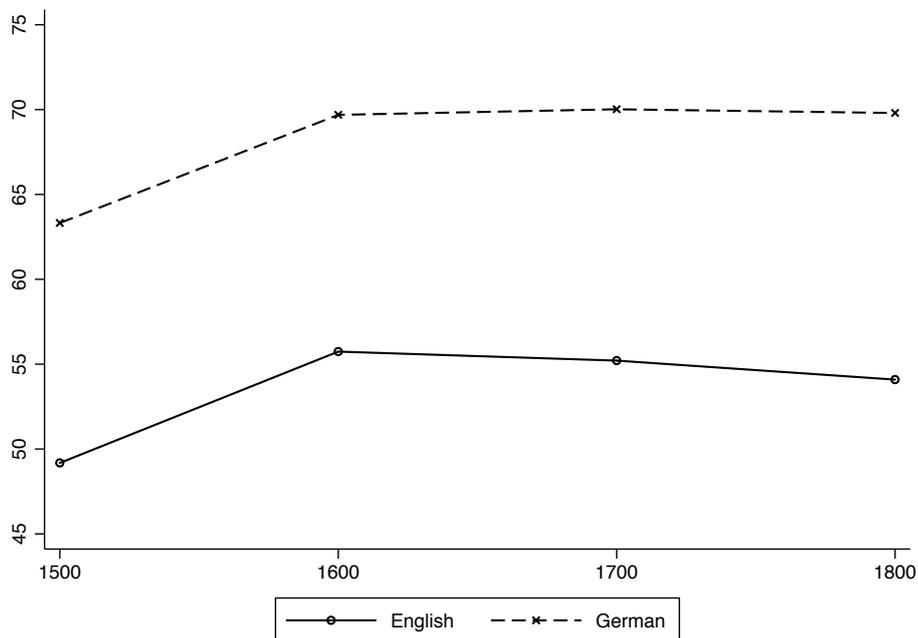
Figure 2 – Percent Homogamous Marriages

In Figure 3 we plot the percentage of hypergamous couples. We can see that in Germany, the tendency for men to marry down follows an "inverted U" pattern which peaked in the 1600s. On the contrary, it is strictly decreasing for English nobles who started out in the 1500s with a higher percentage of hypergamous marriages (roughly 67 percent) than Germans (about 52 percent). This percentage decreased to about 35 percent by the end of the 1800s for English, and only to 45 percent for Germans. While homogamous marriages have two clearly distinct trends, the same conclusion cannot be drawn for hypergamous marriages.

These trends should be interpreted with caution, as they may be highly influenced

by changes in the marginal distributions of husbands' and wives' titles. To determine whether this trend is altered once we control for shifts in the marginal distributions of husbands' and wives' titles, we use log-linear models in the next Section.
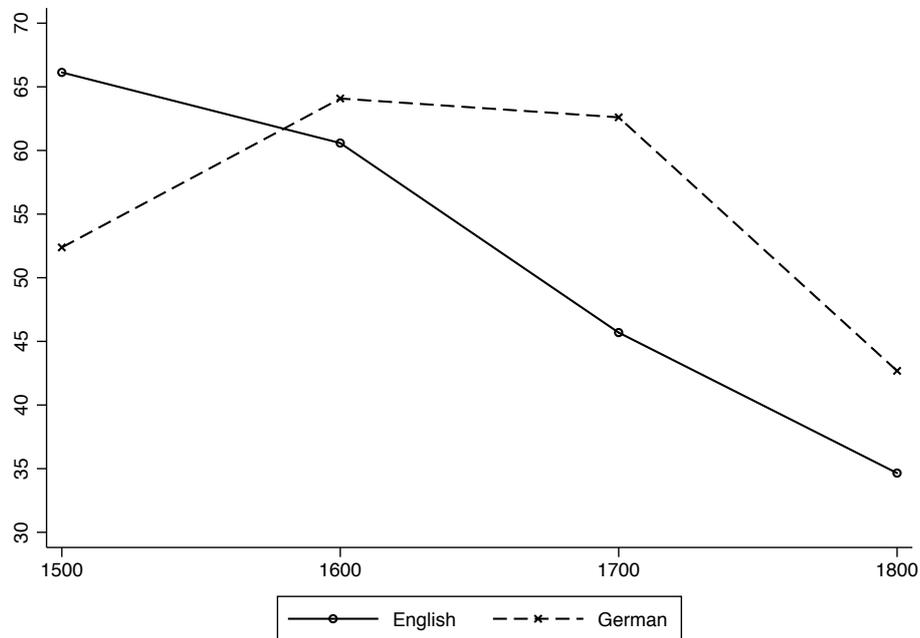
Figure 3 – Percent Hypergamous Marriages Among Heterogamous Marriages

Wealth. Though dominated by prestige, wealth could play an important role in the marriage decision, as already discussed in Section 2. A drawback of our data is the lack of information on wealth, revenues, or land properties. To overcome it, we made use of other sources to recover rough amounts of English and German nobles' wealth from the 16th to the 19th century. Data are in table 2.

For German noble families, we rely on two complementary sources. First, information on the wealthiest Germans of the Rheinprovinz in the early 20th century, is available from Martin (1913).[20] He listed wealth and earning for those who owned more than one million Deutsch Mark. A number of nobles, identified by their titles, are included in the list. Second, Hurwich (2006) explained that the amount of dowries was roughly equivalent to half of the yearly income of the bride's father. She reported the intervalled amount of dowry recorded in the Zimmern Chronicle (16th century). We take these numbers as indirect estimates of wealth by title.

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[20]The book is available at www.digitalis.uni-koeln.de/Million/million_index.html.

For English noble families of the 19th century, exhaustive information on the size of lands are available from Bateman (1883). He listed wealth information by owners' names that we merged to our dataset identifying the owners' titles. Consistent with Piketty and Zucman (2014), we assume that the size of lands approximates wealth because, until the 19th century, landownership was the most important resource of income.

	German	Martin (1913) Wealth (Millions of Deutsch Mark)	Hurwich (2006) Dowry (Gulden)	English	Bateman (1883) Land (Acres)
Rank	Title			Title	
1	König, Prinz(essin), Kronprinz(essin), Kaiser, Erzherzog(in), Grossherzog(in), Kurfürst(in)	9,16	20,000 and more	King, Prince, Emperor	n.a.
2	Herzog, Pfalzgraf, Markgraf, Landgraf, Furst	7,83	[6,000, 10,000]	Duke, Marquess	81,829
3	Graf	4	[3,000, 5,000]	Earl	43,899
4	Freiherr, Freifrau, Freiin, Altgraf, Burggraf	2,9	[1,000, 3,000]	Viscount, Baron	25,099
5	Edler, Edler Herr, Ritter, Herr, Junker	n.a.	[600, 2,000]	Lord, Knight, Sir	17,983
	Observations	61	n.a.	Observations	2,381

Table 2 – Wealth by Title

The number of observations is limited for both countries and we cannot obtain a precise estimate of the correlation between title and wealth. We nevertheless observe a positive relationship between title and wealth for both German and English nobles. Moreover, the difference of wealth between the different categories of titles is of similar magnitude in the two countries. For instance, both in England and in Germany, nobles of rank 2 are roughly twice as rich as nobles of rank 3. These observations enable us to consider the title as the main characteristic representing the role of a particular individual in the noble marriage market.

In Appendix D, Table 11, we include the size of land among the control variables in the regression that estimates the probability to marry for English noble women. We find that its coefficient is not significant in the estimation. Hence, its presence does

not alter the value of the coefficients of other control variables (last column of Table 11). Information on German wealth cannot be included in the empirical analysis as its amount is not exhaustively available for all nobles.

4. Empirical Analysis

4.1. Main Result

To assert the pattern of assortative mating, we apply methods for contingency table analysis, including log-linear models. In the first part of the empirical analysis, we construct a contingency table for both English and German couples (Table 3), to provide an overview of the marriage sorting pattern of the whole sample. In the second part of the empirical analysis, we describe changes over time in patterns of title sorting by using log-linear models. This model provides estimates of the changing association between couples' nobility title characteristics while controlling for shifts in their marginal distributions.

A contingency table is a matrix in which the groom's title is arrayed across rows i, and the wife's title is arrayed across columns j. Each cell in the contingency table has two entries. The first entry contains the fraction of husband-wife couples where the husband's title is at the ith level and the wife's title is at the jth level. The second number displays the fraction that would occur if matching was random and title played no role at all in partner choice. We assume that the expected frequencies are realizations of discrete uniform random variables. It is equal to $(T_i T_j)/T$, where T_i is the total for the ith row; T_j is the total for the jth column; and, T is the total number of observations. The cells on the main diagonal represent men marrying women with the same title as theirs. Next, we take the sum along the diagonal for each of these two types of matches, actual and random. Finally, we compute the ratio of the actual to random matches which can be interpreted as a measure of title homogamy.

When the ratio of observed to expected cases is high, it means that partners with those characteristics are marrying each other in larger numbers than would be expected if their matching was random. In our case, the ratio is larger than one implying that there is positive assortative mating. Moreover, the ratio is higher for Germans (i.e., 1.36 = 68.95/50.76) than for English (i.e., 1.10 = 54.19/49.43), and the Chi-Square test is

such that the null hypothesis of no relationship between titles can be rejected.

Highest groom's title	Highest bride's father's title							
ENGLISH	Duke, Marquess		Earl		Viscount, Baron		Lord, Knight, Sir	
	obs.	rand.	obs.	rand.	obs.	rand.	obs.	rand.
Duke, Marquess	**3.47**	***1.65***	6.46	*8.25*	1.67	*1.16*	0.72	*1.25*
Earl	7.65	*9.19*	**48.09**	***45.91***	5.86	*6.47*	6.94	*6.97*
Viscount, Baron	1.20	*1.37*	6.34	*6.89*	**1.43**	***0.97***	1.31	*1.04*
Lord, Knight, Sir	1.08	*1.18*	6.10	*5.93*	0.48	*0.84*	**1.20**	***0.90***
Marginal	13.40		66.98		9.45		10.17	
Pearson chi2(9) = 32.477								

GERMANS	Herzog, Pfalzgraf, Markgraf, Landgraf, Furst		Graf		Freiherr, Freifrau, Freiin, Altgraf, Burggraf		Edler, Edler Herr, Ritter, Herr, Junker	
	obs.	rand.	obs.	rand.	obs.	rand.	obs.	rand.
Herzog, Pfalzgraf, Markgraf, Landgraf, Furst	**10.69**	***3.32***	6.56	*11.87*	0.63	*2.55*	0.14	*0.28*
Graf	7.24	*12.80*	**52.94**	***45.71***	8.23	*9.81*	0.96	*1.06*
Freiherr, Freifrau, Freiin, Altgraf, Burggraf	0.51	*2.24*	6.06	*8.01*	**5.24**	***1.72***	0.35	*0.19*
Edler, Edler Herr, Ritter, Herr, Junker	0	*0.08*	0.31	*0.28*	0.04	*0.06*	**0.08**	***0.01***
Marginal	18.45		65.88		14.14		1.53	
Pearson chi2(16) = 1.7e+03								

Table 3 – Marital Sorting by Title in England and Germany, 16th - 19th century

We now proceed to analyze the trend of marital sorting, and see if the above findings are persistent over time. Previous studies on marriage across religions, ethnicities, and educational attainments have made use of a number of models for analysis of intermarriage using log-linear models for contingency tables (Agresti, 2002 and Schwartz and Mare, 2005). Our two contingency tables are produced by cross-classifying husband's highest title with (father's) wife's highest title by century (16th, 17th, 18th, 19th). We obtain two 4x4x4=64 cells tables.

In our benchmark model (Model I) we assume that the association between husband's

and wife's title is time-invariant. The model is:

$$\log \mu_{ijl} \;=\; \lambda + \sum_{i=2}^{5} \lambda_i^H H_i + \sum_{j=2}^{5} \lambda_j^W W_j + \sum_{l=16th}^{19th} \lambda_l^C C_l +$$

(4.1)
$$\sum_{i=2}^{5} \sum_{l=16th}^{20th} \lambda_{il}^{HC} H_i C_l + \sum_{j=2}^{5} \sum_{l=16th}^{19th} \lambda_{jl}^{WC} W_j C_l$$

where H is an indicator variable for husband's title ($i = 2,...,5$ as in Table 1), W is an indicator variable for father's wife's title ($j = 2,...,5$), and C is an indicator variable for century ($l = 16th,...,19th$). μ_{ijl} is the number of marriages between husbands with title i and wives with title j in century l.

In Model II we add an homogamy parameter γ_l^{OC}:

(4.2)
$$\log \mu_{ijl} \;=\; \text{Model I} + \sum_{i=2}^{5} \sum_{j=2}^{5} \sum_{l=16th}^{19th} \gamma_{ijl}^{OC} O_{ijl} C_l$$

with $O_{ijl} = 1$ if husband's title equals father's wife's title, and 0 otherwise. The homogamy parameter estimates the change in the odds of homogamy in century l relative to the baseline century (16th). In Model III we allow for variation in homogamy parameters across the main diagonal, that is, we construct title-specific homogamy indicator variables for each century.

Table 8 in Appendix C provides the model specifications and fit statistics of our log-linear models. Smaller BIC statistics indicate a better fitting model. The benchmark model (Model I) fits the data poorly relative to models that allow for changes in title assortative marriage. Model II is the homogamy trend model (4.2), which parameterizes the trend as a change in the likelihood that husbands and wives share the same title. By the BIC, adding these terms improves the fit of the model relative to Model I, indicating that the tendency for couples to marry within the same title category has changed significantly over the period we examine. This simple model, however, may conceal significant variation in trends across different type of title. To address this issue, Model III allows for variation in homogamy trends across the main diagonal. By the BIC, Model III fits the data better than Model II only for Germans, thus indicating that trends in the odds of German homogamy cannot be adequately described by a single parameter.

Figure 4 shows the trend in the odds that husbands and wives share the title estimated

from Model II. Coefficients are graphed at their mid-point.[21]

Net of changes in the marginal distributions of husband's and wife's title, the odds of homogamy for noble marriages remained stable from the 1500s to the 1800s. In the 1500s, English husbands and wives were roughly 1.7 times as likely to have a spouse who shared their title as they were to be married to someone who does not, down to slightly more than 1 time the odds in the 1700s, and returning to their initial value of 1.7 in the 1800s. The stability of the English odds ratio is supported by Schutte (2014). This result is in contrast with the trend in Figure 2, where the percentage of English homogamous marriages increased in the first century. In the 1500s, German husbands and wives were 3 times as likely to have a spouse who shared their title as they were to be married to someone who does not. The odds peaked to 3.7 in the 1600s, and dropped to roughly 2.8 in 1800s.
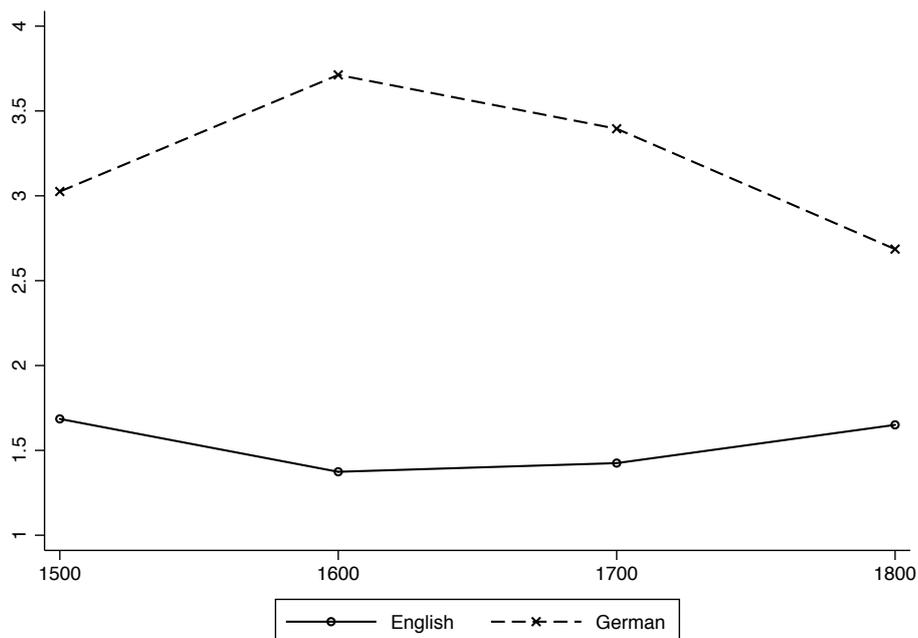
Notes: Odds are graphed at their mid-point. For English nobles, they are significant at the 5% level in 1500 and 1800, and at the 10% level in 1600 and 1700. For German nobles, they are all significant at the 1% level.

Figure 4 – Odds of Homogamy, 16th - 19th century

The results of Model II are qualitatively consistent with the relative ratios of the diagonals from the contingency Table 3. To summarize, both Germans and English tended to marry nobles with the same title, and title endogamy of German nobles was

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[21]The estimation procedure is as in Schwartz and Mare (2005). Full regression results are available under request.

significantly higher than the degree of title endogamy of English nobles. Moreover, the log-linear model tell us that German odds of homogamy were twice as high as English odds of homogamy in the 1500s, and remained higher towards the 1800s.

In Appendix D.1, Figure 7, we show that our results are robust across title classification. If we consider each title as a separate category, odds of homogamy are higher in size than those showed in Figure 4, but similar in their time trend. Table 9 and 10 in Appendix D.1 report the predicted probability of marriage by title and include both the highest nobility and individuals without title. The numbers in the main diagonal are consistent with our main findings.

4.2. Other Results

In the previous Section we showed that odds of homogamy were higher in Germany than in England, or, equivalently, that there were more heterogamous marriages in England than in Germany. In this Section, we investigate whether the distance between partners' titles in heterogamous marriages is larger or smaller in England than in Germany. Such measure is interesting because it reflects the boundaries that separate social groups and, therefore, provide additional evidence on the level of social stratification.

In order to describe trends in title resemblance of spouses, we add interactions between spouses' titles. Models IV through VI analyze the difficulty of crossing the barrier: Model IV captures variation in crossing title barriers across the title distribution; Models V and VI provide odds of marrying a wife or a husband with a higher title (among spouses with different titles), respectively. Model IV is

$$(4.3) \qquad \log \mu_{ijl} \;=\; \text{Model I} + \sum_{i=2}^{5}\sum_{j=2}^{5}\sum_{l=16th}^{19th} \gamma_{ijl}^{SC} S_{ijl} C_l$$

where S_{ijl} is equal to 1 if $i < z$ and $j \geq z$ or $j < z$ and $i \geq z$ for $z = 2, ..., 5$ and 0 otherwise. Models V and VI include a hypergamous coefficient:

$$(4.4) \qquad \log \mu_{ijl} \;=\; \text{Model I} + \sum_{i=2}^{5}\sum_{j=2}^{5}\sum_{l=16th}^{19th} \gamma_{ijl}^{HC} H_{ijl} C_l$$

where $H = 1$ if $i < j$ among couples with different titles in Model V, $H = 1$ if $i > j$ in

Model VI, and 0 otherwise.

Model IV is the crossings trend model (4.3) which adds terms to capture variation in the difficulty of crossing title barriers across the title distribution. By the BIC, the crossings model provides a better fit to the data than the previous models, especially for German marriages. These results suggest that trends in assortative marriage are better explained by variation in the strength of barriers to intermarriage across title boundaries. Models V and VI improves the fit of English data, but the same is not true for Germans.

Figure 5 shows trends in difficulty of crossing adjacent title barriers estimated from Model IV. Larger crossings coefficients correspond to higher odds of intermarriage and thus indicate more permeable barriers. Smaller numbers correspond to lower odds of intermarriage and indicate less permeable barriers and a more stratified market.
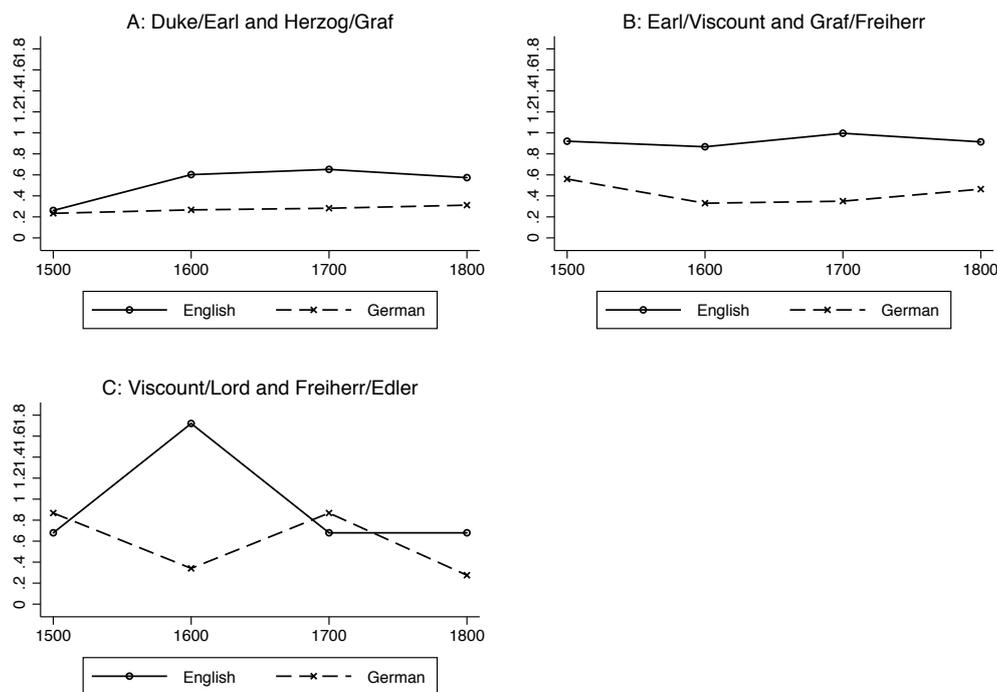
Notes: Odds are graphed at their mid-point. Panel A: For English nobles, they are significant at the 1% level in 1500, at the 5% level in 1700 and 1800, and at the 10% in 1600. For German nobles, they are all significant at the 1% level. Panel B: For English nobles, they are not significant. For German nobles, they are all significant at the 1% level. Panel C: For English nobles, they are not significant. For German nobles, they are significant at the 5% level in 1800 and not significant in all other years.

Figure 5 – Odds of Crossing Title Barrier, 16th - 19th century

The odds of intermarriage between husbands and wives separated by more than one title barrier are the products of the odds ratios for each barrier that a marriage crosses.

The odds are higher for English in panels A and B. These findings are consistent with Hurwich (1998, p. 176) who reports that "[...] the hostile attitude of the German nobility toward intermarriage meant that marriages actually crossed the boundaries between the differ orders of nobility, much less the chasm between nobles non-nobles." In Panel C the odds are less stable over time and diverge largely in the 1600s.

In Figure 6 we plot the odds of hypergamy where wives have higher titles than husbands. The trend of odds is consistent with the percentages in Figure 3 for Germans. It is not the case for English marriages which display a constant trend. We can observe that odds of wives of marrying down have remarkably increased for German nobles in the 1700s. This finding is consistent with Hurwich (2006) who, on page 247, claims that "they consistently followed a hypogamous marriage pattern in which son married up and daughters married down" in the 16th century.
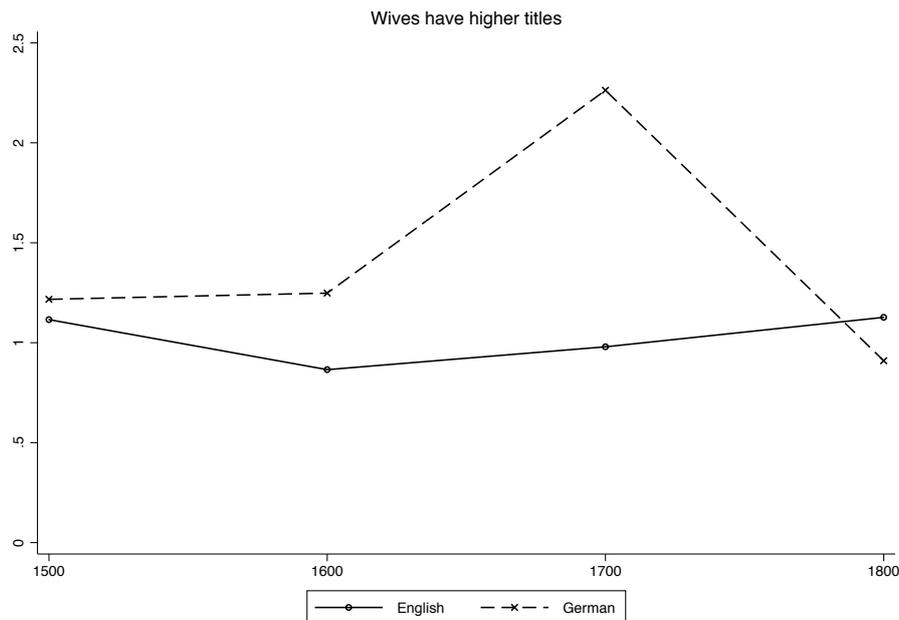
Notes: Odds are graphed at their mid-point. For English nobles, they are not significant. For German nobles, they are significant at the 10% level in 1700 and not significant in all other years.

Figure 6 – Odds of Hypergamy, 16th - 19th century

5. Theoretical model

In the previous Section, we found that odds of homogamy are significantly higher among German nobles than the English ones. Moreover, the result is unchanged when we add country and time fixed effects. This suggests that institutions are the main source

of observed difference in patterns of marriages. In the historical Section 2, we stressed that one main difference between institutions of the two countries was that dowries were more constrained in Germany than in England. To use the terminology of the matching literature (Roth and Sotomayor, 1992), we can say that utility was "more transferable" in England than in Germany. In what follows, we build a simple theoretical model to understand how the level of transferability impacts the matching in a marriage market where participants have the same preferences. Precisely, we would like to understand whether a lower level of transferability or, equivalently, more stringent constraints on dowries may result in higher odds of homogamy.

We are not aware of any paper that builds such a theory. However, much is known in the two extreme cases where utility is not transferable (NTU) or fully transferable (TU). In the NTU case, positive assortative matching (PAM) obtains when men and women have the same ordinal preferences, that is when everyone agrees on who is the most desirable partner, the second one, and so on. In the TU case, PAM obtains under a more stringent condition: the joint surplus has to be supermodular (Becker, 1973). When utility is imperfectly transferable, Legros and Newman (2007) show that PAM obtains when utility is more transferable between men and women who are higher in the preference ranking.

MODEL. There are two men and two women. Men and women only differ by their titles: one man and one woman have title h, and the other man and woman have title l. Title h is considered more prestigious so that everyone prefers *a priori* to marry someone with title h. A match between man i and woman j, $(i,j) \in \{l,h\}^2$, creates positive surplus u_{ij} to the man and v_{ij} to the woman. In addition, bride j must pay a non-negative dowry to groom i. Agents are risk neutral and have quasi-linear preferences. They only care about the sum or the difference between the match surplus and the dowry. An unmatched agent gets a payoff of 0, regardless of his or her type. We assume further that:

(i) men and women have homogenous preferences: $u_{ih} > u_{il} > 0$ and $v_{hi} > v_{li} > 0$, for all $i \in \{l,h\}$;

(ii) there exists $\lambda \in [0,1]$ such that, if woman j is married to man i, the dowry d must be such that $0 \leq d \leq \lambda v_{ij}$. We call λ the *degree of transferability*.

When $\lambda = 0$, utility is non-transferable; when $\lambda = 1$, utility is transferable and man i

married with woman j must receive at least u_{ij}. We follow the literature in assuming that a matching is pairwise-stable in equilibrium.

RESULTS. If $\lambda = 0$, the only possible match is PAM: man h prefers to marry woman h and woman l cannot compensate this with a dowry. Proposition 1 below shows that the same logic applies for the case in which λ is small enough.

PROPOSITION 1. *There exists $\hat{\lambda} \in (0, 1)$ such that, for all $\lambda < \hat{\lambda}$, PAM is the unique equilibrium outcome.*

Proof. See Appendix E.1.   □

It remains to understand what happens for higher values of the degree of transferability. Note first that PAM does not necessarily obtains when $\lambda = 1$: the joint surplus must be supermodular. However, when PAM is an equilibrium for a high degree of transferability, it is also an equilibrium for lower degrees of transferability:

PROPOSITION 2. *Let $\lambda \in (0, 1)$. Suppose there is an equilibrium in which PAM obtains when the degree of transferability is λ. Then, for all $\lambda' \leq \lambda$, there exists an equilibrium in which PAM obtains when the degree of transferability is λ'.*

Proof. See Appendix E.2.   □

The proof of Proposition 2 is not very informative. It is however intuitive. For high values of λ, PAM is an equilibrium only if there is sufficiently large complementarities between types: the logic of the TU case is at stake. Then, there are two cases to consider for lower values of λ: either λ is small enough so that Proposition 1 applies; or, λ is high but complementarities are strong enough to compensate for less stringent constraints on dowries.

PREDICTIONS OF THE THEORETICAL MODEL. Propositions 1 and 2 together suggest that one is more likely to observe assortative mating in environments where the degree of transferability is small. In the context of marriage between nobles, theory therefore delivers:

- PREDICTION 1: homogamy in title in England and in Germany;

- PREDICTION 2: a higher level of homogamy in title in Germany than in England.

Figures 2, 4, and 7 show that the proportion of homogamous marriages is high in both countries and higher for the Germans than for the English, which is consistent with the predictions of the theoretical model.

6. Conclusion

We illustrated the role of institutions like primogeniture and dowry in the marital choices of English and German nobles. We added to the existing literature on elites by constructing and analyzing an original dataset of nobility lineages. Results showed that both Germans and English nobles tended to marry nobles with the same title. In particular, German nobles did it at a higher rate for the entire period of time under analysis, that is from the 1500s to the 1800s. Over time, odds of homogamy decreased in Germany and remained quite constant in England. These results remain valid (and stronger) when we do not aggregate titles and consider each title as a separate category, or we estimate the odds of homogamy using a different econometric model.

We rationalized our empirical results with a model that provides some novel theoretical insights on the matching mechanism that characterizes a group with homogeneous preferences over titles. We showed that more stringent constraints on the amounts of dowries (or, equivalently, a lower degree of utility transferability) lead to homogamy in title in England and Germany, and to a higher degree of homogamy in title in Germany than in England.

Our results also paint a picture of a German upper class that was relatively more stratified and less open than the English one, in that there were higher barriers to intermarriage in Germany than in England. This finding is consistent with Acemoglu and Robinson (2012)'s hypothesis that, in the 19th and early 20th, the difference in economic development between England and Germany was partly explained by the fact that Germany was run by a narrow elite that promoted "extractive" institutions, whereas "inclusive" institutions were implemented in England.

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A. Appendix: Ranking of Titles

In this Appendix, we explain how we build the ranking of titles in Table 1. First, we use the remarkable fact that nobility titles were ranked according to prestige and precedence both in England and Germany. Second, we regroup titles into a small number of categories to allow comparison between the two countries.

For English nobles, the ruling titles King or Prince come first and are then followed by Duke, Marquess, Earl, Viscount, Baron, Lord, Knight and Sir, by order of prestige.[22] Things are more complicated in Germany: there were more than twenty titles, some of them with no equivalent in the English classification.

Table 4 shows the hierarchy between German titles and, where relevant, the corresponding English titles.[23] It should be noted that the order of the titles *Pfalzgraf, Markgraf, Landgraf* and *Herzog* may differ from one source to another. For instance, *Pfalzgraf* (Count Palatine in English), is ranked below *Herzog* by www.adelstitel-info.com or heraldik-wiki.de. A possible explanation is that these four titles were sometimes sovereign titles in Germany. Consider the following example: In the early 17th century, Johann Sigismund and Georg Freidrich were respectively Markgraf von Brandenburg and Markgraf von Baden-Durlach. However, Johan Sigismund was also a Kurfürst (a prince-elector), which means that he participated in the election of the Emperor.[24] Electors were the most prestigious nobles of the Empire and, accordingly, Johan Sigismund (1572-1619) had precedence over Georg Freidrich (1573-1638), though they had the same title. In any case, these four titles were highly prestigious and should be considered part of the higher nobility.[25] It is also worth noting that, though etymologically equivalent to an English *Marquess*, a German *Markgraf* is closer, in terms of prestige, to a Duke than to a Marquess.

There was also a hierarchy among individuals of the same rank, both in England and in Germany. This "intra-category" hierarchy depended mainly on the antiquity of the title. That is to say, the older the title, the more prestigious the title bearer. For instance, in England, the Duke of Somerset has precedence over the Duke of Hamilton because the

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[22]See, e.g., www.debretts.com/expertise/essential-guide-to-the-peerage/ranks-and-privileges-of-the-peerage/

[23]Table 4 is taken from europeandynasties.com/adelsrang.htm.

[24]The Markgraviate of Brandenburg was raised to Electorate on 1356, while the Markgraviate of Baden was elevated only later in 1803.

[25]See the discussion in heraldica.org/faqs/atrfaq.html#p3-2.

former was created in 1443 while the latter was created only later on in 1643.[26]

Rank	German Titles	Corresponding English Titles (whenever possible)
1	Kaiser	Emperor
2	König	King
3	Pfalzgraf	
4	Erzherzog	
5	Kurfürst	
6	Grossherzog	
7	Landgraf	
8	Markgraf	
9	Grossfürst	
10	Herzog	Duke
11	Reichsfürst	
12	Fürst	
13	Reichsgraf	
14	Burggraf	
15	Graf	Earl
16	Freiherr	Baron
17	Baron	Baron
18	Ritter	Knight
19	Junker	
20	Edler	
21	Herr	

Table 4 – Ranks of the German Nobility

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[26]See en.wikipedia.org/wiki/List_of_dukes_in_the_peerages_of_Britain_and_Ireland.

B. Appendix: Descriptive Statistics

	Overall Sample		English		German		Others	
	Males	Females	Males	Females	Males	Females	Males	Females
Mean age	52.59	52.77	62.09	59.88	50.51	51.49	55.11	54.97
Mean n. of children	6.24	6.32	5.14	5.44	6.68	6.59	5.70	5.82
Mean n. of siblings	5.68	6.28	4.75	5.41	5.99	6.54	5.42	5.80
Sex ratio	1.21		1.18		1.16		1.41	
Mean number of partners	1.09	1.01	1.09	1.01	1.09	1.01	1.06	1.01
Fraction who married	45.06	47.95	53.39	61.21	43.29	44.79	44.74	48.77
Fraction of remarried	9.03	1.05	8.00	0.90	10.16	1.13	6.58	0.92
Number obs.:								
all	106,917	88,638	15,477	13,150	68,673	59,393	22,767	16,095
16th century	17,484	12,259	1,412	992	11,236	8,843	4,836	2,424
17th century	24,826	19,994	2,413	1,721	16,312	14,322	6,101	3,951
18th century	27,165	22,309	3,779	2,813	17,770	15,603	5,616	3,893
19th century	37,442	34,076	7,873	7,624	23,355	20,625	6,214	5,827

Table 5 – Descriptive Statistics

Highest groom's title	Highest bride's father's title					
	King, Prince, Emperor	Duke, Marquess	Earl	Viscount, Baron	Lord, Knight, Sir	Total
16th century:						
King, Prince, Emperor	0.00	0.00	0.81	0.00	0.00	0.81
Duke, Marquess	0.81	3.22	3.22	2.42	0.81	10.48
Earl	0.00	1.61	36.29	9.68	12.90	60.49
Viscount, Baron	0.00	0.00	7.26	1.61	4.03	12.90
Lord, Knight, Sir	0.00	0.81	7.26	0.00	7.26	15.32
Total	0.81	5.64	54.84	13.71	25.00	100.00
						N = 124
17th century:						
King, Prince, Emperor	0.41	0.00	0.82	0.00	0.00	1.23
Duke, Marquess	0.41	1.64	7.38	2.05	1.23	12.70
Earl	1.64	3.28	50.00	3.28	10.24	68.44
Viscount, Baron	0.41	0.82	7.38	1.64	1.64	11.88
Lord, Knight, Sir	0.00	0.00	4.92	0.41	0.41	5.74
Total	2.87	5.74	70.49	7.38	13.52	100.00
						N = 244
18th century:						
King, Prince, Emperor	0.00	0.00	0.76	0.00	0.00	0.76
Duke, Marquess	0.00	4.20	8.01	1.14	0.76	14.12
Earl	0.38	10.30	49.24	5.34	4.58	69.84
Viscount, Baron	0.00	2.29	5.72	1.14	0.38	9.54
Lord, Knight, Sir	0.00	0.38	4.96	0.38	0.00	5.72
Total	0.38	17.17	68.70	8.01	5.72	100.00
						N = 262
19th century:						
King, Prince, Emperor	0.44	0.87	1.31	0.00	0.00	2.62
Duke, Marquess	0.44	4.37	4.80	1.31	0.00	10.92
Earl	0.87	11.79	48.29	6.55	2.18	67.68
Viscount, Baron	0.00	0.87	4.80	1.31	0.44	7.42
Lord, Knight, Sir	0.00	3.06	7.42	0.87	0.00	11.35
Total	1.74	20.96	64.63	10.04	2.62	100.00
						N = 229

Table 6 – Distribution of Marriages by Title in England, 16th - 19th century

Highest groom's title	Highest bride's father's title					
	König, Prinz(essin), Kronprinz(essin), Kaiser, Erzherzog(in), Grossherzog(in), Kurfürst(in)	Herzog, Pfalzgraf, Markgraf, Landgraf, Furst	Graf	Freiherr, Freifrau, Freiin, Altgraf, Burggraf	Edler, Edler Herr, Ritter, Herr, Junker	Total
16th century:						
König, Prinz(essin), Kronprinz(essin), Kaiser, Erzherzog(in), Grossherzog(in), Kurfürst(in)	0.96	1.65	0.14	0.27	0.00	3.03
Herzog, Pfalzgraf, Markgraf, Landgraf, Furst	1.93	13.24	5.79	0.70	0.14	21.79
Graf	0.27	6.48	41.24	7.86	2.76	58.62
Freiherr, Freifrau, Freiin, Altgraf, Burggraf	0.00	0.27	7.86	5.24	0.96	14.34
Edler, Edler Herr, Ritter, Herr, Junker	0.00	0.00	1.75	0.29	0.29	2.33
Total	3.17	21.65	56.69	14.34	4.14	100.00 N = 725
17th century:						
König, Prinz(essin), Kronprinz(essin), Kaiser, Erzherzog(in), Grossherzog(in), Kurfürst(in)	0.31	0.76	0.38	0.15	0.00	1.61
Herzog, Pfalzgraf, Markgraf, Landgraf, Furst	0.61	14.38	7.96	0.84	0.00	23.79
Graf	0.08	6.81	47.74	9.18	0.92	64.73
Freiherr, Freifrau, Freiin, Altgraf, Burggraf	0.00	0.31	3.44	5.89	0.08	9.72
Edler, Edler Herr, Ritter, Herr, Junker	0.00	0.00	0.08	0.00	0.08	0.16
Total	0.99	22.26	59.60	16.07	1.07	100.00 N = 1,307
18th century:						
König, Prinz(essin), Kronprinz(essin), Kaiser, Erzherzog(in), Grossherzog(in), Kurfürst(in)	1.21	3.35	1.29	0.14	0.07	6.07
Herzog, Pfalzgraf, Markgraf, Landgraf, Furst	1.64	10.72	7.72	0.57	0.28	20.94
Graf	0.50	5.79	48.75	7.64	0.57	63.26
Freiherr, Freifrau, Freiin, Altgraf, Burggraf	0.00	0.36	4.07	4.79	0.43	9.65
Edler, Edler Herr, Ritter, Herr, Junker	0.00	0.00	0.07	0.00	0.00	0.07
Total	3.36	20.23	61.90	13.15	1.36	100.00 N = 1,399
19th century:						
König, Prinz(essin), Kronprinz(essin), Kaiser, Erzherzog(in), Grossherzog(in), Kurfürst(in)	3.60	3.69	3.65	0.13	0.04	11.13
Herzog, Pfalzgraf, Markgraf, Landgraf, Furst	2.79	4.91	3.56	0.36	0.09	11.71
Graf	3.19	6.80	48.83	6.04	0.40	65.27
Freiherr, Freifrau, Freiin, Altgraf, Burggraf	0.40	0.67	6.71	3.78	0.18	11.76
Edler, Edler Herr, Ritter, Herr, Junker	0.00	0.00	0.09	0.00	0.04	0.13
Total	10.00	16.08	62.84	10.30	0.76	100.00 N = 2,220

Table 7 – Distribution of Marriages by Title in Germany, 16th - 19th century

C. Appendix: Log-Linear Models of Association Between Husband's and Wife's Tile

|	English		Germans	
Model	df	BIC	df	BIC
(I) HY, WY	30	-78	27	1269
(II) Model I + OY	26	-80	23	185
(III) Model I + MY	16	-53	12	-14
(IV) Model I + CY	12	-34	8	1
(V) Model I + HHY	12	-34	12	-14
(VI) Model I + HWY	20	-64	8	-21

Table 8 – Log-Linear Models

D. Appendix: Robustness Checks

In this Section we estimate several models to show that the results described in the main text are robust to an alternative title ranking and control variable inclusion. In particular, we consider the following models:

(1) Log-linear model (similar to model II in section 4) to estimate odds of homogamy without aggregating titles and including both nobles with the highest titles (category 1 in Table 1) and individuals without titles;

(2) Multinomial logit model to estimate odds of homogamy, and where we control for number of siblings, birth order, country and century fixed effects, and include nobles with the highest titles and individuals without titles;

(3) Logit model to account for the role of birth order, celibacy, number of siblings, and wealth (when available) in the probability of getting married.

D.1. Odds of Homogamy - Log-linear Model

We start by estimating Model II and computing odds of homogamy without aggregating titles, adding two additional categories, i.e. nobles with the highest titles and individuals without titles, and considering time lags of fifty years. Results are in Figure 7.
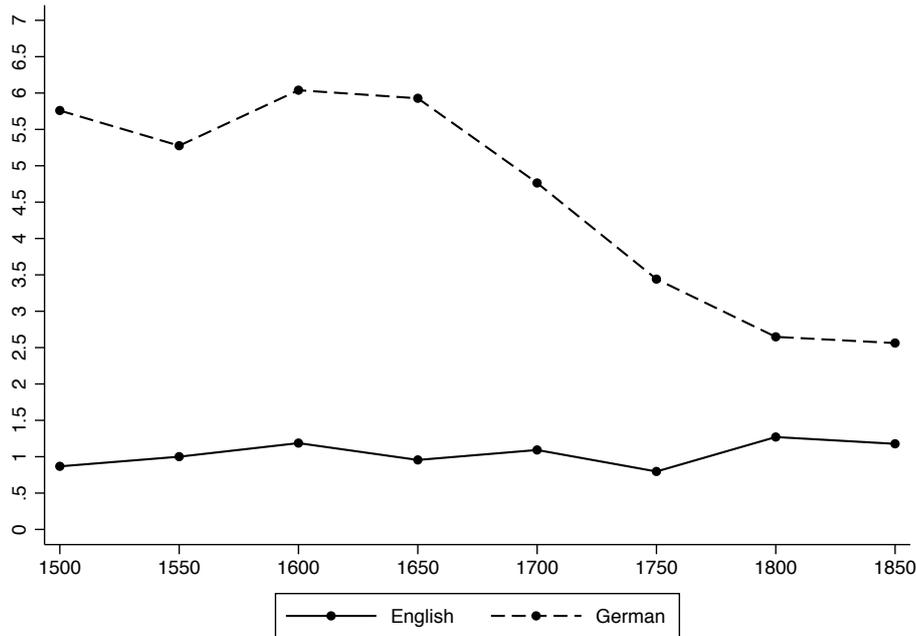
Notes: Odds are graphed at their mid-point. For English nobbles, they are significant at the 5% level in 1650 and 1750, and at the 1% level in all other years. For German nobles, they are all significant at the 1% level.

Figure 7 – Odds of Homogamy, 16th - 19th century

The main difference between Figure 7 and Figure 4 in the main text is in the level of odds and not in their trend. Figure 7 shows that odds are even higher when we do not group titles into five categories, but we consider each title as a separate category. Hence, this result reinforces our main findings in terms of homogamy preferences.

We repeat the exercise for men who do not have title because it is missing or because he did not inherit one. We assign to these individuals their fathers' titles. The results are not statistically significant, and are available upon request.

D.2. Odds of Homogamy - Multinomial Logit Model

In response to concerns about the endogeneity of dowry rules (the amount of dowries may depend on country social norms and preferences), we include country and century fixed effects in a multinomial logit model. We estimate the probability of marrying a spouse in one of the six categories $j = 1,...,6$, i.e. five titles (as in Table 1) and a category including individuals without titles. The model is

$$\text{(D.1)} \qquad p_{ij} = Pr[y_i = j] = \frac{\exp(\alpha_j + \beta_j X_i)}{\sum_{k=1}^{6} \exp(\alpha_k + \beta_k X_k)}, \; j = 1, ..., 6,$$

where X includes number of siblings, order of birth, and country and century fixed effects. The dependent variable y_i is equal to 1 if the individual i (a woman) is married and has title j. We restrict the analysis to English and German individuals. Results are in Table 9 and 10. Each table reports the predicted probability (or margins) of a woman with a title j to marry a man with title $j=1,...,6$, and the corresponding standard errors.

Results are consistent with the estimation in Section 4. In bold are the predicted probabilities of marrying someone who share the same title. Numbers in the main diagonals are always the highest of their corresponding column for both German and For English nobles.

Highest groom's title	Highest bride's father's title					
	King, Prince, Emperor	Duke, Marquess	Earl	Viscount, Baron	Lord, Knight, Sir	No Title
King, Prince, Emperor	**0.117***	0.361***	0.318***	0.020**	0.017*	0.167***
	(0.023)	(0.031)	(0.028)	(0.006)	(0.012)	(0.020)
Duke, Marquess	0.061***	**0.423***	0.381***	0.029***	0.024**	0.082***
	(0.012)	(0.025)	(0.022)	(0.005)	(0.007)	(0.009)
Earl	0.009***	0.076***	**0.679***	0.070***	0.051***	0.116***
	(0.002)	(0.007)	(0.013)	(0.007)	(0.006)	(0.007)
Viscount, Baron	0.005**	0.032***	0.419***	**0.211***	0.065***	0.268***
	(0.02)	(0.006)	(0.021)	(0.020)	(0.013)	(0.018)
Lord, Knight, Sir	0.009	0.052**	0.480***	0.030*	**0.080**	0.347***
	(0.006)	(0.017)	(0.040)	(0.012)	(0.022)	(0.037)
No Title	0.010***	0.034***	0.208***	0.046***	0.061***	**0.642***
	(0.002)	(0.004)	(0.011)	(0.005)	(0.008)	(0.015)
Observations	1,816	1,816	1,816	1,816	1,816	1,816

Notes: Robust standard errors are reported in brackets. *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 9 – Predicted Probability of Marriage, by English Title, 16th - 19th century

Highest groom's title	Highest bride's father's title					
	König, Prinz(essin), Kronprinz(essin), Kaiser, Erzherzog(in), Grossherzog(in), Kurfürst(in)	Herzog, Pfalzgraf, Markgraf, Landgraf, Furst	Graf	Freiherr, Freifrau, Freiin, Altgraf, Burggraf	Edler, Edler Herr, Ritter, Herr, Junker	No Title
König, Prinz(essin), Kronprinz(essin), Kaiser, Erzherzog(in), Grossherzog(in), Kurfürst(in)	**0.161***	0.357***	0.252***	0.026***	0.004	0.200***
	(0.017)	(0.023)	(0.020)	(0.008)	(0.003)	(0.020)
Herzog, Pfalzgraf, Markgraf, Landgraf, Furst	0.088***	**0.443***	0.319***	0.040***	0.006**	0.104***
	(0.008)	(0.015)	(0.013)	(0.006)	(0.002)	(0.009)
Graf	0.014***	0.087***	**0.621***	0.105	0.013***	0.160***
	(0.002)	(0.004)	(0.007)	(0.005)	(0.002)	(0.006)
Freiherr, Freifrau, Freiin, Altgraf, Burggraf	0.007**	0.033***	0.338***	**0.279***	0.015***	0.327***
	(0.002)	(0.005)	(0.015)	(0.014)	(0.003)	(0.015)
Edler, Edler Herr, Ritter, Herr, Junker	0.014	0.056**	0.414***	0.042	**0.020**	0.453***
	(0.010)	(0.018)	(0.040)	(0.017)	(0.006)	(0.041)
No Tile	0.013***	0.032***	0.156***	0.057***	0.013***	**0.729***
	(0.002)	(0.003)	(0.006)	(0.004)	(0.001)	(0.007)
Observations	10,486	10,486	10,486	10,486	10,486	10,486

Notes: Robust standard errors are reported in brackets. *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 10 – Predicted Probability of Marriage, by German Title, 16th - 19th century

D.3. Birth Order

In this Section we compute the probability of marrying an individual with title $j=1,...,6$ by birth order (Figures 8 to 11). This analysis is restricted to English and German women (Figure 8 and 9) and men (Figure 10 and 11). Individuals without a title are included in the sample. The coefficients are from an ordered logit model in which we control for the number of siblings and century fixed effects. Probability is concentrated around 0.1 and 0.3 for German nobility. Moreover, there is no variability across titles. For an English woman, being the third or the fourth oldest sibling provides a higher probability to marry, regardless of husband's title. For English men, the first born child has both the highest probability to marry and a higher probability of marrying a woman carrying a prestigious title (of a category lower than four) than his siblings. In general, birth order is less significant for daughters than for sons, and younger daughters were just as likely as elder daughters to marry into princely families. These results are consistent with the findings of Hollingsworth (1957).
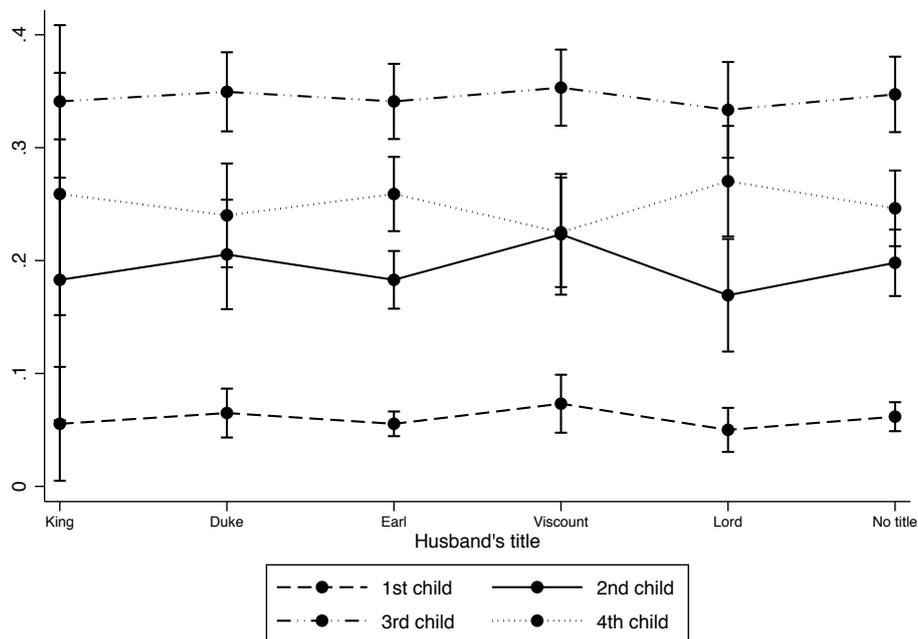

Figure 8 – English Probability of Marriage By Birth Order (Women)
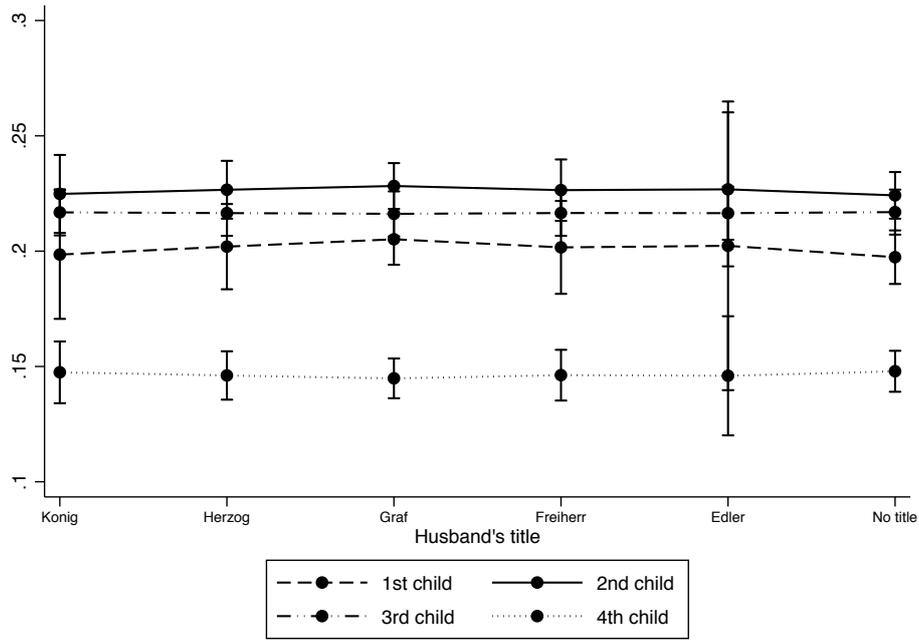
Figure 9 – German Probability of Marriage By Birth Order (Women)
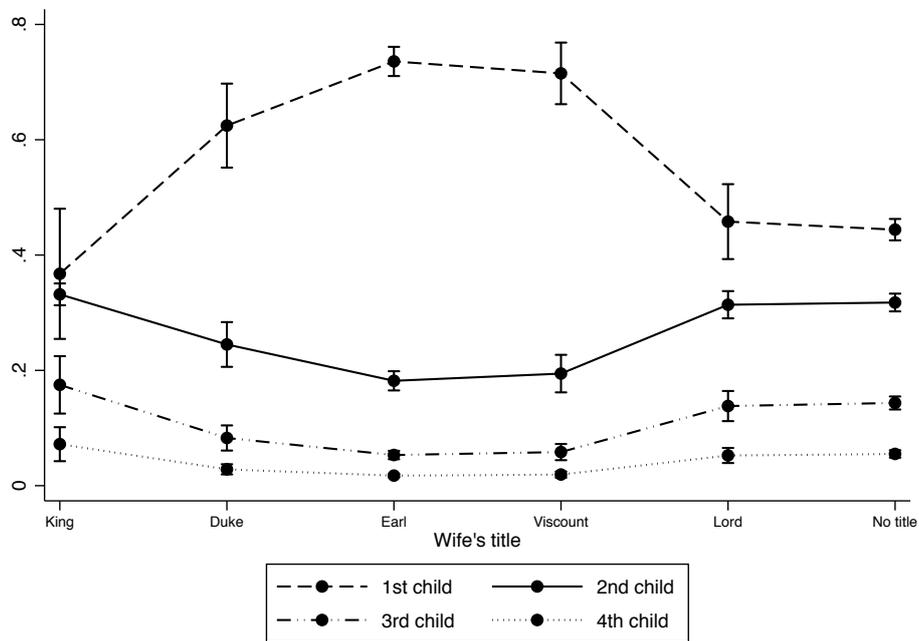

Figure 10 – English Probability of Marriage By Birth Order (Men)
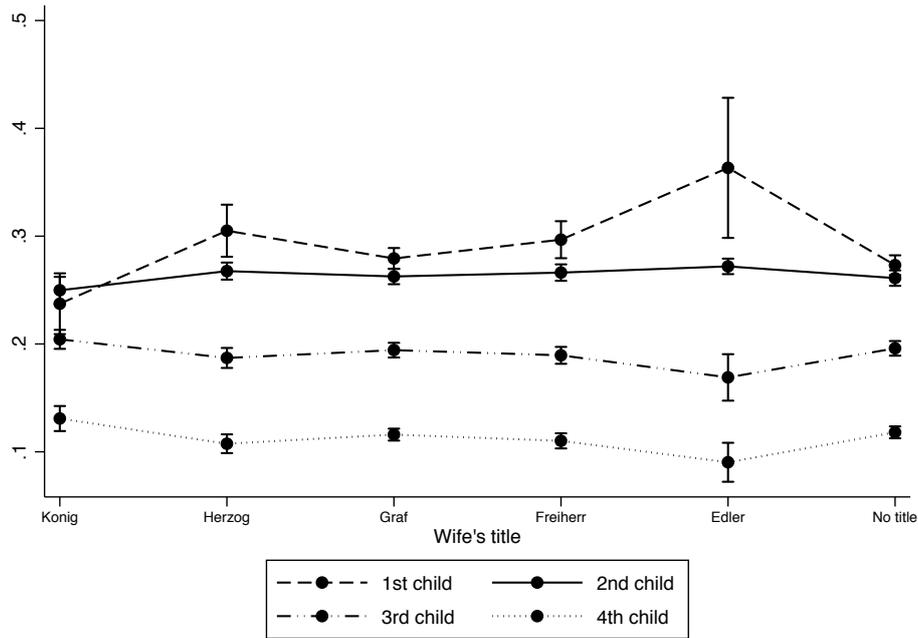
Figure 11 – German Probability of Marriage By Birth Order (Men)

In Table 11, we provide the marginal effects computed from the estimation of five probit models, where the dependent variable is equal to one if the woman is married. Hence, we account for celibacy. In all models we control for number of siblings, birth order, country and century fixed effects, and we allow for marriages across the borders of English and German territories. In models (1) and (2), we only control for century fixed effects for English and German nobles, respectively. In column (1), we can see that the marriage probability remained roughly stable in our sample until the 18th century and declined in the 19th century. This result supports Schutte (2014)'s findings. In general, marriage probability (column 1 and 2) is higher for English nobles than for Germans in all centuries. But the result is reversed once we add control variables (column (3) and (4)). As expected, in column (3), we find that, on average across the two samples, the higher the number of siblings, the lower the chances to get married; and, older daughters were slightly more likely to marry than younger daughters. In column (4) we control for the ratio between men and women in each century. Results are unchanged. In column (5) we add women from other countries: the highest probability of marriage is measured for Spanish and Portuguese nobles. The size of the other margins does not change. Model in column (6) accounts for the available measure of wealth that we recover from Bateman (1883), i.e. average amount of acres associated to English titles, as described in Section

2. Including this control variable has no significant impact on the other coefficients.

	(1) ENGLISH	(2) GERMANS	(3) ENGLISH AND GERMANS	(4) ENGLISH AND GERMANS	(5) ALL	(6) ENGLISH
English			0.266*** (0.002)	0.278*** (0.002)	0.348*** (0.006)	
German			0.343*** (0.006)	0.314*** (0.011)	0.268*** (0.002)	
French					0.228*** (0.008)	
Italian					0.166*** (0.005)	
Spanish					0.463*** (0.010)	
Wealth						0.000 (0.000)
N. of siblings:						
1			0.502*** (0.011)	0.498*** (0.011)	0.510*** (0.009)	0.539*** (0.067)
2			0.329*** (0.008)	0.330*** (0.008)	0.411*** (0.007)	0.423*** (0.050)
3			0.258*** (0.002)	0.263*** (0.002)	0.250*** (0.002)	0.314*** (0.017)
Birth order:						
1st daughter			0.308*** (0.005)	0.309*** (0.005)	0.304*** (0.005)	0.325*** (0.037)
2nd daughter			0.293*** (0.005)	0.296*** (0.005)	0.292*** (0.005)	0.335*** (0.036)
3rd daughter			0.259*** (0.003)	0.267*** (0.003)	0.253*** (0.003)	0.356*** (0.020)
Century:						
16th century	0.841*** (0.012)	0.591*** (0.005)	0.441*** (0.006)	0.329*** (0.008)	0.448*** (0.006)	0.877*** (0.050)
17th century	0.747*** (0.010)	0.456*** (0.004)	0.317*** (0.004)	0.315*** (0.004)	0.316*** (0.007)	0.803*** (0.045)
18th century	0.699*** (0.009)	0.403*** (0.004)	0.253*** (0.004)	0.252*** (0.004)	0.243*** (0.004)	0.606*** (0.041)
19th century	0.520*** (0.006)	0.414*** (0.003)	0.220*** (0.003)	0.265*** (0.004)	0.213*** (0.003)	0.170*** (0.016)
Sex ratio				YES		
Observations	13,150	59,393	46,030	46,030	56,000	807

Notes: Robust standard errors are reported in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 11 – Marginal Effects: Dependent Var. is Marital Status (= 1 if Married)

E. Appendix: Proofs

E.1. Proof of Proposition 1

Define $\hat{\lambda}$ as follow

(E.1) $$\hat{\lambda} = \min\left\{\frac{u_{hh} - u_{hl}}{v_{hl}}, \frac{u_{lh} - u_{ll}}{v_{ll}}, 1\right\},$$

and suppose that $\lambda \leq \hat{\lambda}$. Let us show that there exists a PAM equilibrium in which woman i, $i \in \{l, h\}$, pays dowry $d_i = 0$ to marry man i.

Notice first that woman l cannot outbid woman h. Indeed, in order to attract man h, woman l should pay at least $d_h + u_{hh} - u_{hl} > d_h + \lambda v_{hl} = \lambda v_{hl}$, where the inequality comes from the fact that $\lambda \leq \hat{\lambda}$.

Then, notice that woman h is not willing to outbid woman l. In order to marry man l, woman h has to pay a dowry higher than $d_l - (u_{lh} - u_{ll}) \leq \lambda v_{ll} - (u_{hl} - u_{ll}) \leq 0$, where the second inequality comes from the fact that $\lambda \leq \hat{\lambda}$. Say differently, woman h does not have to "pay" to marry man l: man l would accept any offer from woman h. However, since $v_{hh} - d_h = v_{hh} > v_{lh}$, woman h is better off staying with man h.

To conclude, notice that NAM cannot be an equilibrium if $\lambda \leq \hat{\lambda}$. Indeed, if it were the case, woman h could outbid woman l by offering $d = 0$ to man h and man h would accept this offer.

E.2. Proof of Proposition 2

Let $\lambda \in (0, 1)$ and suppose that PAM is an equilibrium. Let us prove that, for all $\lambda' < \lambda$, PAM is an equilibrium. We can assume w.l.o.g. that λ and λ' are greater than $\hat{\lambda}$, where $\hat{\lambda}$ is defined by equation (E.1) in the proof of Proposition 1.

Let d_h (resp. d_l) the dowries paid by woman h (resp. l) to man h (resp. l) in this equilibrium, i.e. when the degree of transferability is λ. Dowries d_h and d_l must be such that (i) woman l is not willing or cannot outbid woman h for marrying man h; and (ii) woman h is not willing or cannot outbid woman l for marrying man l.

- CONDITION (i) In order to attract man h, woman l must offer a dowry higher than $d_h + u_{hh} - u_{hl}$ (≥ 0). Therefore, woman l cannot outbid woman if

   (E.2) $$\lambda v_{hl} \leq d_h + u_{hh} - u_{hl}.$$

   If she could pay such a dowry, woman l would be better off staying with man l, if:

   (E.3) $$v_{ll} - d_l \geq v_{hl} - (d_h + u_{hh} - u_{hl}).$$

   In equilibrium, inequalities (E.2) or (E.3) must hold. Accordingly, the following condition must hold in equilibrium:

   (E.4) $$d_h \geq \min\{\lambda v_{hl}, d_l + v_{hl} - v_{ll}\} - (u_{hh} - u_{hl}).$$

- CONDITION (ii) Woman h, on the other hand, is always able to outbid woman l: she can offer higher dowries $(\lambda v_{lh} > \lambda v_{ll})$ and man h prefers her to woman l $(u_{lh} > u_{ll})$.

Precisely, the minimum dowry to marry man l is $\max\{0, d_l - (u_{lh} - u_{ll})\}$. Therefore, a necessary condition for PAM to be an equilibrium is that woman h is better for staying with man h:

$$(\text{E.5}) \qquad\qquad d_h \leq v_{hh} - v_{lh} + \max\{0, d_l - (u_{lh} - u_{ll})\}.$$

Let $\mathcal{D}_\lambda = \{(d_l, d_h) \in \mathbb{R}^2 : 0 \leq d_l \leq \lambda v_{ll} \text{ and } 0 \leq d_h \leq \lambda v_{hh}\}$ and $\mathcal{I}_\lambda = \{(d_l, d_h) \in \mathbb{R}^2 : (d_l, d_h) \text{ satisfy conditions (E.4) and (E.5)}\}$. By assumption $\mathcal{I}_\lambda \neq \emptyset$ and $\mathcal{D}_\lambda \cap \mathcal{I} \neq \emptyset$. In particular, when the degree of transferability is λ, PAM can be sustained with minimal dowries $\tilde{d}_l = 0$ and $\tilde{d}_h = \min\{\lambda v_{hl}, v_{hl} - v_{ll}\} - (u_{hh} - u_{hl})$.

Let $\lambda' < \lambda$. Let us prove that PAM is an equilibrium when the degree of transferability is λ'. There are three cases to consider.

- FIRST CASE: $\lambda v_{hl} \leq v_{hl} - v_{ll}$ (λ "small"). Since $\mathcal{I}_\lambda$ is non-empty, $\tilde{d}_h$ satisfies constraint (E.5): $\lambda v_{hl} - (u_{hh} - u_{hl}) \leq v_{hh} - v_{lh}$. It follows that $\lambda' v_{hl} - (u_{hh} - u_{hl}) \leq v_{hh} - v_{lh}$ and, therefore, $(0, \lambda' v_{hl} - (u_{hh} - u_{hl})) \in \mathcal{I}_{\lambda'}$: $\mathcal{I}_{\lambda'}$ is non-empty. Notice that, since $\lambda' \geq \hat{\lambda}$, we have $\lambda' v_{hl} - (u_{hh} - u_{hl}) \geq 0$. Then, since $\lambda' v_{hl} - (u_{hh} - u_{hl}) \leq \lambda' v_{hh}$, dowries $(0, \lambda' v_{hl} - (u_{hh} - u_{hl}))$ also belong to $\mathcal{D}_{\lambda'}$. In the end, $\mathcal{I}_{\lambda'} \neq \emptyset$ and $\mathcal{D}_{\lambda'} \cap \mathcal{I}_{\lambda'} \neq \emptyset$: PAM is an equilibrium when the degree of transferability is λ'.

- SECOND CASE: $\lambda v_{hl} > v_{hl} - v_{ll}$ and $\lambda' v_{hl} \leq v_{hl} - v_{ll}$ (λ and λ' "high"). Then $\mathcal{I}_\lambda = \mathcal{I}_{\lambda'}$. Since, by assumption $\lambda' v_{hl} > v_{hl} - v_{ll}$, we have in particular $\lambda' v_{hh} > v_{hl} - v_{ll} - (u_{hh} - u_{hl})$. Therefore, dowries $(0, v_{hl} - v_{ll} - (u_{hh} - u_{hl})) \subset \mathcal{D}_{\lambda'}$ and $\mathcal{D}_{\lambda'} \cap \mathcal{I}_{\lambda'} \neq \emptyset$: PAM is an equilibrium when the degree of transferability is λ'

- THIRD CASE: $\lambda v_{hl} > v_{hl} - v_{ll}$ and $\lambda' v_{hl} < v_{hl} - v_{ll}$ (λ "high" and λ' "small"). Since $\lambda' v_{hl} < v_{hl} - v_{ll}$, we also have $\lambda' v_{hl} - (u_{hh} - u_{hl}) < v_{hl} - v_{ll} - (u_{hh} - u_{hl}) \leq v_{hh} - v_{lh}$, where the last inequality comes from the fact that $\mathcal{I}_\lambda$ is non-empty. Therefore, in particular, dowries $(0, \lambda' v_{hl} - (u_{hh} - u_{hl}))$ satisfy inequalities (E.4) and (E.5): $\mathcal{I}_{\lambda'}$ is non-empty. Then, since $\lambda' v_{hl} - (u_{hh} - u_{hl}) \leq \lambda' v_{hh}$, dowries $(0, \lambda' v_{hl} - (u_{hh} - u_{hl})) \subset \mathcal{D}_{\lambda'} \cap \mathcal{I}_{\lambda'}$: PAM is an equilibrium when the degree of transferability is λ'.