The social marriage network of Europe's ruling families from 1600-1900

0. Introduction

In this project the social marriage behaviour of the Europe's ruling families from 17th to 19th century is examined and compared.

1. Reason for the choice of topic

Up to the late 17th century, there was little interest in demography. In assessing some belatedly discovered data of earlier centuries, one must not expect results similar to Villani's discovery of the sex ratio at birth (at baptism), or Graunt's and Halley's achievements[1]. Even official demographic data of the 18th century show at times a staggering lack of reliability and of respect for truth – in spite of the already awakened interest in demography of pioneers like Süßmilch[2] who help to gain insight into the problems of their time.

Historical demography is a young branch of academic research, dating from the 1950s when Louis Henry began to apply a new technique to nominative records of the pre-statistic period.

Until now there are no trustworthy and complete demographic data available on the general European population of 1600 up to the establishment of the most nation states in the 19th century. As a result reliable statements on the period before founding of national statistical offices are not possible; although for many sciences for example the question of life expectancy at this time would be regarded as very important. Different demographic scientists (e. g. Knodel, Imhof[3]) with village genealogies ("Ortssippenbücher") and church books as a data source offer only vague and incomplete information. Their territory of investigation is also spatially limited to the local area.

The applied method of family reconstitution has also many shortcomings; it is well adapted to the study of fertility, but less suitable for that of mortality. It is difficult to reconstruct the mortality of individuals at adult ages. Turnover rates in pre-industrial Europe were higher than those of non-European populations[4]. Another problem is that of "stayers" and "leavers". All the demographic measures relate only to the population of "stayers" and the effects are most serious in the study of nuptiality[5].

Likewise the monastery diaries examined by different historians and demographers offer only small statements about mortality too, since registration began naturally only with entrance a monastery.

The most comprehensive region investigated is England but with the use of family reconstruction data of 26 parish registers with their inherent shortcomings[6].

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[1] Villani, Graunt (1665), Halley (1693)
[2] Süßmilch (1761)
[3] Knodel (1968), Imhof (1990)
[4] Laslett (1977), pp. 50-101.
[5] Rugges (1992), pp. 507-522.
[6] Wrigley / Davies / Oeppen / Schofield (1997)

On the other hand reliable and most complete information is available about the Europe's ruling families. In addition the available number of cases (about 12,000) is significant enough to make demographic statements and to reveal demographic patterns. As data source the "Stammtafeln zur Geschichte der Europäischen Staaten"[7] ("Isenburg genealogical tables") are accepted as most trustworthy.

For the first time with this project it is possible to analyse historical demographics of a small but widespread European population strata. This people with their social similarities dominated the political, social, economic and cultural development in the regions and also seem to anticipate the demographic behaviour of the common population.

In the 1930s the physician Sigismund Peller undertook demographic investigations with the help of the first volume of the "Isenburg's genealogical tables" (The German high nobility) and gained international attention[8].

The ruling families and other elites may not be regarded as representative for the European total population; however, their demographic parameters are accurately measurable and represent at least a limit for example for the maximum life expectancy in 17th to 19th century. The investigation begins on 1/1/1600, since the dates of the individuals before the introduction of the Gregorian calendar are not accurately defined.

2. Historical context

The early modern times inherited from the Middle Ages a fully developed nobility world. The European nobility was European by its structures and interweaving. Structurally the European nobility disintegrated into high nobility and low nobility since the Middle Ages. Since then there was build a title hierarchy which spread over the whole continent, even to Northern Europe and East Europe with delay: Dukes, mark counts, counts, barons etc. Only in Poland the juridical equality in the nobility were preserved.

However, partial regardless of the rank question the nobility distinguished itself by a high degree of geographic mobility. Because nobility had admission with nobility, varied contacts could lead to marriages. The members of the high nobility looked for their marriage partners with pleasure beyond own region or own country, because they paid attention to equality. Thus a European-wide net originated in marriage connections which thinned out only in the 19th century.

The European nobility lets itself describe as a "noble élite" with varied functions, as a hierarchic social and political group with special codes of honour, behaviour patterns, (education) ideals, informal norms, relative wealth and social standing expenditure.

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[7] Isenburg (1980)

3. Data sources

3.1 Isenburg stem tables

In 1935, Wilhelm Karl Prinz von Isenburg published the first volume of „Europäische Stammtafeln“ titled „Die deutschen Staaten“ (the German states). One year later, a second volume: “Die außerdeutschen Staaten” (the non-German states) followed. Encouraged by the enormous interest in this work, clearly presented in genealogical trees, Frank Baron Freytag von Loringhoven put together two more volumes on the families of the German and Austro-Hungarian high nobility in 1955 and 1957. In 1977, two further volumes were found in his estate: A revised volume I and a new volume V, continuing in form and content volumes III and IV. At the request of J. A. Stargardt publ., Detlev Schwennicke edited these posthumous volumes in 1978 and 1980.

Down to the present day there were published 26 volumes with genealogies of nobility and rich merchant families of Europe.

The main advantage of these data is their high accuracy, reliability and completeness. Another advantage of this kind of data is the relative homogeneity of this Caucasian population regarding social class and educational background. Since this privileged social group lived in favourable conditions for many centuries, one could expect less influence of adverse social factors (poverty, for example) on life span and hence lower bias caused by these factors. This kind of data allows minimizing the social heterogeneity of the population under study. Thus, although the sample analyzed in this study does not represent the whole human population, it is one of the best possible samples to test demographic hypotheses since the effects of population heterogeneity are minimized with regard to social status.

Practically all European imperious families were related with each other and are therefore part of the dataset. Though in the Isenburg stem tables recordings are already given from the 8th century for the ruling families, the data are recognizably incomplete before the 17th century and are not numerous enough. Especially the documentation of the stillbirths is incomplete. Besides, just the disunity of the German states in consequence of the Thirty Years War created many independent ruling houses at the beginning of the 17th century.

The distinction between ruling families and the rest of the nobility was realized for Germany by three citeria:

- immediate status (Reichsunmittelbarkeit),
- sovereignty over a territory (Landeshoheit),
- seat and vote at the Diet (Reichsstandschaft).

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[8] Peller (1965)

3.2 Gotha Almanac

The "Gothaisches Genealogisches Taschenbuch des Adels" (Gotha Almanac) is the most comprehensive collection of genealogic information about nobility in German language. It was published from 1765 to 1942 and contains much personal information. The completeness in birth and death dates reporting in the Gotha Almanac is very high: dates of all vital events were reported for nearly 95% of all persons. Such high completeness is not common for many other genealogical data sources. For example, for British Peerage data published in Burke almanac in most cases there are no birth dates for women, which makes the calculation of their life span impossible. In fact, this problem (with British aristocratic women) was first noticed a century ago by Pearson[9]. He used the British Peerage data to study the longevity inheritance and had to exclude women from his consideration for the following reason: "The limitation to the male line was enforced upon us partly by the practice of tracing pedigrees only through the male line, partly by the habitual reticence as to the age of women, even at death, observed by the compilers of peerages and family histories"[10].

The accuracy of data published in the Gotha Almanac is also very high: the frequency of inconsistent records is less than 1 per 1000 records while for many other genealogical data sources it falls within 1 per 300-400 records.

As for representativeness, the comparison of the data with Hollingsworth's analysis of British peerage[11] revealed good agreement between his findings and the data on mortality patterns, including male-female gap in life expectancy (7-10 years of female advantage in lifespan).

Another important advantage of this dataset is that the data are not spoiled by selective emigration (common problem for local registers), because every person is traced until his/her death in this dataset.

3.3 Disadvantages of parish registers

To get demographical information one can transcribe the registers of christenings, marriages and burials of the parish church so they can be restructured into family order in a database. This is then correlated with other archival records such as tax, land and testamentary documents, and published as a biographical index. When such a study is done scientifically as a precursor to academic analysis, it is known as family reconstitution. But there are some problems.

The cause of the absence of ages at death is always that no entry in the burial register can be positively identified as referring to the person in question. Now if a man was buried on a certain day according to a parish register, it may be impossible to know whether it was a father or his son, and neither can be credited with the burial. But this ensures also that neither will ever be given an age at death, although at least one of them died in the parish. The same difficulty can easily arise with first cousins, who will

[9] Beeton and Pearson (1899, 1901)
[10] Beeton and Pearson (1901), pp. 50-51.
[11] Hollingsworth (1962)

usually be about the same age, moreover. A second snag is that migration from the parish will not occur uniformly over a lifetime. Modern research on migration has shown that a man (or woman) is more likely to emigrate at the age of about, 25 than at any other time in his life, the frequency falling steadily until the age of about 55, after which it stays roughly constant at a level of perhaps one-third of its peak.

3.4 Advantages of genealogical records

For the analysis of demographic trends since the early years of the modern era, a unique source is found in the genealogical records of the high nobility. For the Middle Ages and even for the sixteenth century this source is also often unreliable; for many members of these families, especially the females, there are no data on birth, on the age at death, or on the age at marriage. For some who 'died young', sex is not recorded – indicating miscarriages or stillbirths. Most probably even in the late sixteenth century the Family Bibles failed to list some babies who had died at the threshold of life. Genealogies of the European ruling families were worked out in part by Westergaard and by Prinzing[12]. This investigation is based mainly on Isenburg's genealogical tables.

4. Methods

All birth cohorts of the Europe's ruling families from 17th to 19th century are complete, and available, without censoring problems. Therefore it is possible to make a real profile analysis by the production of cohort life tables. In order to obtain significant statements a range of 50 years for a birth cohort is practicable. Cohort analyses are possible both between the six resulting birth cohorts and within a cohort. One should speak primarily of cohort analysis if an inter cohort study is made. With that, the life courses of members of at least two cohorts are compared. Cohort effects (systematic differences between cohorts) can be measured only by a cohort comparison.

Studies, which regard only one defined cohort in the profile, represent intra cohort studies. They permit the investigation of aging and life processes itself, since cohort specific influences are kept constant.

Naturally all data can also be interpreted as event data (e. g. time span from birth to death, period between birth and marriage, length of time from marriage to birth of the first child, duration from marriage to death...). Event history analysis is used increasingly for the analysis of process data in the sociology, economics and also in the political sciences. The censoring problem typical for event data doesn't appear using nobility data.

In addition heterogeneity investigations can easily be made concerning changes in the average ages of death between the cohorts.

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[12] Westergaard (1882), Prinzing (1930)

4.1 Table analysis

In mortality, a life table is sufficient to summarize all the data. Survival rates and the expectation of life at various ages may then be calculated. The two sexes, various countries, other variables like 'religion' can be profitably compared, and the role of violent death in total mortality can be appreciated.

The life table is one of the most important research tools used in demography. In its classical form, it is a table that displays various pieces of information about the dying out of a birth cohort. One column of a classical life table is invariably "age". The remaining columns tabulate age-related functions pertaining to mortality, such as the number of survivors to various ages, deaths in particular age intervals, age-specific death rates, probabilities of death in various age intervals, and so on. The life table is only one way of summarizing a cohort's mortality experience; other ways, for example, are in graphical form or in the form of a mathematical function. The extended double decrement tables and increment decrement tables make it possible to analyze the marriage and family status behaviour.

4.2 Event history analysis

Event history models are quite useful to account for the time dependency and for the fact of censoring in the data. Also, recently produced Software ("SPSS ver. 17") makes it possible to account for unobserved heterogeneity and it allows multilevel modelling in event history models. Heterogeneity with respect to individual fecundability is one of the major problems in research focused on the correlates of reproductive behaviour in traditional or historical populations with natural fertility levels. The issue of heterogeneity basically refers to underlying differences between women in the levels of their fecundability. Some women are more fertile due to their better health status or genetic endowment. Therefore heterogeneity might obscure true relationships between studied variables and cause severe difficulties in isolating proper causal relationships.

4.3 Social network analysis

The science of social networks was initiated by sociologists more than a century ago, and has grown to be a central field of sociological study over the past 50 years.[13] Over that same period, a mathematical literature on the structure of random graphs moved steadily along.[14] While economists have occasionally showed interest in networks, an explosion of studies of networks using game-theoretic modelling techniques and with economic perspectives has occurred over the last decade.[15] An example

[13] Freeman (2004)
[14] Bollobás (2001)
[15] Dutta and Jackson (2003)

is the network analysed by Padgett and Ansell[16] on marriages between the key families in Florence in the 1430s. During this period the Medici rose in power and largely consolidated control of the business and politics of Florence. Previously Florence had been ruled by an oligarchy of elite families.
A key to understanding this can be seen in the network structure. To the extent that marriage relationships were keys to communicating information, business deals, and reaching political decisions, the Medici were much better positioned than other families, at least according to some measures of betweeness or centrality. Medician political control was produced by network disjunctures within the elite, which the Medici alone spanned.

5. Utilization

The demographic behaviour of the high nobility is thus of interest in itself and may also give advance clues to the later behaviour of other social strata – of the middle classes and of the population at large. This can in fact be seen in respect, for example, of nuptiality and mortality. What John Hajnal has referred to as the 'European pattern' of marriage with a high age at marriage and a substantial fraction of people remaining unmarried – thus already acting as an important control of population growth – clearly emerges fairly early among the high nobility and is well established in the cohorts born in the late 17th century. There are subsequently no signs of major changes until the very recent reverse trend to lower age at marriage and higher proportions married, which the high nobility shares with the general population. As regards mortality, too, the high nobility displayed the beginnings of a persistent fall among the cohorts born in the late 17th century – the elimination of bubonic plague appears to have marked a turning point in time. The group born in the mid-eighteenth century achieved an expectation of life equal to that of the general population born about a hundred years later.
The course of fertility is no less interesting. There is, for example, a strong suggestion that fertility fell among the cohorts born in the late seventeenth century and rose again among those born in the mid-eighteenth century. In addition, the beginnings of the systematic, long-term reduction are to be found in the cohorts born in the early 19th century – much earlier than among the population at large. Advance developments of this kind present questions which demand further investigation, but it is investigation which (unlike that involved in some of the earlier controversies on eighteenth century population growth) starts from fairly firm data and which may help to see how far and why significant changes in demographic behaviour took place before the occurrence of major industrialization and without the assistance of medical progress.
Secondly, it can not entirely deny the possibility of comparing the elite data with other materials. There is, for example, a very clear interest in seeing whether groups of elites in European countries

[16] Padgett and Ansell (1993)

behaved in this manner. Comparisons with middle-class groups and with more general populations will become practicable as research into the demographic history of Europe yields new analyses.

An enhancement with qualitative information sketches the purely demographic possibilities of the material; hereditary influences might also be sought. Most of the members were related, and in some instances descents can be completely traced for several generations. A hereditary resistance to death or a hereditary tendency to high fertility might be found and measured statistically, correcting for any general changes in mortality and fertility owing to changing conditions. The effects of inbreeding could be studied wherever it had occurred.

Probably the most important application, however, would be the study of a population throughout the transition from high to low levels mortality. This is a change which has already occurred in many nations, and may eventually happen to the whole human race, but demographic data are always scarce for the earlier stages of the process. Usually those stages occurred either so long ago that any records are now lost, or they were quite recent, but the society did not keep effective records. A full account of how the changes occurred might be very valuable in considering the likely prospects for the less developed parts of the world.

6. Current state

Primarily the "Isenburg stem tables", 2nd corrected edition of 1956, were taken for the collection of the demographic data about Europe's ruling families. In order to determine the religious orientation and to correct plausibility errors, the "Gotha Almanac" and the "Staatskalender" were consulted.

12,657 cases of the Europe's ruling families were recorded starting from the date of birth 1/1/1600 with the help of the statistical program package "SPSS". Exact and reliable information about birth, marriage, legitimate fertility, mortality and religious orientation is thereby open to investigation. A complete analysis of the demographic life courses of Europe's ruling families was possible for 17th to 19th century. The next step is to expand the investigation from the life course level to the level of dynamic social network analysis of the marriages.

7. First results

7. 1 Infant mortality

In the 17th century the infant mortality of Europe's ruling families was much higher than the mortality of the middle-class and rural population. In the 18th century the values for ${}_1q_0$ from 160 to 170 (per 1,000) were statistically significantly lower than the preceding century. However, they were still far unfavorable as those values which are published, for example, by Imhof[17] in his historical live tables

[17] Imhof (1990)

for different German regions. For the 17th century Imhof for Germany or Wrigley[18] for England determined partially values of only 70 per 1,000 (living) born for the general population.

Europe's ruling families started relatively early, much earlier than the population of Europe, a strong decline in infant mortality. For the whole 19th century the infant mortality of Europe's ruling families was only 72.7 per 1,000 living-born. From the middle of the 19th century, where exact data also for the general population of different European states are available, is a very big difference recognizable. Between 1850 and 1899 another 53.8 died per 1,000 living-born in the first year. Also the dead born frequency sank in the second half of the 19th century to 9.9 per 1,000 born.

7.2 Fertility

With the comparison of observed age specific marriage fertility rates of the cohorts 1 to 3 (17th to 19th century) to the „natural fertility" appear high rates which do not reach, however, the „natural level". And in the course of centuries the rates decrease:

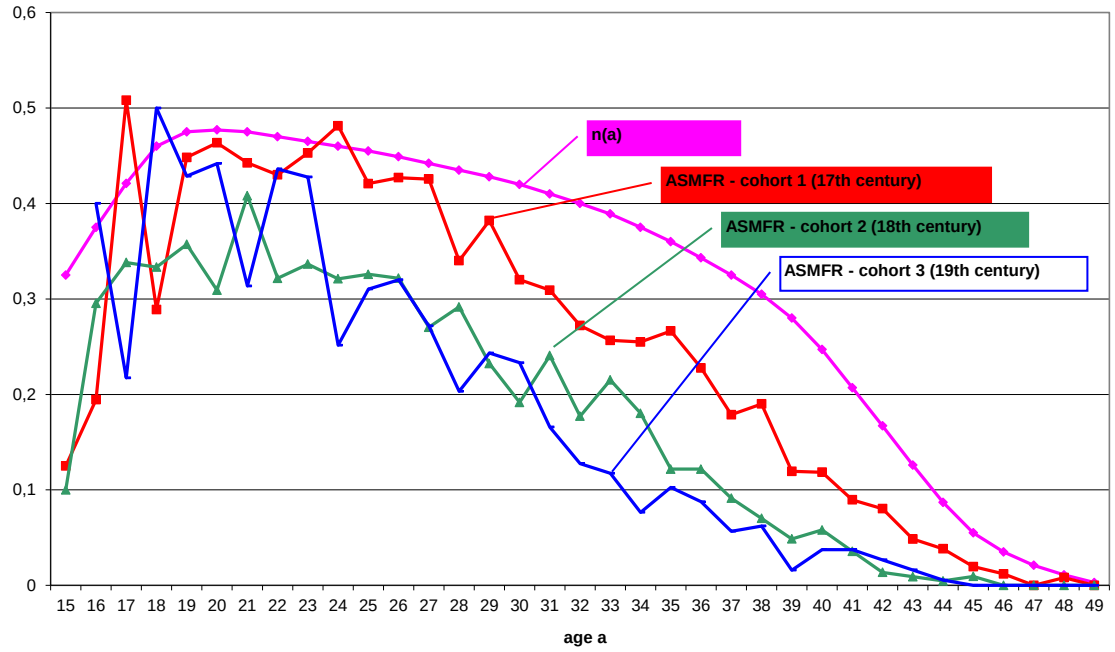

Figure 1: Age-specific marriage fertility rate (ASMFR) and natural fertility n(a)

The thesis that Europe's ruling families have a fertility behaviour according to the "natural fertility" since the 17th century should be rejected. It is more probable that also this population group had "target fertility" up to the desired number of potential successors. In the course of the centuries due to the decreasing infant and child number of deaths this goal could be achieved with ever fewer births. For the ruling families extinction was a threat, vice versa, child wealth was not problem-free. The danger

[18] Wrigley (1972)

that their family went down did not threaten a child-rich family, but the adequate supply of numerous children always burdened the budget to a great extent.

7.3 Marriage behaviour

Marriage data are dependent in least from biological, but strongest from social factors. The organisation form of the family finds her precipitation in the marriage behavior and trends of change deliver hints to changed structures of the nobility family.

By marriage a sort of competence in the reproduction was given. There were no illegitimate children between the partners of the ruling families. The marriage was most important fertility regulator in a society which didn't know or practiced a deliberate birth control.

cohort	*male*	*female*
1600-1699	*28,02*	*23,19*
1700-1799	*28,71*	*21,53*
1800-1899	*29,64*	*22,89*

Table 1: Average age at first marriage

	cohort, male			*cohort, female*		
age	*1600-1699, m*	*1700-1799, m*	*1800-1899, m*	*1600-1700, f*	*1700-1800, f*	*1800-1899, f*
15	0,1	0,5		2,1	2,4	0,5
20	7,3	9,9	1,7	23,5	33,5	24,4
25	26,5	30,6	22,9	47,9	60,0	60,8
30	47,5	49,3	52,0	61,6	72,6	74,0
40	70,4	69,2	75,2	71,0	82,9	83,2
50	75,7	79,6	82,6	75,1	86,8	87,7

Table 2: Proportion of married men and women by age

The tables show a high average age at first marriage and a significant proportion of persons who never get married. This corresponds approximately to the "European Marriage Pattern" of the common population.

8. Further steps

8.1 Social network analysis

The random-graph-based literature builds networks either through a purely stochastic process where links appear at random according to some distribution, or else through some algorithm for building links. This allows show how observed networks at some given point in time might have resulted from some stochastic or mechanical process. These sorts of models essentially match observed characteristics back to specific processes.

The economic approach, in contrast, has tended to focus on equilibrium networks, where links are formed at the discretion of self-interested agents who are or control the nodes. A big advantage of this approach is that it naturally incorporates the costs and benefits into the analysis. This enables to

answer questions relating to the right networks form, in the sense of maximizing the total benefit. Such models also give insight into the why behind network formation, as they trace network form to the incentives of the agents and the costs and benefits of different links. The main shortcoming of these models is that while they can analyse tensions between incentives and efficiency, but they generally stop short of giving predictions concerning things like which degree distribution should emerge.

These two approaches are very complementary. This suggests that some combination of the two approaches might be very fruitful. Incorporating some random elements in terms of which links might be considered at a given time, and then some explicit payoffs and insight into why that link might or might not be added, should end up producing important new insights into the types of networks that we should expect to emerge in different settings, and the how and why behind them.

8.2 Marriage and birth decline as contagious disease

There are also studies of the physical spread or transmission of infections and behaviour that are transmitted directly or by chance, and not through some updating or optimization procedures. Examples include the spread of diseases, computer viruses, and also the spread of some types of behaviour and information. Standard models of such spreading come from the epidemiology literature, which has focused on the spread of contagious disease.

The change in infection rate due to a change in network structure comes from countervailing sources, as more extreme distributions have relatively more very high degree nodes and very low degree nodes. Very high degree nodes have high infection rates and serve as conduits for infection, thus putting upward pressure on average infection. Very low degree nodes have fewer neighbors to become infected by and thus tend to have lower infection rates than other nodes. The overall impact depends on how the increase in infection in changing some nodes to have higher degree compared to the decrease in infection due to changing some nodes to have lower degree.

Beyond the understanding of infection rates, the statistical characteristics of networks can be used to deduce the impact that they have on behaviour more generally[19], for example to explain a changing marriage and fertility behaviour.

8.3 Recent network research

There are also recent studies of play in games with complementarities in neighbors' actions, such as in the context of coordination games[20] as well as other structures with complementarities[21]. These studies have looked at both the change in play and co-evolution of the network itself. However, most of the

[19] cf. Galeotti, Goyal, Jackson, Vega and Yariv (2005)
[20] cf. Ellison (1993), Young (1998), Morris (2000), Jackson and Watts (2002)
[21] cf. Galeotti and Vega-Redondo (2005)

work has focused on very simple games, and there is much that is unknown beyond these special cases.

8.4 Used method in this project

In this project all data are interpreted as event data (e. g. time span from birth to death, period between birth and marriage, length of time from marriage to birth of the first child, duration from marriage to death...). This principle is be used to build a dynamical network of the marriage relationships of Europe's ruling families with births to enlarge and deaths to reduce the network size, because the families form a closed society. The examination of the marriage risks in this network and its dynamics with methods of event history analysis will reveal the rise of the Habsburg family as a clever marriage policy and also the reason for the role of the high nobility as "demographic forerunner" with an early fertility decline.

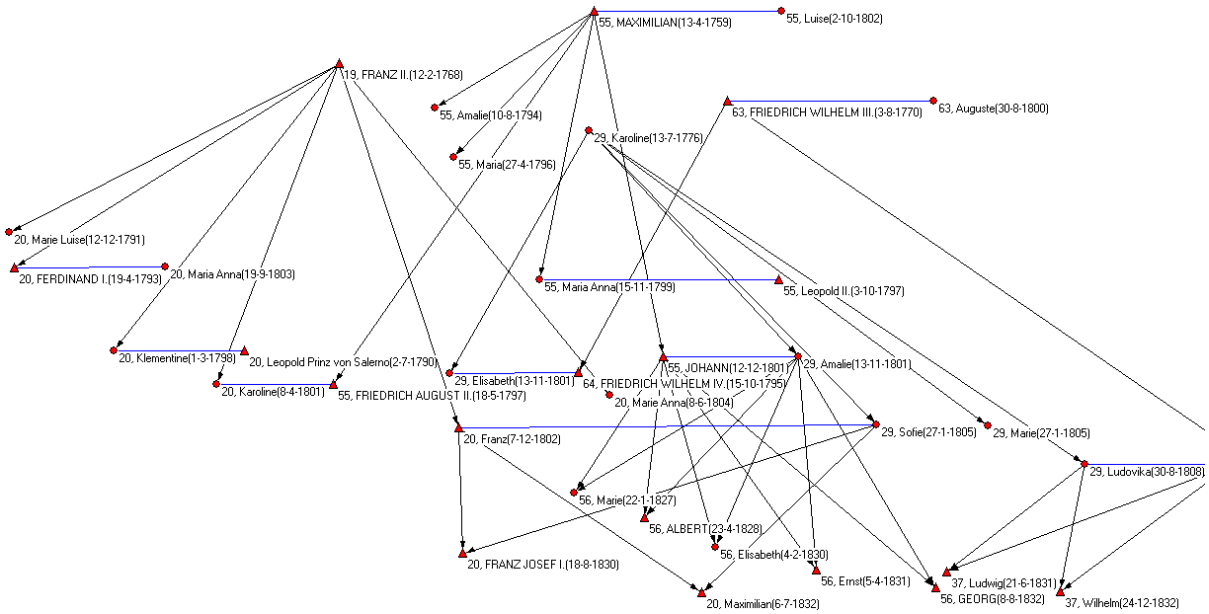

Figure 2: The kinship and marriage network of Europe's ruling families, 1832 (example of some relationships): 19+20 – Austria, 29+37 – Bavaria, 55+56 – Saxonia, 63 – Prussia

All demographic and kinship data were transformed into network data to build up the entire network with "Pajek". With that program package it is possible to generate time frames year by year with relevant relationships from 1600 to 1900. The next step will to evaluate the persons in the network to calculate their marriage risk at any time. Over time can be identified from whom the marriage chances were used. Moreover, the marriage strategies of the families become visible.

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