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Love and money with inheritance: marital sorting by labor income and inherited wealth in the modern partnership

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Non-technical summary

Research Question

Homogamy, the tendency of people to marry similar people, in education or income can result from an implicit trade-off between *love* and *money*. Inherited wealth is an additional dimension which may matter for marital sorting and furthermore impact the dynamics of wealth inequality. The present study sheds light on this issue by investigating the concentration and substitutability of labor income and inheritance underpinning marital patterns in Germany.

Contribution

We identify whether an inheritance was received from the parents of the husband or the wife, using the *Panel on Household Finances* (PHF). We also find the joint distributions of labor income and inherited wealth in marital sorting. Since future labor income is relatively uncertain, parental wealth (inheritance) however is observable, we develop a model based on segregation and asymmetric information. This model successfully reproduces the sorting structures in the data using marginal distributions of these two dimensions from either gender.

Results

The empirical evidence suggests that inheritance is a crucial dimension for modern partnerships. Our distributional results are quantitatively similar to those observed in France. The estimation implies that inheritance plays a significant role beyond income in the implicit payoff of marriage. Future research exploring the potential impact of rising inheritance flows on the dynamics of wealth inequality would thus gain by taking into consideration the consequences of homogamy.

Nichttechnische Zusammenfassung

Fragestellung

Homogamie von Ehepartnern bezüglich ihres Bildungsniveaus oder Eikommens, also die Tendenz, einen ähnlichen Menschen zu heiraten, kann aus einer impliziten Abwägung zwischen *Liebe* und *Geld* folgen. Ererbtes Vermögen ist eine zusätzliche Dimension, die bei der Partnerwahl eine Rolle spielen könnte, und die eine Auswirkung auf die Dynamik der Vermögensungleicheit haben könnte. Diese Studie beleuchtet dieses Thema, indem sie die Konzentration und Substituierbarkeit von Arbeitseinkommen und Erbe analysiert, die die Partnerwahl in Deutschland untermauern.

Beitrag

Bei Haushalten, die eine Erbschaft erhalten haben, wird mittels des *Panel on Household Finances* (PHF) identifiziert, ob der Ehemann oder die Ehefrau diese erhalten haben. Des Weiteren analysieren wir die gemeinsame Verteilung des Arbeitseinkommens und des ererbten Vermögens. Da zukünftige Arbeitseinkommen unsicher als (zu erwartetende) Erbschaften sind, entwickeln wir ein auf Segregation und asymmetrische Information basiertes Modell. Mit Hilfe der Randverteilungen dieser beiden Eigenschaften für jedes Geschlecht reproduziert das Modell erfolgreich die empirisch beobachtete Sortierungsstruktur.

Ergebnisse

Die empirischen Befunde weisen darauf hin, dass Erbe eine bedeutende Dimension für die moderne Partnerwahl ist. Unsere Verteilungsergebnisse sind quantitativ ähnlich denen, die in Frankreich festgestellt worden sind. Die Ergebnisse bedeuten, dass Erbe eine wichtige, über das Einkommen hinausgehende, Rolle bei der impliziten Auszahlung der Ehe spielt. Da in den nächsten Jahren mit einem Anstieg an Erbschaften gerechnet wird, würde die Forschung zu den Implikationen für die Dynamik der Vermögensungleicheit von einer Berücksichtigung der Konsequenzen der Homogamie profitieren.

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Abstract

As the importance of capital is resurging in rich countries, the dynamics of wealth inequality are being increasingly affected by inheritance distribution. The relative attraction derived from inherited wealth and acquired human capital in marital choices may be undergoing change. We expand the traditional dimension of assortative mating through labor income only, covering both labor income and inheritance. This paper studies the concentration and substitutability of these two traits in forming partnerships using data for Germany from the Panel on Household Finances (PHF). Relative to France, Germany's aristocratic wealth has experienced more negative shocks since WWII, social stratification is perceived as less acute, and half of the country went through decades of communism. However, our results come quantitatively close to the distributional outcomes seen in France. By assuming a sequential revelation of inheritance and labor income in marital sorting, we develop a stylized multidimensional matching model which adequately replicates the sorting pattern observed using marginal distributions of these two traits from either gender. Our estimate suggests inheritance is about two and a half times more important than labor income in explaining marriage choice. This quantitative result seems to characterize the expected lifetime inheritance and labor income after marriage for Germany under the actual rate of return, growth rate, demographics as well as rapid expansion of bequest flows in recent history.

Keywords: Assortative mating, Inheritance, Labor income, Multidimensional matching

JEL classification: D31, J12, D64, D83.

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1 Introduction

"*I love her: but it crowns my happiness and pride to think that when she becomes mine, our firm will at the same time gain a very considerable increase of capital.*"[1] With these words, Thomas Buddenbrook expresses his view of his upcoming marriage to his fiancée Gerda Arnoldsen in Thomas Mann's family saga and monumental opus of German literature *Buddenbrooks* (1901), whose father's wealth without any doubt reinforces his love for her. Driven by both historical and contemporary motivations, this paper analyzes the bi-dimensional matching pattern – acquired human capital and inheritance – in the most fundamental social relationship: marriage.[2] The importance of inherited wealth for matrimonial strategies in 19th-century Europe and even earlier stages of human history, as revealed in novels or in real-life high society, symptomized the rigid social structure of the "patrimonial capitalism" that prevailed at the time.[3]

The last decades have seen a resurgence of wealth inequality which may lead to a renewed importance of inherited wealth for mating choices.[4] On the other hand, inheritance type can be a strong proxy for "social classes" as well as a signal of specific tastes which can contrast with or enhance those associated with labor income – proxy of acquired human capital. Selection of children's preferences and values by parents, as claimed by Doepke and Zilibotti (2008), can be endogenous in the occupation choices which then define "social classes". These attitudes to work and leisure are rather critical predictors of career success.[5] Likewise, the mating process largely involves the matching of attitudes and values. There can be an interaction of this two-dimensional selection of preferences since there are different roles they play in determining well-being, e.g. family wealth.

Frémeaux (2014) provides impressive evidence on these issues for the French case, showing that marital sorting by inherited wealth has regained in importance: in France heirs tend to marry heiresses, and wealth enhances this likelihood. He relies on partial correlations and risk-ratios to measure the degree of assortative mating by inherited wealth and labor income, and controls for observable differences between income earners and inheritors (education and age) to present a net effect. Against the hypothesis on the materialistic

[1] Mann (1901, p. 239)

[2] Regarding the modern emphasis on human capital acquisition, Cervellati and Sunde (2005), for example, discuss the virtuous cycle of increasing level of education, prolonged longevity and economic prosperity.

[3] Eugène de Rastignac in *La Comédie humaine* by Honoré de Balzac (1799–1850), a poor non-Parisian skilled at leveraging his aristocratic background, climbed the social ladder in Paris by marrying the right heiress. Gianni Schicchi, a peasant and the protagonist of Giacomo Puccini's eponymous opera (1917), wisely "redistributed" a significant heritage as dowry to secure a love between a poor couple, his daughter Lauretta and her lover Rinuccio (we thank Arthur Kennickell for this reference). One main plot in the great classical novel *Dream of the Red Chamber* by Cao Xueqin (1791) is the struggle by Jia Baoyu, a very well-off relative of the Emperor, to make a marital choice between a sensible and tactful wife, Xue Baochai, who is knowledgeable in maintaining household finances, or an unconventional and hypersensitive wife, Lin Daiyu, who is very proficient in music and poetry – all the romantic components – but has no interest in managing wealth. Both girls are raised in wealthy aristocratic families. Subject to his family's craving for sustaining a dynastic wealth, Jia Baoyu is finally forced to marry Xue Baochai despite his intrinsic attachment to the pure love of Lin Daiyu.

[4] See e.g. Piketty (2014).

[5] In the modern context, other traits such as risk aversion or perception of innovation are becoming increasingly relevant.

equivalence of these two sources of wealth, he estimates the substitutability by regressing a probit of the chance of marrying a spouse in a given top tail of inheritance or labor income on the two-dimensional traits of the opposite gender and rejects the hypothesis of perfect substitutability. The analysis accounts for both levels and positions of distributions. For Germany, however, data tracing wealth across generations is scarcer, which means that few studies have addressed this topic so far.

Our contribution is twofold. On the one hand, being the first study on two-dimensional marital sorting for Germany, we make use of a relatively new dataset containing detailed information on households' finances – the Panel on Household Finances (PHF). It is the German equivalent of the French *Enquête Patrimoine* used in Frémeaux (2014), although the former contains less information on inherited wealth and fewer observations. This dataset allows us to enquire whether inherited wealth does play a role, directly or indirectly, in partnerships among today's Germans.[6] The empirical analysis is partially parallel to Frémeaux (2014) in order to compare the results with France, and similarly relies on risk ratios and substitutability analysis which allow us to control for other factors in shaping marital sorting. We also present the sorting pattern by comparing the actual and random joint distribution of marriage matching conditional on the marginal distributions of labor income and inheritance types.

Of course, modern Germans do not live in a Buddenbrooks-like world: such a cynical view of marriage would run counter to the prevailing view of partnership driven mainly by mutual affection. Nevertheless, we cannot exclude *a priori* the possibility that individuals take this information into account in the matrimonial market, inasmuch as it can substantially raise the starting point for a couple's standard of living, and as some individuals may have strong dynastic preferences. Our comparison study reveals that the distributional characteristics in marital sorting are quite close between France and Germany. Although they are neighboring countries and enjoy cultural proximity, German aristocratic wealth has been more negatively impacted by WWII; there is less social stratification given the German political and institutional setting – e.g., enforced mixture of wealthy and poor neighborhoods and reluctance to set up an elite higher education system such as the French *Grandes Ecoles*; and Germany has been indirectly (for the West) or directly (for the East) affected by decades of communism. Our investigation can also be useful for discussions on causes and consequences of enduring wealth inequality or for analyzing the degree of social stratification.

On the other hand, the similarity of the distribution on assortative mating in both countries might imply a sharing of common structure in the marital market.[7] Motivated by this

[6]We can identify whether the financial inheritance comes from the side of husband or wife, while information about the source of inherited housing is not requested in this survey. To circumvent this drawback, we propose to impute the latter information by either a multiple random assignment or picking the side with larger predicted probability in receiving the financial inheritance from a gender specific probit model. Either approach yields very similar distributions and matching pattern. The model estimation also does not differ fundamentally from using either result. Indeed, Künemund, Motel-Klingebiel, and Kohli (2005) provide evidence that parental bequests in Germany are not primarily distributed to sons or daughters. It is worth noting that PHF has started to ask the identity of the housing inheritor since the third wave.

[7]In the future, we could estimate the same model on the French data to examine whether both countries share some common parameters.

inquiry, we extend Fernández, Guner, and Knowles (2005) to build a stylized model precisely describing the marital sorting pattern between inheritance and labor income. Our modelling can be deemed an effort to build towards simulating the long-run wealth inequality. The inputs for the model are the marginal distributions of labor income – inheritance types for each gender of married population. The main outputs are simply the joint distribution of matching these types from either gender. Each participant in the marriage market has uncertainty about his or her potential mate's performance in the labor market. Only a distribution of the other gender's labor income conditional on inheritance type is publicly known in the beginning. However, inheritance type is revealed all the time. Sorting by inheritance occurs in the first stage by taking conditional expectations of the sorting outcome on labor income in the second stage. Through an institution of segregated mating market, marital choice on inheritance is carried over from the first to the second stage where it is fixed. In the second stage, a specific type of labor income is revealed and sorting on this basis takes place. A trade-off between the random matching quality and a two-dimensional pecuniary payoff for the marriage sequentially arises.[8]

Besides the distributional concern, our model also incorporates the empirical evidence of imperfect substitutability between these two dimensions by explicitly specifying and estimating it in a payoff function. This defines the major difference between our model and the literature on informational friction and mismatch. Similar to Chade and Eeckhout (2016), who propose the notion of *stochastic sorting*, we let agents match firstly on inheritance, a noisy signal of labor income, which introduces the mismatch on the income dimension and selection of matched income distribution conditional on the matching on inheritance.[9] However, our emphasis of mismatch is different. Imperfect assortative mating by labor income can be explained by weak complementarity between labor income and inheritance in the payoff function beyond only the stochastic sorting.[10] For example, down-payment through inherited wealth is independent from efforts in the labor market. On the other aspects, we share some other common features with Chade and Eeckhout (2016). We turn a multidimensional problem into a tractable and empirically intuitive one-dimensional one through the sequential sorting setup. Instead of assuming unobserved heterogeneity such as Choo and Siow (2006), Galichon and Salanie (2010) and Lindenlaub (2017) on multidimensional matching to disentangle mismatch, we endogenize the ex-post mismatch from the agents' angle since all elements of the partner's types are observed before the second stage of matching.

We estimate the model by fitting the equilibrium with the observed matching pattern. To our surprise, the estimated equilibrium distribution on the joint matching types of labor income and inheritance type exactly replicates the observed distribution. The model suggests that inherited wealth explains about 70% of the pecuniary part in a marital

[8]We could not rule out the non-pecuniary value which agents may attach to the pecuniary payoff such as class specific values and attitudes. Therefore, the payoff in our model can also be interpreted as a belief in two sources for success as in Piketty (1995) and Bénabou and Tirole (2006).

[9]We empirically observe that the positive sorting on labor income becomes weaker or disappears when one side has an inheritance. Richer parents can afford to access a better education market (e.g. due to school district segregation) and/or endow their children with an advantageous network which introduces the selection.

[10]Comparing the relative importance between complementarity in payoff and stochastic sorting is an inviting future direction.

payoff function incorporating both finance and "love quality". The labor income accounts for only 30% of the family's financial well-being. And the estimate on this substitutability measure simply reaches a unique global optimum.[11] Using the reasonable parameter values of rate of return, income growth, and demographics in the recent history for Germany, we may interpret our model under a lifetime wealth maximization perspective.

In section 2 we review the existing literature on assortative mating and inherited wealth. Section 3 illustrates the PHF data, characteristics of couples in the PHF as well as inherited wealth. Some evidence of assortative mating is provided in section 4 using contingency tables and risk ratios. Section 5 presents the other distributional characteristics on bi-dimensional marital sorting. Section 6 discusses a comparison between French and German results. Section 7 presents a stylized theoretical model. Section 8 concludes.

2 Assortative mating and inherited wealth

Since the influential work of Sorokin (1959), sociologists and economists have sought to investigate social stratification within a given society by looking at the extent of social mobility as measured by the difference between an individual's status and his parents' status. One important form of social mobility is marriage, which can allow an individual to enter another social group or to change his or her standard of living. Several empirical studies have stressed the importance of homogamy based on educational attainment since the 1960s: a relatively high level of educational homogamy has been found in the US (Kalmijn, 1991), in France (Vanderschelden, 2006), and in Germany (Blossfeld and Timm, 2017). The last decades have seen a general reinforcement of such sorting on the basis of education, for instance in the US (Schwartz and Mare, 2005) or in Germany (Grave and Schmidt, 2012). In France, however, homogamy based on educational attainment appears to be decreasing over time, except among the graduates of elite schools; this may be related to a general decrease in social-class identity, except at the very top of society (Bouchet-Valat, 2014). Following this literature, we systematically use education as a control in our empirical strategy focusing on wealth homogamy.

Economists have been particularly interested in studying the impact of this observed educational homogamy on income inequality. Indeed, educational background is highly correlated with income, which means that increasing educational assortative mating may lead to higher earnings polarization. While Kremer (1997) concluded that rising marital sorting was not leading to an increase in income inequality (even as it was reducing intergenerational mobility), Fernandez and Rogerson (2000) argued that, if concave instead of linear transmission of education from total years of parental education as well as the sensitivity of wages to the supply of skilled workers are taken into account, increasing assortative mating leads to more income inequality as greater sorting leads to a decline in average education and an increase in return to higher education. Moreover, labor supply adjustments occurring after the mating have a key income inequality: Greenwood, Guner, Kocharkov, and Santos (2014) argue that marital sorting by potential wage will affect income inequality between couples only if spouses do not adjust their labor supply. In this respect, Pestel (2017) contends that, in Germany, the post-mating labor supply

[11] The estimator is a least square function.

reaction of women is different by region. In Western Germany, women with high earnings potential married to high wage-earners stop working or reduce the numbers of hours worked. Consequently, the sorting by potential wage (i.e. on educational attainment) does not lead to an increase in income inequality between couples because of the labor supply reaction of married women. In Eastern Germany, however, the labor supply reaction following the mating is rather small. As a result, sorting by potential wage reinforces income inequality. Pestel does not enquire into sorting by wealth, which could also interact with other characteristics on the marriage market as well as induce heterogeneous labor supply reactions. Our empirical analysis explicitly takes these considerations into account.

While assortative mating based on education and income is now well-documented in the literature, there are fewer studies that address sorting by inherited wealth or parental wealth. Charles, Hurst, and Killewald (2013) use American data from the Panel Study of Income Dynamics to study the extent of marital sorting based on parental wealth. They estimate a correlation of 0.4 in parental wealth among married spouses. For France, Frémeaux (2014) studied sorting by inherited wealth and estimated a correlation of inherited wealth between spouses of 0.25; he finds a stronger marital sorting based on inherited wealth than on labor income. By decomposing inherited wealth and labor income quantiles, Frémeaux argues that the similarity of inherited wealth is higher for the wealthiest heirs. Moreover, both dimensions appear to be rather non-substitutable: for the mating process in France, being a top wage-earner is not equivalent to being a top heir.

Regarding the sorting by parental or inherited wealth, various explanatory mechanisms have been pointed out. Both Charles et al. (2013) and Bozon and Héran (1988) stressed the importance of the place to socialize for couple formation.[12] Even if individuals often perceive the first encounter with their partner as happenstance, the socio-spatial segregation favors homogamy. Places of study, places of holiday, working places, as well as friends' parties, are selective places where individuals from a high social background meet. On the other hand, individuals from poorer social backgrounds meet their partners in public places more often, for instance at popular nightclubs. Therefore, even if there is no systematically conscious matrimonial strategy pushing individuals to marry their likes, the different places that people frequent as a result of their social background leads de facto to a preselection of potential partners.

Our study is also relevant to the literature on the evolution of inheritance and wealth inequality across countries. Using a mortality multiplier approach and combining national accounts, tax statistics, and survey data, Schinke (2012) found a U-shaped evolution of the annual flow of inherited wealth (as a proportion of national income). While the importance of inherited wealth had decreased until the 1960s, the annual flows of inheritance and gifts have since then increased steadily in both Germany and France. According to this measure, inherited wealth seems to be slightly less important in Germany than in France: in 2011 it represented almost 11% of annual income in Germany and around 15% of annual income in France.[13] However, wealth inequality is relatively higher in Germany.[14]

[12] Charles et al. (2013) show that controlling for education only accounts for one-quarter of sorting by parental wealth.

[13] Tiefensee and Westermeier (2016) show that a significant lower share among the older cohorts in Germany receive an inheritance compared to that in France.

[14] See Grabka and Westermeier (2014) and Bach, Thiemann, and Zucco (2015).

These evidences motivate our comparative study of this bi-dimensional marital sorting between Germany and France. Finally, several German studies have stressed the equalizing effect of inherited wealth for wealth inequality in Germany (see Westerheide (2005), Kohli, Künemund, Kohli, Künemund, Schäfer, Schupp, and Vogel (2006) and Corneo, Bönke, and Westermeier (2016)). Our findings of the existence of marital sorting by wealth contribute to this debate by emphasizing the marriage channel. Further research using long-term micro-data series would allow an analysis confirming its implication for wealth inequality dynamics in Germany.

3 Data

In this section, we introduce the PHF data, describe the characteristics of the couple sample, illustrate the various sources of inheritance as well as the procedure to assign the inherited housing and future inheritance whose source was not identified by the survey, discuss the inheritance distribution and finally present the rationale and construction of two subsamples used for robustness check.

3.1 Overview of the Panel on Household Finances (PHF)

The Panel on Household Finances (PHF) is a panel survey on household finances and wealth in Germany, which contains detailed information on financial and non-financial wealth and various sources of income. The first wave of data refers to 2009 and the second wave to 2013.[15]

The first wave contained 3,565 households (8,135 persons, with 7,084 being over 16) and the second wave 4,461 households (10,201 persons, with 8,825 being over 16). In the second wave, 2,191 households are panel members who were already surveyed in the first wave and 2,270 households were refresher members. In both waves wealthy households were oversampled in order to improve the estimate of the top of the wealth distribution. The PHF database is processed by a multiple imputation step, following Rubin's (2004) methodology. Item non-response is thus dealt with by an imputation with five implicates for almost all the variables (Eisele and Zhu, 2013).

For our analysis, we use the second wave database to yield a larger sample of couples which can be more informative for the assortative mating patterns at the top of the wealth and income distributions. However, since the second wave questionnaire omits the collection of inherited wealth which was received and reported in the first wave interview for the panel households, we then retrieve this piece of information from the first wave.

In order to select couples, we combine information from the family matrix (describing the relationships between household members) with the marital status declared. We ignore the very small number of homosexual couples. We include both married and non-married couples, and we will hereinafter use the terms "partners" and "spouses", "wife" and "female partner", "husband" and "male partner" interchangeably, without distinguishing between

[15] For example, this reference year applies to the labor income. On the other hand, the data collection for the second wave occurs in 2014, the year to which the current asset values actually refer.

married and non-married couples. We end up with 2,472 heterosexual couples (4,944 persons) for which we have information on both spouses. This amounts to 61.61% of the 8,825 adults present in the second wave of the PHF survey (with weights, 60.77%)[16].

3.2 Descriptive statistics for the couples population

This section presents various descriptive statistics for the couples population. All numbers are obtained using the weights. Table 1 presents the proportion of individuals in a stable relationship (marriage or stable partnership declared within the survey, with cohabitation) by age, as well as high education level and employment status for each gender. Women are more likely than men to be in a relationship for the youngest ages (16-25 and 26-35), which corresponds to the fact that they tend to marry up. Between 36 and 65, around 70%-72% of men and women are in a relationship. After 66, women are less likely than men to be in a relationship, which reflects the shorter life expectancy of men (there are more widows than widowers).

Most of the individuals have professional and vocational training. The proportion of university graduates is comparable for both genders (11.7% of the men, 11.4% of the women). There is a higher proportion of women without any higher education (17.0%) than among the men (7.3%).

While 60% of the men are employed full-time, this is the case for only 25.2% of the women. Consequently, 13.4% of the women are homemakers (housewives) and 29.1% of them are employed part-time, while this is the case for 0.2% and 5.2%, respectively, of the men. A higher proportion of pensioners is found for men (26.9%) than for women (20.1%), which is related to the differences in gender age distributions as described above.

Our current (labor) income concept covers wages, self-employed income and public pensions. Table 2 contains the distribution of household estimated net wealth and annual labor income of partners for the couples population. This is close to the actual estimated net wealth for couples since only 36 couples out of the 2,472 are living in a multi-couple household. The median net wealth of the couples is €80,000, which is higher than the values for all households: according to the Deutsche Bundesbank (2016) on the 2014 PHF survey, the median net wealth for all households is €60,400. The interquantile ratio p90/p50 is 6.25 for couples while it is 5.83 for all households.

Labor incomes are always substantially lower for the women, most likely because fewer of them are employed full-time as well as because they might be more likely to marry up financially. The median value of labor income amounts to €26,000 for men in a stable relationship and €10,000 for women in a stable relationship. The interquantile ratio p90/p50 is 2.43 for men in couples and 3.60 for women; overall labor income is more equally distributed than household net wealth (e.g., the standard deviation of the former is much smaller).

Table 3 provides the distribution of couples by status of homeownership and current value of the main residence conditional on ownership type. A majority of the couples (57%)

[16] This is broadly the same order of magnitude as stated by Destatis in *Alleinlebende in Deutschland-Ergebnisse des Mikrozensus 2011*, Begleitsmaterial zur Pressekonferenz am 11. Juli 2012 in Berlin, Statistisches Bundesamt.

owns its main residence, whereas this is the case of only 44% of all households. We observe a higher disparity for the value of the inherited main residence among couple households with the top and bottom distribution being higher and lower than the counterparts in the distribution of all the main residences among couple households. For instance, the p95 and p98 can be about two to three times higher in the pool of inherited main residences than the counterparts in the total distribution.

3.3 Source of inheritance

Depending on the structure of inherited wealth, the PHF assigns them to different sections. The inheritance section presents all substantial inheritances and gifts received by members of the household, apart from the household's main residence. Households are asked to report all large inheritances and gifts: money, housing (except if this is their main residence), grounds, firms, stock, jewelry, pieces of art, and life insurance. For each item respondents are asked about the year in which it was received, its value at that time, from whom it was received and which member(s) of the household were among the receivers. The smallest values declared are between €100 and €1,500; however, most households declare quite significant amounts. The highest value declared is €17 million.

The housing section presents information on the way the household main residence (HMR) was acquired. Therefore, if members of the household were given or have inherited housing in which they still live at the time of the survey, the information is not included in the inheritance section but mentioned in the housing section instead.[17] Unfortunately, the housing section does not give any information on the origin of the inherited housing: we do not know which member of the household was the beneficiary or from whom she/he inherited this.

The same uncertainty exists for the expected future inheritance (FH): only the household as a whole was asked whether it expected to receive a future inheritance. But it is highly possible to have been revealed and considered during the mating process. Particularly, most marriages happen much earlier, when the couple is young, than the first time at which any significant inheritance arrives, when the couple turn to late middle age and their parents pass away. We should also classify the inheritance type in our context to additionally account for the expected

In order to explore assortative mating, we need to know the respective inherited wealth of wives and husbands. Therefore, not knowing the origin of the inherited HMR could be problematic. Furthermore, inherited HMR is an important form of intergenerational wealth transmission. As a result, we will adopt two different scenarios in assigning the inherited housing and future inheritance within couples. By doing so, each serves as a robustness check for the other.

Information on inheritance and gift values are taken from the question: "*What was the value of the inheritance/the gift when the household received it?*" As a result, inheritance and gifts' values need to be standardized to ensure comparability. We use the Bundesbank's discount rate for the years 1949 to 1998, and the European Central Bank's interest rates

[17] The specific question is "*How did you become the owner of your main residence: did you purchase it, build it yourself, receive it as an inheritance or receive it as a gift?*"

for main refinancing operations for the years 1999 to 2014, in order to get an actualized value with 2014 as the reference year. For instance, the declared value of inheritances received in 1960 is multiplied by 7.95; those received in 1980 by 3.52; those received in 2000 by 1.39. If the household has inherited his main residence, we take its current value (in 2014) as the value for this type of inherited wealth. We are aware that this methodology is quite coarse, inasmuch as we use the Bundesbank's interest rates before 1989 for Eastern Germany. However, using alternative actualization of the inheritance value does not affect the main results. In addition, we also implemented the analysis restricting the sample to Western Germany.

3.4 Assignment of inherited housing (HMR) and future inheritance (FH) within the couple

We describe how we impute whether inherited HMR is from the wife or husband. The same imputation is separately applied to FH without being explicitly mentioned throughout most of the paper.[18]

In order to determine the degree of assortative mating, we use the information on the origin of the inherited wealth of the couple. In the inheritance section, it is always stated whether inherited wealth belongs to the wife or to the husband. We refer to the analysis only using the inherited wealth from inheritance section as case 0. However, if the couple lives in inherited housing, which is the case of 13% of the couples (Table 3), two different assignment strategies are implemented to attribute inherited HMR to either side of the couple due to the information shortfall mentioned above.

Our first strategy is to assign the inherited HMR randomly within each couple living in an inherited housing. We repeat this procedure 500 times (100 random draws for each of the 5 implicates) and the estimates and descriptive statistics we present thereafter are the average thereof. We will refer to this assignment as "random assignment of inherited housing (and future inheritance)", or case 1.

Our second strategy is to use probit regressions to estimate and compare the probability of each spouse being an inheritor. The side with higher probability is assigned. We will refer to this strategy as "probit-based assignment of inherited housing (and future inheritance)", or case 2. We estimate first a probit model on the women-in-couples population, excluding the women living in inherited housing. The covariates include region, education, age, nationality and other demographical attributes.[19] The estimated coefficients are used to predict the probability that each woman in a couple living in inherited housing is an heiress. The key assumption is that the variables predicting non-housing bequests are the same as the variables predicting the probability of receiving a bequest in the form of housing. A

[18]Since the amount of FH is not observable (and can actually not be estimated straightforwardly), the identification of inheritance type is not involved in (assigning) FH whenever we have to deal with the distribution of inherited wealth in some of the analyses.

[19]These include age, household's net wealth, type of school education, type of higher education, employment status, official marital status, region of residence, municipality population size, a dummy for living in a wealthy neighborhood, a dummy for living in Eastern Germany in 1989, a dummy for expecting future inheritance, a dummy for individuals having acquired German citizenship after birth.

similar probit estimation and prediction is performed on the men-in-couples population, excluding the men living in inherited housing, and using the same set of covariates.

As indicated before, there is evidence pointing towards gender-neutral inheritance in German society, which supports the random assignment. We propose this probit-based assignment with the hypothetical structure to examine whether a sensible *economic imputation* makes a difference in the following analysis. Case 2 results are presented as the benchmark mostly followed by the case 1 results. However, this does not equate to advocating either as the truth.[20]

3.5 Heirs and heiresses

This section presents descriptive statistics for heirs and non-heirs determined by either past receipt of inheritance or expecting the future inflows. All of them are obtained using household weights.

Table 4 presents the distribution of inherited wealth for the men and the women in a stable relationship who have received an inheritance.[21] The majority of the individuals in our sample have received no inheritance or gift: only 19.2% of the men in a stable relationship are heirs and 20.2% are heiresses. Some of them could be the potential recipients of an inheritance (for instance if their parents are still alive at the time of the survey) but the PHF database does not include information on parental wealth. As a result, when discussing the concentration of assortative mating, we only consider assortative mating on observed inherited wealth and not potential inherited wealth.[22] This can lead to an underestimation of the actual level of marital sorting by wealth, since partners may take into consideration parental wealth that is to be transmitted in the future.

The comparison of the inherited wealth distribution without inherited main residence (Table 4) with the inherited wealth distribution after assignment of inherited main residence shows that taking into account inherited main residence expands the proportion of heirs and heiresses, and increases significantly the quantiles. Moreover, both assignment strategies yield similar distributions.

Table 5 presents the proportion of heirs and heiresses among the men and women in a stable relationship by region, age and level of higher education.[23] Proportionally more heirs and heiresses live in the South than in the rest of the country. Therefore, it is necessary to control for the region of residence if we want to investigate whether heirs are more often in a committed relationship with heiresses than with non-heiresses: more mating occurs in the neighborhood.

[20]The whole purpose is to provide an acceptable empirical basis for answering our question. Each assignment is independent of both our empirical strategies and model setup.

[21]Potential heirs and heiresses who report that they expect to receive an inheritance but have not received any inheritance in the past are not included.

[22]However, we account for the potential inheritance in studying the substitutivity of the marital sorting by two dimensions, particularly in building and fitting the model.

[23]For instance, among the men in a stable relationship and living in the East, the proportion of heires is 14.9%. Inheritance type is decided by the case 2 assignment to allocate the inherited HMR and FH. Outcomes based on the case 1 assignment are similar.

Table 5 also presents the proportion of heirs and heiresses for each age class. The chance to receive inheritance almost always increases with age. The smaller proportion of heirs and heiresses for those aged more than 76 can be interpreted as the dominance of a cohort effect (World War II) on the age effect. As a result, we need to also control for age in assessing the assortative mating across income and inherited wealth, to rule out a mundane age or cohort effect: mating is more likely to happen within the same generation, and age is highly correlated with both income and inheritance.

Finally, education sorting is very common in the marriage market. Table 5 presents the conditional proportion of heirs and heiresses according to the level of higher education for individuals in a stable relationship. There is a strong positive relationship between inheritance and level of higher education. Relatively speaking, significantly more heirs and heiresses hold a university degree than the population without a university degree or professional training (the figures are 40.2% vs 6.3% for men and 34.1% vs 16.3%). This difference is even more conspicuous among those with a doctorate / habilitation title. Therefore, we need to disentangle the selection on education from that on inheritance type.

3.6 Subsamples for robustness analysis: working-age and West German couples

Since replacement ratios between wages and pensions are lower than 100%, and we do not include private pension income (which can rather be considered as capital income), retired individuals have often lower current income than working individuals. Consequently, in order to check whether our results are entirely driven by the cohort effect – poorer old men and women intermarry, as do richer young men and women, we implement the exact same analysis from the whole couple sample to the subsample of working-age couples, i.e. the 1,989 couples where both partners are aged between 16 and 65.[24]

Besides the cohort effect, the other rationale for using the working-age subsample is survival bias. It might be possible that couples sorting less assortatively are more likely to divorce: after a certain age, we would observe only long-lasting partnerships presenting a higher degree of assortative mating.[25]

Moreover, we may underestimate sorting by labor income insofar as there is a labor supply reaction after household formation: e.g., women with high incomes marrying high wage earners may decide to fully or partially exit the labor market. As we only observe current income distribution, and not income distribution at the time of the partner's choice, we are not able to assess the extent to which initial labor income matters for marital sorting. Moreover, Frémeaux (2014) raised the issue of the distortion associated with using current income instead of permanent income: the latter can account for life cycle effects. The permanent income might better reflect the potential value borne by the partner, which is critical in the marital choice. To correct for this, we implement alternative specifications using the wage rate as a proxy of "potential income" or "permanent income". To determine

[24]The other aforementioned cohort effect partially under control by using this subsample is the chance of receiving inheritance greatly rising after retirement.

[25]The focus of this paper is the entry into marriage, although duration is also shaped by assortative mating.

such a wage rate for working individuals, we use the labor income and the working hours. For the non-working individuals such as housewives or unemployed, as well as for self-employed people (for which the self-reported number of working hours can be highly unreliable or incomparable), we impute such a wage rate using a Heckman procedure.

The subsample of working-age couples consists of 1,989 couples for which both partners are younger than 65. This amounts to 49.57% of the 8,025 adults present in the second wave of the PHF survey (with household weights, 44.44%).

Finally, since, as observed, not many couples receive an inheritance in East Germany, the overall assortative mating may be simply driven by the East-West difference since socialization in the neighborhood is one of the major mating channels. To dismiss such a claim, we also apply the analysis to the West German subsample to ensure the difference is minor with the results for the whole country. This subsample entails 2,554 couples.

4 Evidence of assortative mating: contingency tables and risk ratios

Contingency tables and risk ratios are provided to describe the existence and degree of assortative mating across both dimensions of labor income and inheritance.

4.1 Contingency tables

We use contingency tables to illustrate the degree of assortative mating across two dimensions, showing the difference between the observed mating pattern and a hypothetical random mating pattern. The contingency table illustrates the joint distribution of marriage defined by types of either gender. Each dimension has two types: heir/heiress vs. non-heir/non-heiress and husband/wife in the top 50% vs. bottom 50% income distribution. Each gender thus has four types when considering both dimensions. Consequently, we have a four by four contingency table. The alternative random mating simply generates cell proportion of couples as a product of the marginal proportions of women and men according to sorting dimensions (i.e. labor income and inheritance type). We can then examine the sorting by comparing these two contingency tables. Before presenting our four by four tables, we start with the sorting on single dimensions by showing the two by two tables.[26]

4.1.1 Labor income

We implement this exercise first on labor income. By doing so, we should obtain a two by two random mating contingency table with 25% in each cell. Table 6 illustrates such a distribution in the hypothetical random mating case.[27]

[26]They serve both tautological and contrasting purposes for the bi-dimensional analysis.

[27]However, since several individuals earn exactly the median labor income, the cell proportions are not exactly 25%.

Table 7 presents the observed distribution of couples using the PHF weighted sample. Table 8 then presents the relative difference between observed matching and random mating, i.e. the absolute difference from Table 6 and Table 7 in each cell divided by the random mating value from Table 6. For example, with respect to the random mating predicting 24.4% of bottom-bottom type of couples in the population, we observe a surplus of 2.8% / 24.4% = 11.3% of bottom-bottom couples in the observed distribution.

To sum up, Table 8 shows that there exists a strong sorting by labor income, since there is a surplus of bottom-bottom couples and top-top couples as compared to bottom-top and top-bottom couples, i.e. we find more couples in the diagonal of the table from the observed matching. For robustness purpose, we repeat by restricting our analysis to the working-age subsample, using current income or wage rate. (See Appendix A.1, Tables 26 and 27).

4.1.2 Inheritance status: heirs and heiresses

We conduct the same exercise on the other sorting dimension – inheritance status. Table 9 presents the relative difference between observed and random matching distribution conditional on the inheritance type of both genders.[28] Overall, assortative mating by inheritance type proves robust and invariant across both allocation scenarios for inherited housing. Furthermore, this cannot be rejected as a pure age effect, insofar as we observe a very similar pattern qualitatively and quantitatively while restricting the analysis to a subsample of working-age couples.

4.1.3 Two-dimensional analysis

We are primarily interested in combining both dimensions of marital sorting by resorting to the same evaluation as above. The illustration of two-dimensional assortative mating concentrates on the broadest classification of inheritance type: reported inheritance either in the inheritance section, or HMR or FH. We show the distributions under case 2 assignment. As shown in Appendix A.1, the contingency table under case 1 assignment looks very similar.

We produce the relative difference between observed and random mating (case 2) in Table 10 (See Appendix A.1 for more details). We can observe that sorting by inherited wealth is relatively stronger than sorting by income. Indeed, the general picture is that there is a surplus of "heir/heiress" couples for all types of labor income matchings (the entire bottom-right block is highly positive): for instance, there are 50.1% more couples of type "heiresses in the top 50 income / heirs in the top 50 income distribution" in the observed matching distribution than in the random mating table. Conversely, in the bottom-left and top-right blocks, there are "too few" couples in almost all cells, even when we could have

[28] Heir/Heiress is decided from either the inheritance section or inherited HMR. As discussed, we present the results using either random (case 1) or probit-based (case 2) assignment of inherited HMR to husband or wife. Results by further incorporating the assignment of future inheritance are similar. We skip such a comparison here since they will be shown in the following bi-dimensional tables. The replications on the subsample of working-age couples under both cases are again not much different. This rules out the possibility that our result is driven only by a cohort effect.

expected a surplus due to sorting by labor income. The assortative mating on income does not seem to compensate for the disassortative mating on inherited wealth. Following what we have performed for the 2×2 tables, these results also broadly hold for the subsample of working-age couples.[29]

4.2 Risk ratios

Following Frémeaux (2014), we also use risk ratios to present assortative mating patterns. The superiority of risk ratios lies in the ability to control for endogeneity such as age, education and region of residence which are jointly correlated with inheritance and marital sorting. Since significant inheritance is not widespread across the whole population in Germany as described previously, only 25% of the population has received positive inherited wealth in our data. However, we choose to define the quantiles on the inherited wealth distribution with zero value covered, which is equivalent to our construction of income quantiles by including the population that is latent in the labor market.

Risk ratios are defined as

$$RR_{T,\ Wife} = \frac{P\left(Husband\ in\ top\ T\%|\ Wife\ in\ top\ T\%\right)}{P\left(Husband\ in\ top\ T\%|\ Wife\ in\ bottom\ (100-T)\%\right)}$$

from the wife's perspective (T is measured in percentage points). Among the women that are in a stable relationship, those from the top T% of the inherited wealth distribution for women are on average $RR_{T,Wife}$ times more likely than women from the bottom (1-T)% of the same distribution to mate with a top T% husband of the inherited wealth distribution for men. Likewise, $RR_{T,Husb}$ is defined in the same way from the husband's perspective.

Moreover, we would like to disentangle pure sorting by inherited wealth from sorting by generation – older men and women are more likely to inherit and match with each other – and sorting by education – inheritance is positively associated with education achievement and simultaneously people tend to mate with partners holding similar education backgrounds. In addition to this, Germany has a strong regional differentiation in terms of inherited wealth: there is more private wealth to inherit in the South (Hesse, Baden-Württemberg and Bavaria) than in the rest of Germany, and less private wealth to inherit in ex-East Germany than in ex-West Germany.

We illustrate the procedure by taking the wife's perspective as an example. The denominator and numerator in the risk ratio are estimated by a probit model – $Pr\left(TopTman = 1|\ TopTwoman,\ X\right) = \phi(\ b_0.TopTwoman\ +\ b_1.X)$ where TopTman and TopTwoman are the dummies for being in top $T\%$ of gender-specific distributions, X is a set of control variables (age of the woman, education of the woman, and region of residence of the couple) and ϕ the cumulative distribution function of the normal distribution. Following Cummings (2009), we deduce the average log-risk ratio from performing a prediction of log risk ratio: $\ln RR_{T,\ Wife} = \ln[\frac{\sum_{i=1}^{N}\omega_i\phi(\ b_0\ +\ b_1X_i)}{\sum_{i=1}^{N}\omega_i\phi(\ b_1X_i)}]$, where ω_i is the household weight and N the number of couples (2,472) in the sample. Next, we use

[29] Results for the working-age subsample can be delivered as request.

the delta method to derive the standard error. This is a standardized estimate in that we are dividing the average probability conditional on all the sample being in the top T% distribution with the other average probability conditional on all the sample not being in the top T% distribution.

4.2.1 Full sample

We present risk ratios from the wives' perspective and from the husbands' perspective. Results are very similar for both genders. Then, we restrict our analysis to the working-age couples and find generally the same trends, although the estimated risk ratios are less precise, potentially due to the smaller sample size.

Table 11 presents the risk ratios for different distributions in four columns: inherited wealth from the inheritance section only (case 0), inherited wealth from the inheritance section and the random assignment of inherited housing (case 1), inherited wealth from the inheritance section and probit-based assignment of inherited housing (case 2) and labor income.

For each of these variables, risk ratios are computed for different quantiles. For the inherited wealth variables, a risk ratio is also computed using the dummies for heir and heiress (this is not done for labor income in the fourth column). Since only 19.2% of the men are heirs and 20.1% of the women are heiresses when we only take into account inherited wealth from the inheritance section (case 0), we do not compute a risk ratio for the top 20% of this measure of inherited wealth. Finally, we provide for each estimate of risk ratio the significance in terms of difference with one.[30]

Overall, for the measures of inherited wealth under all scenarios and for labor income, risk ratios are almost always significantly different from one at the 1% level: there is sorting by inherited wealth as well as by current income, even when controlling for age, education and region. However, it remains true that there could be some unobserved variables, particularly preferences, socialization, attitudes, etc. driving this mating pattern. These risk ratios are still descriptive and do not reveal that individuals develop conscious strategies to marry their like in terms of inherited wealth, as often portrayed for 19th-century Europe.

A striking feature of Table 11 is that risk ratios tend to increase with the percentiles of inherited wealth. For instance, if we take the second column (inherited wealth from the inheritance section and random assignment of inherited housing), the risk ratio increases from 2.26 for the top 20% to 2.99 for the top 10% and 4.38 for the top 2% of the inherited wealth distribution. However, under cases 1 and 2, for instance, we also observe that risk ratios are slightly lower for the top 5% than for the top 10%, which means that the concentration trend may not be persistent over the inherited wealth distribution.

Table 12 provides the same risk ratios from the husbands' perspective. We observe results very similar to those obtained from the wives' perspective. In fact, it seems that risk ratios are slightly lower from the husbands' perspective than those from the wives' perspective,

[30] One means that among the women that are in a stable relationship, women from the top T% of the inherited wealth distribution are on average as likely as women from the bottom (1-T)% of the inherited wealth distribution to mate with a top T% husband from the inherited wealth distribution, i.e. there is no assortative mating based on inherited wealth.

which would mean that the difference in the probability of marrying someone with inherited wealth between heiresses and non-heiresses is more marked than the difference between heirs and non-heirs. However, the difference appears to be rather small and not economically significant.

To sum up, our results suggest that there exists marital sorting based on both current income and inherited wealth, driven by factors beyond age, educational or regional effects. Moreover, assortative mating becomes stronger at the top of the distribution: not only heirs tend to marry heiresses, but rich heirs to marry rich heiresses. This is of particular interest in terms of both cross section and intergenerational wealth inequality, insofar as such a mating pattern seems a priori to accelerate an increasing wealth concentration.

4.2.2 Working-age couples

As a robustness check, we consider only the working-age couples. We compute new percentile thresholds within this subpopulation. Table 13 presents the results from the wives' perspective. We observe that an heiress is two to three times more likely to mate with an heir than that a non-heiress, even when controlling for age, education and region of residence. This is very close to the outcome for the entire couples population (Table 11). The equivalent similarity can be observed from the husband's perspective.

Concerning the concentration, restricting the analysis to the subpopulation of working-age couples leads to insignificant results for the very top of the inherited wealth distribution (top 5% and top 2%) and no concentration pattern such as the one that was observed for the entire couples population, except for the labor income and the wage rate. This could be driven by the smaller sample size (1,989 couples in the working-age sample instead of 2,472 couples in the full sample).[31]

4.2.3 All couples excluding Eastern Germany

As a second robustness check, we consider only couples living in Western Germany (i.e. we exclude the couples living in the ex-German Democratic Republic). For them, new percentile thresholds are computed. Table 14 presents the results from the wives' perspective and Table 15 presents the results from the husbands' perspective. The risk ratios are very similar to those obtained for the entire German couples population. The results confirm that marital sorting by either of the two dimensions in Germany is not simply an outcome of East-West wealth gap: mating through socialization in the neighborhood also plays a role. However, the risk ratios on labor income appear to be slightly lower in the Western German subpopulation than in the entire German population, which is also evidenced in Pestel (2017).

[31] Also, we might suspect the within couple age gap to be larger for richer heirs/heiresses given the substitutability between attraction from wealth and age in the marriage market. The working-age sample is younger on average. There may be some partners marrying a rich heir/heiress who is much younger than those in the full sample at the top distribution. Therefore, it might be too early for them to receive the inheritance now, but they are actually expecting a future inheritance.

5 Bi-dimensional perspective

From a purely pecuniary point of view, broadly speaking, marrying a top rich heir or a top high income earner should not be so different since the quality of living in either scenario should not deviate much. But there can be other concerns which include, for instance, the conviction that labor income is riskier than inherited wealth, or the other way around. Therefore, we need to investigate how equivalent labor income and inherited wealth are playing in the degree of sorting. First, we will show that rich heirs and high-wage earners are not perfect substitutes in the other's gender specific distribution. Otherwise, studying the bi-dimensional effect collapses to a single-dimensional effect. Second, we will follow the approach in Frémeaux (2014) to assess this degree of substitutability between income and inherited wealth.

5.1 Overlapping of both dimensions

In order to show that both dimensions are not fully overlapping, we provide in Table 16 the proportion of top T% men and women in a stable relationship in terms of labor income that are equally top T% in terms of inherited wealth. From these tables, we can argue that the income dimension and the inherited wealth dimensions are positively, but not perfectly, correlated.

5.2 Substitutability between inherited wealth and income

We implement the substitutability analysis firstly from the wives' perspective and secondly from the husbands' perspective. To calculate the effect of the wife's position in the labor income and inherited wealth distribution on the probability of being together with a man from the top of the distribution of inherited wealth (or top of income distribution which can be constructed similarly), we follow a procedure described below (we only demonstrate from the wives' perspective).

We run a probit estimation with the form

$$\begin{aligned} &Pr\left(TopTmaninh = 1 | TopTwomaninh, TopTwomaninc, age\right) = \\ &\qquad \phi\left(b_0 TopTwomaninh + b_1 TopTwomaninc + b_2 age\right), \end{aligned}$$

where TopTmaninh is a dummy variable equal to one if the male partner belongs to the top T% of the inherited wealth distribution, TopTwomaninh is a dummy variable equal to one if the female partner belongs to the top T% of the inherited wealth distribution, TopTwomaninc is a dummy variable equal to one if the female partner belongs to the top T% of the inherited wealth distribution, controlling for the age of the female partner, and ϕ is the cumulative distribution function of the normal distribution. This regression produces the marginal effects of TopTwomaninh and TopTwomaninc on TopTmaninh. We then compare the two marginal effects by computing the difference between them and test the significance.

Table 17 presents the results. We observe that belonging to the top of the labor income distribution always has a positive impact on the probability of being together with someone from the top of the inherited wealth distribution (except for the top 2% women). Belonging to the top of the inherited wealth distribution also seems to have a positive impact on the probability of being together with someone from the top of the labor income distribution (except for some at the very top of the distribution). Therefore, there seems to be some degree of substitutability between labor income and inherited wealth in terms of mating.

However, the difference between the two dimensions indicates that the substitutability between them is not perfect. In fact, belonging to the top of the labor income distribution increases more the probability of being together with someone from the top of the labor income distribution than belonging to the top of the inherited wealth distribution. Equally, belonging to the top of the inherited wealth distribution increases more the probability of being together with someone from the top of the inherited wealth distribution than from the top of the labor income distribution.

6 Comparing German with French marital sorting

We provide two sets of statistics assessing the degree of assortative mating on labor income and inherited wealth which can be directly comparable between Frémeaux (2014) and our German outcomes. Table 18 collects the risk ratios on mating in different dimensions from both countries. Overall the scales are close. Particularly when we consider mainly two cases (1 and 2) which account for the inherited housing and thus more comparable to the French study, all the ratios are in the range around two to three for Germany and three to four for French. The relative weaker sorting by the top after accounting for inherited housing in Germany may be attributed to the rather moderate housing price development in recent decades in contrast with much stronger consistent growing trend in France. It seems that the degree of sorting by inherited wealth is larger than that based on labor income for both countries.

Table 19 is simply the counterpart of Table 17 which measures the additional probability induced by belonging to the top 10% distribution to mate with a partner that is also in the top 10% for either dimension. Again, all the figures including the differences are quite close. Since we do not impute the future expected inheritance as Frémeaux (2014) did and current labor income is much noise than permanent income, the German figures are a bit lower.[32]

This observation of close distributional characteristics in marital sorting between France and Germany is very intriguing. Although they are neighbors and enjoy cultural proximity, we would have expected a further lower level of assortative mating based on wealth as well as higher degree of substitutability between inherited wealth and labor income in Germany due to various historical and socio-cultural characteristics already mentioned. Frémeaux (2014) argues that, from a pecuniary perspective, inheritors should be less attractive in the marriage market since their lifetime wealth seems to be lower than that

[32]Note, due to the World Wars, that the German inheritance flow is only picking up in much recent decades (Schinke, 2012) and therefore the expected inheritance can play an increasingly significant role in the marital sorting.

of income earners.[33] Table 20 provides supportive evidence by contrasting the top decile mean of inherited wealth with the counterpart of annual labor income from each gender in both countries.[34] In both countries, the inherited wealth as a stock is just about four to five years' or seven to eight years' value of annual labor income for men or women even without accruement. However, as reflected in both Table 17 and Table 19, the chance for both men/women in the top 10% labor income distribution to marry each other is only marginally higher (for the French) or even lower (for the Germans) than the supposedly least possible marriage combination – both men/women in the top 10% inherited wealth distribution in France/Germany.[35] For instance, such odds are 13% vs. 16.9% from the wives' perspective in Germany. We will revisit this empirical puzzle after estimating a structural model in the following text.

7 A stylized model of marital sorting with inheritance

Motivated by the similar marital sorting distribution in both countries, we extend a search model with random matching from Fernández et al. (2005) in a sequential setting to explore the existence of sorting structure in our two-dimensional traits. The inputs for the model are the marginal distributions of labor income-inheritance types for each gender of the married population. The main outputs are simply the joint matching distribution of these types from either gender. In the context of our matching contingency table shown above, either margin (gender) has four discrete marginal probably and there are 16 cells of joint probabilities.

7.1 Setup

The economy is populated by a large number of people who live in two stages. This population is composed of equal numbers of women and men. Each person has two defining characteristics at birth. They have a particular earning ability $\theta_g \in \{u, s\}$ and an inheritance to receive (or not) in the future, $\alpha_g \in \{h, n\}$, where $g \in \{f, m\}$ is a gender index. The low realization, $\theta_g = u$, corresponds to an unskilled worker, while $\theta_g = s$ corresponds to a skilled worker. A value of $\alpha_g = h$ assures a future inheritance, while $\alpha_g = n$ implies that no inheritance will be received. The information structure is such that each individual knows his characteristics and observes the inheritance status of others but not their earning ability.[36]

In the second stage of the lives of the agents, all are matched in married households (more on this later) consisting of one woman and one man. The couple is characterized by the types $(\theta_f,\ \alpha_f,\ \theta_m,\ \alpha_m)$. Additionally, each marriage has an intrinsic quality (e.g. love)

[33] See Footnote 20 in Frémeaux (2014).

[34] Inherited wealth in Germany accounts for the inherited HMR according to the probit-based assignment (case 2).

[35] Note we do not use the permanent income concept for the German case.

[36] The likelihood of receiving an inheritance can be directly or indirectly inferred by family background/class. The latter can generally be perceived with certainty in the beginning of the mating.

γ_g which is a public good in the household and therefore enjoyed by each member. The prevailing wage function $w_g(\cdot)$ is gender and skill type specific. The function of inherited wealth e_g assigns the positive values to heir/heiress and zero to non-heir/non-heiress. We adopt a transferrable utility framework. Then the joint utility derived from both members of the household is given by

$$V(\gamma_g \ ; \ \theta_f, \ \alpha_f, \ \theta_m, \ \alpha_m) = (1-\beta)[w_f(\theta_f) + w_m(\theta_m)] + \beta[e_f(\alpha_f) + e_m(\alpha_m)] + \gamma_g, \quad (1)$$

where β measures the degree of substitutability between labor income and inheritance in the marriage payoff function.[37]

At the beginning of the first stage of their lives, young individuals of each gender are indexed by the future income abilities and heritor status (θ_g, α_g). This marginal distribution $F(\theta_g \times \alpha_g)$ on joint types from each gender is common knowledge. They will now enter into a marriage matching game which will deliver the prevailing marital matching structure in the economy.

We assume that marriage matching happens in two stages – the potential spouses sort firstly by inheritance and by earning ability conditional on the first stage sorting outcome. Following Bozon and Héran (1988), there is a segregated mating market (society) imposed to ensure that sorting by inheritance is permanent after the first stage. For example, suppose that the school system is the main area for socialization and that there are four types of schools (school districts) recruiting specifically one combination of inheritance type across genders: namely, heir-heiress ("Zehlendorf"), heir-non-heiress ("Charlottenburg"), non-heiress-heir ("Charlottenburg") and non-heir-non-heiress ("Kreuzberg").[38] The settlement of the sorting by inheritance in the end of the first stage is equivalent to selection into one type of the schools according to the inheritance type of both sides of partners coupled in that stage. Everyone will stay in the same school type until the end of the game.

Figure 1 presents the stage of the game. In the first stage, there are two rounds of random matching on the dimension of inheritance where the joint type of inheritance type can be formed in either round of random matching. In the first round, match-specific quality γ_g is drawn from a distribution $Q(\gamma_g)$ with a non-negative support $\left[0, q\right]$. The match is either accepted by both potential partners, resulting in a potential marriage, or is rejected by at least one of the potential partners.[39] All the men and women rejecting the first round of matches enter the second round, which again matches them randomly, and assign a random quality to each match by the distribution $Q(\gamma_g)$. After two rounds, the matching on inheritance is settled. The agents can only observe α_g of the potential mate delivered by random matchings. Thus, they form the marriage payoff function by taking the expectation of the earning ability from the opposite gender according to $F(\theta_g \times \alpha_g)$. In

[37]We can characterize this utility function as a lifetime wealth accumulated from marriage. Alternatively, it reflects an abstract marriage value symbolized by inheritance and labor income which can be derived from culture, religion, and ideology. We will revisit this definition after the model is solved and estimated.

[38]The districts in Berlin are in parentheses to symbolize the concept. Alternatively, living quarters or parties can be other mating institutions to cultivate different class mixtures.

[39]All the matches in the first stage are still potential because they can be rejected in the second stage once earning ability has been revealed.

the second stage of the matching, the agents sort based on earning ability conditional on the match of inheritance type in the first stage. Similarly, two rounds of random matching follow. In the first round, the draw of earning ability from the potential mate settled in the end of first stage is revealed. A new draw of love quality occurs from the same distribution $Q(\gamma_g)$.[40] Again, this match is maintained by both or rejected by one partner. For those rejecting the match, a second round of random matching occurs with a new draw of love quality by the same distribution $Q(\gamma_g)$. In the end of the second stage matching, all the marriages are formed, i.e. matching on both inheritance and earning ability comes to an end. We assume that the value of single life is always lower than the value of married life, which basically amounts to having the lowest realization of the match-specific quality at zero. Therefore, in the end all individuals would accept their matches.

7.2 Solution

Each stage of matching actually follows the framework of sorting with gender specific inequality in Fernández et al. (2005).[41] Before presenting the model, a brief introduction of notation in both superscripts and subscripts used in our text is necessary: the subscripts contain the gender (m, f or g) in the first place and period index ($0,\ 0',\ 1,\ 1'$ or 2) in the second one.[42] The period index 0 is the moment in the beginning of stage one, 0' is at the end of the round one in stage one, 1 is at the end of stage one and beginning of stage two, 1' represents the end of the round one in stage two and 2 is for the end of the stage two. Most superscripts consist of four positional indices – e.g. $ijkl$ where $i = \theta_g,\ j = \alpha_g,\ k = \theta_{g^-}$ and $l = \alpha_{g^-}$. g represents the gender for the agent and g^- is the opposite gender. Thus the first two positions/traits always belong to the agent and the last two are those of the (potential) partner. Sometimes some positions may have dots which mean the agent is at a period of the game when the information corresponding to those positions is not revealed. The alternative format of superscripts containing a vertical bar denotes the conditional probability. For instance, $\lambda_{g^-,1}^{i|kj}$ is the conditional probability of meeting an opposite gender (partner) at the beginning of stage two whose earning ability α_{g^-} is i when the partner' inheritance type θ_{g^-} is k and the agent's inheritance type θ_g is j.

The marginal distribution of labor income-inheritance type for each gender of the married population is $\lambda_{g,0}^{ij\cdot\cdot}$ at the beginning of the game, where $g = \{m, f\},\ i = \{u, s\}$ and $j = \{n, h\}$. There are four marginal distributions for each gender and $\sum_{i,j} \lambda_{g,0}^{ij\cdot\cdot} = 1$. Therefore, the expected value function for an agent with gender g, earning ability i and

[40]We argue the partners would always reassess their love quality after receiving new information (on earning ability) and that this is not path-dependent.

[41]See section II and Appendix 2 in that paper.

[42]Period index denotes the earliest moment when the object can be observed (for the state variables, e.g., marginal distributions) or formed (for the control variables, e.g., reserved love quality, or the value functions).

inheritance type j at the beginning of stage one is

$$\begin{aligned} V_{g,0}^{ij\cdot\cdot} &= \sum_i \lambda_{g^-,0}^{ij\cdot\cdot} \int_0^q \max\left\{V_{g,1}^{ij\cdot j}(x;\Lambda_0), E_k\left[V_{g,1}^{ij\cdot k}(\mu;\Lambda_0)\right]\right\} \mathrm{dQ}(x) \\ &+ \left(1-\sum_i \lambda_{g^-,0}^{ij\cdot\cdot}\right) \int_0^q \max\left\{V_{g,1}^{ij\cdot j^-}(x;\Lambda_0), E_k\left[V_{g,1}^{ij\cdot k}(\mu;\Lambda_0)\right]\right\} \mathrm{dQ}(x), \\ &\text{for } g=\{m,f\},\ i=\{u,s\},\ \text{and } j=\{n,h\}, \end{aligned} \tag{2}$$

where $\Lambda_0 = \left\{\lambda_{g,0}^{ij\cdot\cdot}\right\}_{g=m,f}^{i=\{u,s\};j=\{n,h\}}$, j^- denotes the opposite inheritance type of j, $V_{g,1}^{ij\cdot k}$, for $k=j$ orj^-, is the expected value function at the beginning of stage two and μ is the mean of love quality distribution $Q(\cdot)$. Expectation $E_k[\cdot]$ is taken on the marginal distributions of the remaining unmatched agents in the end of the first round matching.[43]

In the end of the first stage, matching based on inheritance takes place, which also means the sorting of population with gender g, earning ability i and inheritance type j according to the heritor status of their (potential) partners is accomplished. Namely, we can state $\sum_k \phi_{g,1}^{ij\cdot k} = \lambda_{g,0}^{ij\cdot\cdot}$, for $g=\{m,f\}$, where $\phi_{g,1}^{ij\cdot k}$ is the proportion of agents in the whole population with gender g whose earning ability is i, inheritance type is j and partner has inheritance type k for $i=\{u,s\}$, $j=\{n,h\}$ and $k=\{n,h\}$. It then follows with $\sum_{i,j,k} \phi_{g,1}^{ij\cdot k}=1$ for $i=\{u,s\}$, $j=\{n,h\}$ and $k=\{n,h\}$. Using $\phi_{g,1}^{ij\cdot k}$, we can construct $\lambda_{g,1}^{i|jk}$, the marginal distribution of earning ability conditional on sorting pattern for inheritance being j for agent with gender g and being k for the partner, as $\frac{\phi_{g,1}^{ij\cdot k}}{\sum_i \phi_{g,1}^{ij\cdot k}}$, for $g=\{m,f\}$, $i=\{u,s\}$, $j=\{n,h\}$ and $k=\{n,h\}$. Given these factors, the expected value function for an agent with gender g, earning ability i, inheritance type j and partner's inheritance type k at the beginning of stage two is

$$\begin{aligned} V_{g,1}^{ij\cdot k} &= \lambda_{g^-,1}^{i|kj} \int_0^q max\{V_{g,2}^{ijik}\left(x;\Lambda_1^{\cdot j\cdot k}\right), E_p\left[V_{g,2}^{ijpk}(\mu;\Lambda_0)\right]\}\mathrm{dQ}(x) \\ &+ \left(1-\lambda_{g^-,1}^{i|kj}\right) \int_0^q \max\left\{V_{g,2}^{iji^-k}\left(x;\Lambda_1^{\cdot j\cdot k}\right), E_p\left[V_{g,2}^{ijpk}(\mu;\Lambda_0)\right]\right\} \mathrm{dQ}(x), \\ &\text{for } g=\{m,f\},\ i=\{u,s\},\ j=\{n,h\},\ \text{and } k=\{n,h\}, \end{aligned} \tag{3}$$

where $\Lambda_1^{\cdot j\cdot k} = \left\{\lambda_{m,1}^{i|jk}, \lambda_{f,1}^{i|kj}\right\}^{i=\{u,s\}}$, i^- denotes the opposite earning ability of i, $V_{g,2}^{ijpk}$ for $p=i$ or i^- is the expected value function at the end of stage two, and expectation $E_p[\cdot]$ is taken on the marginal distributions of the remaining unmatched agents in the end of the first round matching.[44] Actually $V_{g,2}^{ijpk}$ is simply the value function expressed in (1).

[43] $E_k\left[V_{g,1}^{ij\cdot k}(\mu;\Lambda_0)\right] = \sum_i \lambda_{g^-,0'}^{ij\cdot\cdot}(\Lambda_0) V_{g,1}^{ij\cdot j}(\mu;\Lambda_0) + \left[1-\sum_i \lambda_{g^-,0'}^{ij\cdot\cdot}(\Lambda_0)\right] V_{g,1}^{ij\cdot j^-}(\mu;\Lambda_0)$, where $\lambda_{g^-,0'}^{ij\cdot\cdot}$ is, in the end of the first round, the marginal distribution of earning ability among the unmatched agents, with gender g^-, earning ability i and inheritance type j, available for the random match in the second round.

[44] $E_p\left[V_{g,2}^{ijpk}\left(\mu;\Lambda_1^{\cdot j\cdot k}\right)\right] = \lambda_{g^-,1'}^{i|kj} V_{g,2}^{ijik}\left(\mu;\Lambda_1^{\cdot j\cdot k}\right) + (1-\lambda_{g^-,1'}^{i|kj}) V_{g,2}^{iji^-k}\left(\mu;\Lambda_1^{\cdot j\cdot k}\right)$, where $\lambda_{g^-,1'}^{i|kj}$ is, in the end of the first round, the marginal distribution of earning ability among the agents with gender g^-

Table 21 and Table 22 illustrate the equilibrium matching distribution to be solved in the two stages given the marginal distributions, the average annual labor income $w_g^{x|jk}$, with $x = u, s$, $j = n, h$ and $k = n, h$, and the average inherited wealth e_g for each gender ($g = \{m, f\}$).[45]

The key trade-off for both stages is presented in the max operator of both (2) and (3): namely, the agent has to weigh the (expected) payoff between a first-round match with a (potential) partner, holding specific type of traits and a random draw of love quality, and a future partner in the second round, with average type of traits and love quality. The traits are the earning ability (in the second stage of game) or heritor status (in the first stage of game). The chance to meet a specific type of partner is $\sum_i \lambda_{g^-,0}^{ij\cdot\cdot}$ (or $1 - \sum_i \lambda_{g^-,0}^{ij\cdot\cdot}$) in the first stage and $\lambda_{g^-,1}^{i|kj}$ (or $1 - \lambda_{g^-,1}^{i|kj}$) in the second stage. They are given in the beginning of each stage of game. $\sum_i \lambda_{g^-,0'}^{ij\cdot\cdot}$ (or $1 - \sum_i \lambda_{g^-,0'}^{ij\cdot\cdot}$) and $\lambda_{g^-,1'}^{i|kj}$ (or $1 - \lambda_{g^-,1'}^{i|kj}$) are the chance to meet a specific type of partner in the beginning of the second round for the first stage and second stage respectively. They are endogenously determined.

The model is recursively solved backward from the second stage. Let's assume the match quality distribution is uniform.[46] The wage rate and inherited wealth value w_g^u, w_g^s, and e_g for both genders as well as the marginal distribution Λ_0 for the first stage and $\Lambda_1^{\cdot j \cdot k}$, for $j = \{n, h\}$ and $k = \{n, h\}$, in the second stage are given (or solved) in the beginning of each stage. Since sorting by inheritance has been settled in the first stage, agents, in each of the four inheritance type combinations with type-j male population matched with type-k partners, solve the four reserved love qualities $q_{m,1}^{*xjyk}$ and $q_{f,1}^{*xkyj}$, for $x = \{u, s\}$ and $y = \{u, s\}$, from the trade-off mentioned above between labor income and love. Then the equilibrium distribution of matches in the first round can be expressed by the marginal distribution $\Lambda_1^{\cdot j \cdot k}$ and these reserved qualities $q_{m,1}^{*xjyk}$ and $q_{f,1}^{*xkyj}$. The proportion of type-i agents among gender g population remaining to be available for the match in the second round, $\lambda_{m,1'}^{i|jk}$ and $\lambda_{f,1'}^{i|kj}$, for $i = \{u, s\}$, can be derived as a function of initial marginal distribution $\Lambda_1^{\cdot j \cdot k}$ and the equilibrium distribution of matches in the first round. After substitution, we can simply obtain a system of two equations containing two unknowns $\lambda_{m,1'}^{s|jk}$ and $\lambda_{f,1'}^{s|kj}$ as a fixed point problem.[47] Using the solution of this problem, we can finally construct the equilibrium distribution of matches in the end for marriage pattern with inheritance type-j male population matched with inheritance type-k partners as $\phi_2^{xy|jk}$ for $x \in \{u, s\}$ representing the earning ability type for men and $y \in \{u, s\}$ representing

available for the random match in the second round conditional on the sorting pattern for inheritance being k for agent with gender g^- and j for the partner.

[45] The equilibrium distribution is simply the observed one presented in Table 31 using the broadest classification of inheritance type: reported inheritance either in the inheritance section, or HMR or FH.

[46] Uniform distribution seems to be the most intuitive distribution for the love quality (also because we do not have any prior knowledge). This assumption also enhances the tractability since the core system of equations to solve becomes least complex – they have terms involving the cumulative distribution of love and the CDF of uniform distribution introduces the linearity with respect to unknown probabilities. In the end, we can achieve the lowest degree of polynomials. Another benefit of this specification is to refrain from estimating more than one distributional parameter.

[47] The equation on $\lambda_{m,1'}^{u|jk}$ disappears because $\sum_i \lambda_{m,1'}^{i|jk} = 1$. The same applies to the female. Reserved qualities $q_{m,1}^{*xjyk}$ and $q_{f,1}^{*xkyj}$ can be solved as a function of $\lambda_{m,1'}^{i|jk}$ and $\lambda_{f,1'}^{i|kj}$. See Appendix 2, Fernández, Guner, and Knowles (2005) for the derivations.

the counterpart for women. Plugging the solutions in (2), all 16 expected payoff values $V_{g,1}^{ij\cdot k}$ are also calculated.

Given $V_{g,1}^{ij\cdot k}$ and Λ_0, we can similarly derive the equilibrium distribution of matches $\phi_{g,1}^{ij\cdot k}$ in the end of the first stage for $g = \{m, f\}$, $i = \{u, s\}$, $j = \{n, h\}$ and $k = \{n, h\}$. It involves solving a system of six equations and six unknown probabilities.

When love quality is distributed uniformly, the system of equations in either stage turns out to be (piecewise) cubic, which is solved numerically. As discussed above, the marginal distribution $\lambda_{g,1}^{i|jk}$ used in the second stage is simply a function of $\phi_{g,1}^{ij\cdot k}$ solved in the first stage. An iteration to repeatedly solve these two stages can be continued until a convergence of these two groups of probabilities is achieved. All the details on the derivation and estimation results can be accessed from our online appendix.[48]

7.3 Estimation

The parameters to be estimated are the mean t of $Q(\cdot)$ and the substitutability measure β. Estimation of t is carried out by minimizing a least squares function of the 16 observed proportions $\phi_2^{xy|jk}$ and their estimates in the second stage. This stage is separate from the estimation of β which is by construction independent from the equilibrium solutions in this stage. We also estimate 16 $\phi_{g,1}^{ij\cdot k}$'s in the first stage by fitting a least squares function of the observed and estimated proportions. The final estimates can be picked from a converged iteration procedure stated above.

The wage rate and inherited wealth value w_g^u, w_g^s, and e_g for both genders as well as the marginal distribution Λ_0 for the first stage and Λ_1^{jk}, for $j = \{n, h\}$ and $k = \{n, h\}$, in the second stage are already contained in Table 21 and Table 22. Table 23 and Table 24 provide both the estimated and observed equilibrium matching distributions in two stages. It is interesting to observe that the model fit is almost perfect and the difference, if any, between observed and estimated proportions are almost always below or equal to 0.01 for a probability measure in the first stage and 0.02 for a conditional probability in the second stage. Given this, we do not proceed beyond one iteration. The least squares functions regarding both t and β have a U shape on the support between zero and one with the bottom reaching 30,387.5 and 0.70 respectively.[49]

All the estimates so far are calculated from the data using case 2 (probit-based) assignment of inherited housing and future inheritance to fully identify the inheritance type. A comparison of Table 31 and 33 in Appendix A.1 shows the matching pattern is almost invariant under both assignments. Appendix A.2 assures that our results are insensitive

[48] Link: https://sites.google.com/site/junyizhu21/mating_modelling.zip

[49] Namely, the length of the support for love distribution is 60,775. If we fit with two digits of observed proportions, the β estimate is 0.72. We decide to fit with the observed proportions rounded up to the fourth digit for the final estimate since fit starts to be stable from rounding up to the third digit on. The model is estimated using Maple. We use NLPsolve from the Optimization package and SolveEquations from the DirectSearch package (v2; Moiseev (2011)) alternatively in solving the model and fitting data. To deal with potential multiple optima, branch and bound method is adopted in NLPSolve and global search strategy is taken for SolveEquations. When solving the core system of polynomial equations in each stage, we randomly select 30 starting points between zero and one (the support of unknowns in probability) using uniform distribution. Results seem to be robust to using different optimization methods and setups.

to the assignment rules. We re-estimate the model using the alternative case 1 (random) assignment and results are robust.

7.4 Sensitivity analysis

We inspect two aspects of our model setup: the necessity of imposing average income and inheritance values for various margins using observed data and the validity of the alternative sorting sequence – firstly on income and then on inheritance. Using the observed income and inheritance for different marriage types in the equation (1), we seem to map our marital payoff to a pecuniary consideration – e.g. couples are making a trade-off between life-long financial resources and a love quality measured by money. But couples might have an abstract valuation of income and inheritance type – i.e. marrying a partner from the top half income and/or being heir/heiress is simply a status gain. In the first exercise, we then replace all the observed income and inheritance (average) values with an indicator variable which is zero for being in the bottom half income group or non-heir/non-heiress, and one for being in the top half income group or heir/heiress. The other key assumption in our model is the mating market segregated by inheritance types from each gender. In the second exercise, we reverse the sorting sequence, which corresponds to a hypothetical segregation by income types from each gender. The observed four by four contingency table is simply produced by switching the position of income and inheritance variables for each gender. Likewise, we estimate our model by exchanging these two variables/margins.[50]

In the first exercise, the least squares functions regarding t again appears to be U-shaped, which hits the bottom at 0.91. The estimated least square is 0.0012, which is even better than 0.0014 – in our benchmark case above. However, the estimated β is the one in which the corresponding least squares function monotonically rises when β decreases away from one. The estimated least square is 0.0030, which is much worse than 0.0005 – in our benchmark case above.[51] It seems the sorting by income in our stage II model can also be well fitted by a "status-gain" marital payoff function. But this alternative model assumption performs more poorly in fitting stage I observations. Furthermore, this result leads to the inconsistency of identification: β being one implies that income plays zero role in matching which contradicts with the identifiability of t in the first stage of game or the fact that matching by income is not random.

After we switch the sorting order, the estimators for both parameters/stages stall: the least squares function in estimating t is always flat for a range between zero and about 25,000 and then shoots up as t rises further.[52] β estimate by using some t in the initial flat range is rather unstable: the associated least squares function either fluctuates or almost

[50]These exercises can also be deemed to test if our model identifiability is driven simply by the mathematical artifice such that any kind of hypothetical two-dimensional matching contingency table and/or payoff levels can be fed into our model and identify the parameters.

[51]This distance in least squares represents averagely more than 1% difference between observed and estimated cell proportion. Note we have 16 cells to match in the stage I estimation for β.

[52]When t, the mean of $Q(\cdot)$, is small enough, there is only one identical equilibrium matching distribution in stage II: those skilled-skilled (or heir-heiress) matches in the first round should all accept and do not move to the second round since the expected love is always too small to compensate for the drop in pecuniary payoff in the second round; and all the other match types in the first round should all reject and move to the second round due to the exact opposite reasoning.

all flat for β between zero and one. Basically, this model setup can not be identified by our data.

7.5 A lifetime wealth perspective

We have presented before that the degree of difference between the stock of inheritance and annual income level seems to be unable to justify such dominance in sorting by inheritance over sorting by income observed in both Germany and France. To disentangle this contrast, we transform our marital payoff function in (1) to a form of life-long family wealth together with the love quality which marital choice maximizes.[53] We then perform a back-of-the-envelope calculation by plugging in the sensible economic and demographic parameters to perceive how far a life-long perspective may explain the superior sorting role from inheritance.

The lifetime wealth for a couple is composed of the accumulation from two flows: inheritance and gifts b_t and (labor) income y_t for each year t.[54] Consider an average person who is married at year m and dies at year n. The rate of return for wealth accumulation is r and (income) growth rate is g. We annualize b_t flows as b for the years before marriage and kb for the years after marriage where k is the scaling factor between the inheritance received before and after marriage. Then the couple's wealth at the end of life is

$$kb\int_m^n e^{r(t-m)}dt + y_m\int_m^n e^{(r+g)(t-m)}dt. \tag{4}$$

The saving rate is 100% here. A saving rate smaller than one and constant for both inheritance and income will simply yield the same result. At q years after marriage, we observe B_{m+q} the stock of b_t accumulated from year 0 and y_{m+q} the income at that year. By inserting B_{m+q} to substitute away from b and factoring, (4) becomes

$$A[\frac{ke^{-rq}\int_m^n e^{r(t-m)}dt}{A\int_0^m e^{rt}dt}B_{m+q} + \frac{e^{-gq}\int_m^n e^{(r+g)(t-m)}dt}{A}y_{m+q}], \tag{5}$$

where A is $\frac{ke^{-rq}\int_m^n e^{r(t-m)}\mathrm{d}t}{\int_0^m e^{rt}\mathrm{d}t} + e^{-gq}\int_m^n e^{(r+g)(t-m)}$. e^{-rq} and e^{-gq} are the discount factors such that $B_{t+q}e^{-rq} = b\int_0^m e^{rt}\mathrm{d}t$ and $y_m = y_{m+q}e^{-gq}$. Then the lifetime wealth is just the pecuniary part in the marital payoff of (1) scaled by A. And our estimate of β is equivalent to $\frac{ke^{-rq}\int_m^n e^{r(t-m)}\mathrm{d}t}{A\int_0^m e^{rt}\mathrm{d}t}$.

To examine the degree to which we can describe the marriage payoff from the lifetime wealth perspective, the distance between a calibrated scale k and the observed (or estimated) one from the literature is judged. We equalize our estimate of β to the mapping expression in (5) with reasonable parameter values for all except k and then solve for k. r and g are chosen to be 1.1% and 3.8% as the world average level from approximately the first half

[53] We thank Winfried Koeniger and John Sabelhaus for motivating this thought.

[54] Resources are always assumed to be pooled for the couple. To simplify the analysis, we assume zero saving before marriage. We also carry out a calculation allowing saving before marriage which can produce the similar result under a sensible scenario.

and second half of the 20th century, respectively (Piketty and Zucman, 2014).[55] We let the age at (first) marriage m be 27 and the age at death n be 69.[56] We then solve for k at five age cohorts – i.e. letting q being 10, 20, 30, 40, 50, which accounts for the most of our couple sample. The solutions are 146, 111, 85, 65 and 50 when q ranges from 10 to 50. Table 25 collects the aggregate flows of inheritance and gifts in Germany for 1961 - 2009 which is reported by Schinke (2012).[57] The largest ratios between any two years are those with respect to 1961 and this ratio corresponds to our concept of k. They range from 5 to 87. Considering the rising trend of inheritance flows, our estimate from the marriage matching model seems to suggest that agents are reasonably proficient in forecasting the future inheritance flows relative to the past observations. And the weak substitutability between income sorting and wealth sorting can be driven by the long run strong growth of future inheritance.

To push forward this back-of-the-envelope analysis is beyond the scope of this paper. It deserves further research along at least two dimensions: incorporating more knowledge from other social sciences such as sociology on the nature of the "superstructure" through, for example, micro data on the role of the class preference in socialization; and analyzing the causes and consequences of rational expectations in marital sorting by these two dimensions – i.e. how well and why the population can predict the rising flows of inheritance when they were still at a relatively low level as well as who benefits economically from the sorting.[58]

8 Conclusion

Using German PHF data, this study establishes the empirical analysis parallel to the French study (Frémeaux, 2014) on two-dimensional assortative mating based on labor income and inherited wealth. Similar to the French outcome, we observe a stronger sorting by inheritance than more established evidence about sorting by income. This degree of sorting becomes more concentrated at the top of the distributions. Labor income and inherited wealth are not perfect substitutes in marital choice.

Our model almost exactly replicates the equilibrium matching distribution over two dimensions under a sequential sorting setup. The estimated contribution from inherited wealth to the pecuniary pay-off of the marital choice is about two and a half times higher than that from labor income. The estimator reaches a unique global optimum. The alternative models of "status-gain" setup or reverse sorting sequence cannot be identified from the data.

[55] See Figure 15.28 in that paper. We assume people are more informative about the current development of the growth rate than the rate of return which is generally consistent with the German context in the 20th century.

[56] See Table 4 for the age at first marriage in Engstler and Menning (2017). We use the average value in the 1990s which corresponds to roughly the age at first marriage for the 50-year-old cohort in 2013, the reference year of second wave of PHF. The average age for our couple sample is around 50. See http://data.worldbank.org/indicator/SP.DYN.LE00.IN for the life expectancy of the 1960s, our average age cohort.

[57] See Table 10 in that paper.

[58] For instance, Corneo and Jeanne (1999) discuss the relationship between matching under social segmentation and wealth accumulation.

Theoretically, we could extend this model to discuss finer matching distribution (e.g., every decile in one gender's (employee's) trait matching the decile in the other gender's (employer's) trait). It can be used as long as the context in question shares an "unfolding bracket" structure such as our current application.

The good fit of the model may contrast with the public discourse, which does not hold that the pecuniary payoff itself, or as proxy for some hidden belief – e.g., a "patrimonial capitalism" as depicted in (Milanovic, 2014) – can be so powerful in explaining the marriage market. Our back-of-the-envelope calculation to associate the model estimate with a lifelong wealth perspective for the marital choice seems to support the hypothesis that marriage formation can be modelled using an economic rationality analysis. A major limit of our work is that it does not address the issue of whether this economic rationality analysis properly reflects the actual social fact of marriage formation as experienced by individuals. Indeed, observed sorting by inherited wealth does not necessarily mean that individuals consciously develop such rational strategies for marriage formation, and could be interpreted as a symptom of social stratification and socio-spatial segregation. Studies on other countries (e.g. China and US) are expected to test our model in other social contexts. Using our model to perform simulations for policy purposes, such as the effect of inheritance and family taxation on household-level inequality, could be an attractive avenue for further research.

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Table 1: Age, high education level and employment status of individuals in a stable relationship by gender

Proportion of individuals in a stable relationship by age and gender		
	Men	Women
16-25	11.9%	25.4%
26-35	55.4%	69.8%
36-45	72.0%	72.0%
46-55	69.9%	72.4%
56-65	71.4%	71.1%
66-75	73.1%	59.7%
76+	65.6%	34.0%
Distribution of higher education level by gender		
	Men	Women
No university degree or professional training	7.3%	17.0%
Currently studying	1.0%	1.6%
Professional and vocational training	70.4%	63.7%
University of applied science or engineering school	7.6%	4.8%
University	11.7%	11.4%
Doctorate / Habilitation	1.9%	1.1%
Other	0.2%	0.5%
Distribution of employment status by gender		
	Men	Women
Employed full-time	60.0%	25.2%
Employed part-time	5.2%	29.1%
Parental leave	1.4%	4.7%
Unemployed	3.3%	3.4%
Pupil, student or unpaid intern	1.2%	2.1%
Retiree, pensioner	26.9%	20.1%
Early retiree or unfit for work	2.0%	2.0%
Homemaker	0.2%	13.4%

Table 2: Distribution of estimated household net wealth and labor income for the couples

	Estimated household net wealth	Annual labor income	
		Men	Women
p10	200	7,200	0
p10	7,000	13,000	1,500
Median	80,000	26,000	10,000
p80	300,000	46,000	23,900
p90	500,000	63,100	36,000
p95	700,000	86,700	46,660
p98	1,050,000	120,000	70,000
Mean	196,111	34,639	15,972
s.d.	478,382	45,793	26,692

Table 3: Distribution of couples by main residence ownership and current value of the main residence conditional on ownership type

Couples by acquiry of main residence		
Not owning main residence		43%
Owning main residence not through inheritance		44%
Owning main residence through inheritance		13%
Current value of the main residence (€)		
	Couples with ownership	Couples with inherited ownership
p10	70,000	50,000
p10	100,000	75,000
Median	190,000	170,000
p80	350,000	350,000
p90	450,000	600,000
p95	600,000	1,000,000
p98	1,000,000	3,000,000
Mean	255,978	315,698
s.d.	330,351	569,728

Table 4: Distribution of inherited wealth for the population of heirs and heiresses receiving inheritance in the past

	Case 0[1]		Case 1		Case 2	
	Heirs	Heiresses	Heirs	Heiresses	Heirs	Heiresses
	(19.2%)[2]	(20.2%)	(24.4%)	(25.05%)	(23.8%)	(25.0%)
p10	6,933	6,032	8,514	7,856	8,352	7,874
p20	14,137	14,126	20,011	17,339	20,000	17,324
Median	53,488	56,620	80,331	74,188	81,852	73,270
p80	205,380	166,250	253,137	225,085	250,368	221,840
p90	411,840	242,916	497,773	368,549	492,164	411,222
p95	712,500	362,416	829,621	560,937	854,400	578,540
p98	1,302,488	622,280	1,446,382	1,056,856	1,386,500	1,000,000
Mean	186,344	152,245	230,086	203,381	231,696	207,553

Note:
[1] Three cases are distinguished by the coverage of inherited wealth: 0 - without accounting for inherited HMR; 1- with accounting for inherited HMR by the random assignment to either partner and 1 - with accounting for inherited HMR by the probit-based assignment.
[2] Percentages in all the parentheses reflect the estimated proportions of heirs and heiresses in each case.

Table 5: Proportion of heirs/heiresses conditional on region of residence, age and high level of education in a stable relationship (case 2: inheritor determined by inheritance section and probit-based assignment of both inherited housing and future inheritance)

	Heirs[2]	Heiresses
Region of residence		
East[1]	14.9%	26.3%
South	29.8%	36.2%
West	28.5%	22.6%
North	30.5%	27.5%
Age cohorts		
16-25	6.2%	17.2%
26-35	13.6%	23.4%
36-45	22.1%	25.9%
46-55	31.1%	31.6%
56-65	37.3%	34.1%
66-75	28.6%	35.6%
76 +	25.8%	27.0%
High education level		
No univ degree or professional training	6.3%	16.3%
Currently studying	8.8%	33.7%
Professional and vocational training	25.3%	30.5%
Univ of applied science or engineering school	32.8%	37.0%
Univ	40.2%	34.1%
Doctorate / Habilitation	47.9%	38.9%
Other	62.5%	57.8%

Note:
[1] East (Berlin, Brandenburg, Mecklenburg-West Pomerania, Saxony, Saxony-Anhalt, Thuringia), South (Bavaria, Baden-Württemberg, Hesse), West (North Rhine-Westphalia, Rheinland-Palatinate, Saarland) and North (Bremen, Hamburg, Schleswig-Holstein, Lower Saxony)
[2] Inheritors are pinned down by either receipt of past inheritance or the expectation of a future inheritance. We account for the inherited HMR and expected inheritance by a probit assignment (case 2). Results derived from the random assingment (case 1) is just close.

Table 6: Hypothetical cell proportion for the couples population in the random mating conditional on observed gender-specific income distribution

	Wife's labor income in bottom 50%	Wife's labor income in top 50%
Husband's labor income in bottom 50%	24.4%	24.9%
Husband's labor income in top 50%	25.1%	25.6%

Table 7: Observed cell proportion for the couples population in the actual mating conditional on gender-specific income distribution

	Wife's labor income in bottom 50%	Wife's labor income in top 50%
Husband's labor income in bottom 50%	27.2%	22.1%
Husband's labor income in top 50%	22.4%	28.3%

Table 8: Relative difference in cell proportion between observed and random mating for the whole couples population conditional on gender-specific income distribution

	Wife's labor income in bottom 50%	Wife's labor income in top 50%
Husband's labor income in bottom 50%	11.3%	-11.1%
Husband's labor income in top 50%	-11.0%	10.8%

Table 9: Relative difference in cell proportion between observed and random mating for the whole couple population conditional on the inheritance status for husbands and wives (heir/heiress is identified by either the inheritance section or inherited HMR with the latter assigned by random (case 1) or probit-based (case 2; in parentheses) rules)

	Non-heiress	Heiress
Non-heir	9.2% (8.2%)	-27.3% (-24.6%)
Heir	-28.2% (-26.3%)	84.5% (78.8%)

Table 10: Relative difference in cell proportion between observed and random mating for the whole population of couples conditional on gender-specific income distribution and inheritance status for husbands and wives (case 2: inheritor determined by inheritance section and probit-based assignment of both inherited housing and future inheritance)

		Non-heiress		Heiress	
		Wife's labor income in bottom 50%	Wife's labor income in top 50%	Wife's labor income in bottom 50%	Wife's labor income in top 50%
Non-heir	Husband's labor income in bottom 50%	23.74%	-0.61%	-19.66%	-36.34%
	Husband's labor income in top 50%	-7.48%	15.18%	-28.72%	8.74%
Heir	Husband's labor income in bottom 50%	-14.69%	-27.06%	75.11%	28.37%
	Husband's labor income in top 50%	-31.45%	-13.54%	60.15%	50.12%

Table 11: Risk ratios for the whole couples population, wives' perspective

	Inherited wealth[1]									Labour income		
	Case 0			Case 1			Case 2					
	Est[2]	Sig[3]	S.E.	Est	Sig	S.E.	Est	Sig	S.E.	Est	Sig	S.E.
Heir/Heiress	3.47	***	0.101	2.31	***	0.091	2.30	***	0.094			
Top20				2.26	***	0.141	2.17	***	0.108	1.34	**	0.140
Top10	4.33	***	0.159	2.99	***	0.210	3.10	***	0.331	1.66	***	0.213
Top5	7.19	***	0.244	2.18	***	0.262	2.02	***	0.352	2.39	**	0.560
Top2	5.12	***	0.546	4.38	***	0.496	5.36	***	1.037	2.99	**	0.781

Note:

[1] Three cases are distinguished by the coverage of inherited wealth: 0 - without accounting for inherited HMR; 1- with accounting for inherited HMR by the random assignment to either partner and 1 - with accounting for inherited HMR by the probit-based assignment.

[2] Risk ratio is simply P(husband with characteristic Y|wife WITH characteristic Y, X) / P(husband with characteristic Y|wife WITHOUT characteristic Y, X). Y are inheritance status (eg. heir or non-heir) or distributional features (e.g., belonging to top 20% of inherited wealth distribution/labor income or not) and X are the control variables (age, education and region). Distributional features are defined within their own genders. For example, according to the inherited wealth distribution from the inheritance section and random assignment of inherited housing (case1), a top 10% heiress is 2.99 times more likely than a bottom 90% heiress to mate with a top 10% heir.

[3] Significantly different from one at: *10% **5% ***1%.

Table 12: Risk ratios for the whole couples population, husbands' perspective

	Inherited wealth[1]									Labour income		
	Case 0			Case 1			Case 2					
	Est[2]	Sig[3]	S.E.	Est	Sig	S.E.	Est	Sig	S.E.	Est	Sig	S.E.
Heir/Heiress	3.31	***	0.096	2.28	***	0.089	2.17	***	0.093			
Top20				2.21	***	0.106	2.05	***	0.111	1.64	***	0.168
Top10	4.05	***	0.152	2.92	***	0.239	2.95	***	0.184	1.96	***	0.289
Top5	6.70	***	0.258	2.15	***	0.262	1.88	***	0.291	2.49	**	0.555
Top2	4.70	***	0.594	4.08	***	0.480	4.58	***	0.802	3.17	***	0.671

Note:
[1] Three cases are distinguished by the coverage of inherited wealth: 0 - without accounting for inherited HMR; 1- with accounting for inherited HMR by the random assignment to either partner and 1 - with accounting for inherited HMR by the probit-based assignment.
[2] Risk ratio is simply P(wife with characteristic Y|husband WITH characteristic Y, X) / P(wife with characteristic Y|husband WITHOUT characteristic Y, X). Y are inheritance status (eg. heir or non-heir) or distributional features (e.g., belonging to top 20% of inherited wealth distribution/labor income or not) and X are the control variables (age, education and region). Distributional features are defined within their own genders. For example, according to the inherited wealth distribution from the inheritance section and random assignment of inherited housing (case1), a top 10% heir is 2.92 times more likely than a bottom 90% heir to mate with a top 10% heiress.
[3] Significantly different from one at: *10% **5% ***1%.

Table 13: Risk ratios for the subpopulation of working-age couples, wives' perspective

	Inherited wealth[1]									Labor income			Wage rage		
	Case 0			Case 1			Case 2								
	Est[2]	Sig[3]	S.E.	Est	Sig	S.E.	Est	Sig	S.E.	Est	Sig	S.E.	Est	Sig	S.E.
Heir/Heiress	3.20	***	0.129	2.14	***	0.114	2.11	***	0.107						
Top20				1.95	***	0.124	1.83	***	0.123	1.44	***	0.148	1.44	**	0.152
Top10	3.22	***	0.243	2.52	***	0.216	2.27	***	0.201	1.56	**	0.259	1.43		0.264
Top5	4.37	***	0.316	1.77	**	0.340	1.47		0.394	2.13		0.757	2.07	**	0.390
Top2	1.22		0.536	2.28		1.279	1.73		1.173	2.98	*	0.941	3.75		1.425

Note:
[1] Three cases are distinguished by the coverage of inherited wealth: 0 - without accounting for inherited HMR; 1- with accounting for inherited HMR by the random assignment to either partner and 1 - with accounting for inherited HMR by the probit-based assignment.
[2] Risk ratio is simply P(husband with characteristic Y|wife WITH characteristic Y, X) / P(husband with characteristic Y|wife WITHOUT characteristic Y, X). Y are inheritance status (eg. heir or non-heir) or distributional features (e.g., belonging to top 20% of inherited wealth distribution/labor income or not) and X are the control variables (age, education and region). Distributional features are defined within their own genders. For example, according to the inherited wealth distribution from the inheritance section and random assignment of inherited housing (case1), a top 10% heiress is 2.52 times more likely than a bottom 90% heiress to mate with a top 10% heir.
[3] Significantly different from one at: *10% **5% ***1%.

Table 14: Risk ratios for the subpopulation of couples residing in western Germany, wives' perspective

	Inherited wealth[1]									Labor income		
	Case 0			Case 1			Case 2					
	Est[2]	Sig[3]	S.E.	Est	Sig	S.E.	Est	Sig	S.E.	Est	Sig	S.E.
Heir/Heiress	3.22	***	0.104	2.21	***	0.095	2.22	***	0.094			
Top20				2.13	***	0.116	2.07	***	0.138	1.26	*	0.145
Top10	4.54	***	0.160	2.93	***	0.190	3.18	***	0.221	1.68	**	0.268
Top5	5.30	***	0.249	2.47	***	0.307	2.78	***	0.301	2.18	**	0.507
Top2	4.62	***	0.451	4.96	***	0.736	5.15		2.351	2.60	*	0.779

Note:

[1] Three cases are distinguished by the coverage of inherited wealth: 0 - without accounting for inherited HMR; 1- with accounting for inherited HMR by the random assignment to either partner and 1 - with accounting for inherited HMR by the probit-based assignment.

[2] Risk ratio is simply P(husband with characteristic Y|wife WITH characteristic Y, X) / P(husband with characteristic Y|wife WITHOUT characteristic Y, X). Y are inheritance status (eg. heir or non-heir) or distributional features (e.g., belonging to top 20% of inherited wealth distribution/labor income or not) and X are the control variables (age, education and region). Distributional features are defined within their own genders. For example, according to the inherited wealth distribution from the inheritance section and random assignment of inherited housing (case1), a top 10% heiress is 2.93 times more likely than a bottom 90% heiress to mate with a top 10% heir.

[3] Significantly different from one at: *10% **5% ***1%.

Table 15: Risk ratios for the subpopulation of couples residing in western Germany, husbands' perspective

	Inherited wealth[1]									Labor income		
	Case 0			Case 1			Case 2					
	Est[2]	Sig[3]	S.E.	Est	Sig	S.E.	Est	Sig	S.E.	Est	Sig	S.E.
Heir/Heiress	3.14	***	0.102	2.20	***	0.095	2.17	***	0.100			
Top20				2.09	***	0.115	1.92	***	0.136	1.65	***	0.172
Top10	4.05	***	0.161	2.82	***	0.192	2.79	***	0.211	2.01		0.938
Top5	4.60	***	0.257	2.41	***	0.305	2.48	***	0.287	2.35	*	0.636
Top2	4.31	***	0.458	4.92	***	0.566	4.52		2.083	2.73	*	0.890

Note:
[1] Three cases are distinguished by the coverage of inherited wealth: 0 - without accounting for inherited HMR; 1- with accounting for inherited HMR by the random assignment to either partner and 1 - with accounting for inherited HMR by the probit-based assignment.
[2] Risk ratio is simply P(wife with characteristic Y|husband WITH characteristic Y, X) / P(wife with characteristic Y|husband WITHOUT characteristic Y, X). Y are inheritance status (eg. heir or non-heir) or distributional features (e.g., belonging to top 20% of inherited wealth distribution/labor income or not) and X are the control variables (age, education and region). Distributional features are defined within their own genders. For example, according to the inherited wealth distribution from the inheritance section and random assignment of inherited housing (case1), a top 10% heir is 2.82 times more likely than a bottom 90% heir to mate with a top 10% heiress.
[3] Significantly different from one at: *10% **5% ***1%.

Table 16: The proportion of top T% individuals in a stable relationship at the gender-specific labor income distribution located also within top T% at the gender-specific inherited wealth distribution

T	Men	Women
Top10	19.9%	13.7%
Top5	15.5%	11.4%
Top2	4.4%	4.1%

Note: Inherited wealth according to the inheritance section only. For example, among the top 10% husbands in terms of labor income, 19.9% are also top 10% men in terms of inherited wealth.

Table 17: Change in chance to mate a partner at the top 10, 5 and 2% of the inherited wealth or labor income distributions gained by the wives or husbands belonging to the same top distribution

	Wives' perspective						Husbands' perspective					
	Inheritance			Labor income			Inheritance			Labor income		
	Est[1]	Sig[2]	S.E.	Est	Sig	S.E.	Est	Sig	S.E.	Est	Sig	S.E.
Top 10 inherited wealth[3]	0.169	***	0.017	0.067	***	0.020	0.165	***	0.016	0.044	*	0.024
Top 10 labor income	0.061	***	0.023	0.130	***	0.019	0.043	**	0.019	0.127	***	0.019
Difference	0.109	***	0.029	-0.063	**	0.026	0.122	***	0.028	-0.082	**	0.034
Top 5 inherited wealth	0.117	***	0.017	0.052	***	0.015	0.112	***	0.017	0.019		0.016
Top 5 labor income	0.032	*	0.018	0.094	***	0.017	0.044	***	0.017	0.096	***	0.017
Difference	0.078	***	0.026	-0.042	*	0.023	0.068	***	0.026	-0.078	***	0.026
Top 2 inherited wealth	0.041	***	0.010	0.017		0.016	0.041	***	0.010	0.001		0.011
Top 2 labor income	-0.001		0.011	0.053	***	0.015	0.019		0.013	0.049	***	0.013
Difference	0.043	***	0.017	-0.036		0.023	0.023		0.017	-0.048	***	0.018

Note:

[1] For example, 0.169 (first column, first row) means that for a female partner, belonging to the top 10% of the inherited wealth distribution increases by 16.9% the probability to mate a male partner belonging to the top 10% of the inherited wealth distribution. The equivalent interpretation applies to 0.061 (first column, second row) in terms of a female partner in the top 10% labor income distribution to a male partner belonging to the top 10% of the inherited wealth distribution. 0.109 (first column, third row) is the difference between the above two figures. It provides an assessment about the degree at which the first dimension (inherited wealth) overperforms/underperforms the second dimension (labor income) in terms of the chance to mate a partner at the same top distribution of either dimension.

[2] Significantly different from one at: *10% **5% ***1%.

[3] Inherited wealth is taken from the approach of Case 2: inheritance section plus probit-based assignment rule of inherited housing.

Table 18: Risk ratios: French vs German results

			Wives' perspective		Husbands' perspective	
	Top T% distribution		10	5	10	5
French[1]	Inheritance		3.68***[3]	4.29***	3.29***	3.58***
	Current Income		2.97***	4.25***	1.56***	2.00***
	Permanent Income		5.27***	7.29***	2.14***	2.86***
German[2]	Inheritance	Case 0[4]	4.33***	7.19***	4.05***	6.7***
		Case 1	2.99***	2.18***	2.92***	2.15***
		Case 2	3.10**	2.02***	2.95***	1.88***
	Current Income		1.66***	2.39**	1.96***	2.49**
	Permanent Income		1.43	2.07**	1.31	1.94*

Note:
[1] Table 3 in Frémeaux (2014);
[2] Table 10 / 11 for the wife / husband's perspective except the values for permanent income which is taken from the column of wage rate in Table 22 / 23;
[3] Significantly different from one at: *10% **5% ***1%.
[4] Three cases are distinguished by the coverage of inherited wealth: 0 - without accounting for inherited HMR; 1- with accounting for inherited HMR by the random assignment to either partner and 1 - with accounting for inherited HMR by the probit-based assignment.

Table 19: Table 5 in Frémeaux (2014) as counterpart of Table 17 for the French result

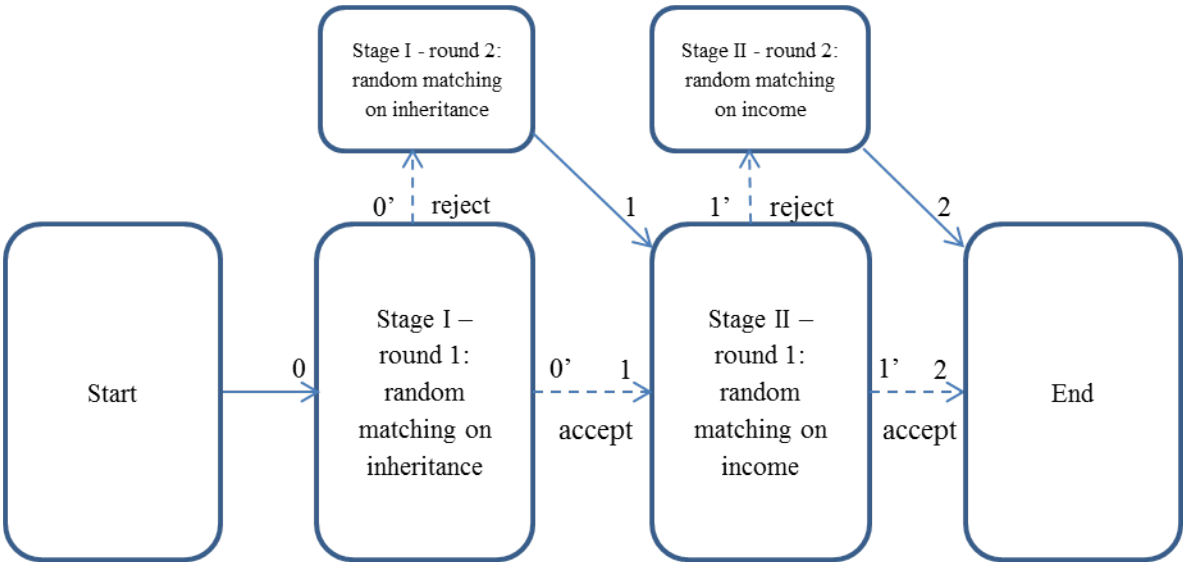
	Panel A: Male partners		Panel B: Female partners	
	Inheritance	Permanent income	Inheritance	Permanent income
Top 10% inheritance [1]	0.200***	0.041***	0.203***	0.059***
	(0.000)	(0.000)	(0.000)	(0.000)
Top 10% permanent income [2]	0.067***	0.285***	0.052***	0.280***
	(0.000)	(0.000)	(0.000)	(0.000)
Difference [1-2]	0.133***	-0.244*	0.151***	-0.221*
	(0.000)	(0.000)	(0.000)	(0)

Table 20: Top decile mean(€) of inherited wealth (including probit assigned inherited HMR - case 2) and annual labor income for men and women

		Men	Women
French[1]	Inherited wealth	353,310	299,300
	Labor income	71,080	36,630
German	Inherited wealth	486,887	458,686
	Labor income	117,379	65,046

Source: Table B.1 and B.2 of Frémeaux (2014) for France.

Figure 1: Stage of the game



Notes: Numbers next to the end of path arrow represent the period indices shown in the subscripts of our notation system. The path with action (acceptance/rejection) involved is denoted by the dashed arrow. When less than the full population participate, a smaller size of box is used (eg. the stage I - round 2).

Table 21: The second stage of matching distribution $\phi_2^{xy|jk}$ on labor income given the marginal distribution $\lambda_{g,1}^{i|jk}$ conditional on inheritance type matching type (nn, hn, nh and hh presented in four blocks) settled in the first stage (case 2: inheritor determined by inheritance section and probit-based assignment of both inherited housing and future inheritance)

	$\lambda_{f,1}^{u\|nn} = 0.50$ $w_f^{u\|nn} = 3,435$	$\lambda_{f,1}^{s\|nn} = 0.50$ $w_f^{s\|nn} = 27,436$		$\lambda_{f,1}^{u\|hn} = 0.46$ $w_f^{u\|hn} = 2,789$	$\lambda_{f,1}^{s\|hn} = 0.54$ $w_f^{s\|hn} = 29,363$
$\lambda_{m,1}^{u\|nn} = 0.54$ $w_m^{u\|nn} = 13,397$	$\phi_2^{uu\|nn}$	$\phi_2^{us\|nn}$	$\lambda_{m,1}^{u\|nh} = 0.47$ $w_m^{u\|nh} = 14,578$	$\phi_2^{uu\|nh}$	$\phi_2^{us\|nh}$
$\lambda_{m,1}^{s\|nn} = 0.46$ $w_m^{s\|nn} = 50,971$	$\phi_2^{su\|nn}$	$\phi_2^{ss\|nn}$	$\lambda_{m,1}^{s\|nh} = 0.53$ $w_m^{s\|nh} = 59,155$	$\phi_2^{su\|nh}$	$\phi_2^{ss\|nh}$
	$\lambda_{f,1}^{u\|nh} = 0.48$ $w_f^{u\|nh} = 3,680$	$\lambda_{f,1}^{s\|nh} = 0.52$ $w_f^{s\|nh} = 28,994$		$\lambda_{f,1}^{u\|hh} = 0.52$ $w_f^{u\|hh} = 3,924$	$\lambda_{f,1}^{s\|hh} = 0.48$ $w_f^{s\|hh} = 29,776$
$\lambda_{m,1}^{u\|hn} = 0.41$ $w_m^{u\|hn} = 17,182$	$\phi_2^{uu\|hn}$	$\phi_2^{us\|hn}$	$\lambda_{m,1}^{u\|hh} = 0.40$ $w_m^{u\|hh} = 12,267$	$\phi_2^{uu\|hh}$	$\phi_2^{us\|hh}$
$\lambda_{m,1}^{s\|hn} = 0.59$ $w_m^{s\|hn} = 60,336$	$\phi_2^{su\|hn}$	$\phi_2^{ss\|hn}$	$\lambda_{m,1}^{s\|hh} = 0.60$ $w_m^{s\|hh} = 56,038$	$\phi_2^{su\|hh}$	$\phi_2^{ss\|hh}$

Note:$\lambda_{g,1}^{x|jk}$ is the marginal distribution of labor income for each gender (g) of married population conditional on the settled sorting male type-j and female type-k of inheritance type for $x = u, s$, $j = n, h$, $k = n, h$ and $g = m, f$. $\phi_2^{xy|jk}$ is the equilibrium proportion of male type-x and female type-y on labor income matching conditional on the settled sorting male type-j and female type-k of inheritance type for $x = u, s$, $y = u, s$, $j = n, h$ and $k = n, h$. $w_g^{x|jk}$ is the average annual labor income for $x = u, s$, $j = n, h$ and $k = n, h$ for each gender ($g = m, f$).

Table 22: The first stage of matching on inheritance by allocating the marginal distribution of labor income (i) – inheritance type (j) types for each gender (g) $\lambda_{g,1}^{ij\cdot\cdot}$ to $\phi_{g,1}^{ij\cdot n}$ and $\phi_{g,1}^{ij\cdot h}$ for two heritor types of partner: male sorting choice in the left block and female sorting choice in the right block (case 2: inheritor determined by inheritance section and probit-based assignment of both inherited housing and future inheritance)

		f $e_f = 178,770$ n	h
m	$\lambda_{m,1}^{un\cdot\cdot} = 0.39$	$\phi_{m,1}^{un\cdot n}$	$0.39 - \phi_{m,1}^{un\cdot n}$
	$\lambda_{m,1}^{sn\cdot\cdot} = 0.35$	$\phi_{m,1}^{sn\cdot n}$	$0.35 - \phi_{m,1}^{sn\cdot n}$
	$\lambda_{m,1}^{uh\cdot\cdot} = 0.11$	$\phi_{m,1}^{uh\cdot n}$	$0.11 - \phi_{m,1}^{uh\cdot n}$
	$\lambda_{m,1}^{sh\cdot\cdot} = 0.16$	$\phi_{m,1}^{sh\cdot n}$	$0.16 - \phi_{m,1}^{sh\cdot n}$

		f			
		$\lambda_{f,1}^{un\cdot\cdot} = 0.35$	$\lambda_{f,1}^{sn\cdot\cdot} = 0.35$	$\lambda_{f,1}^{uh\cdot\cdot} = 0.14$	$\lambda_{f,1}^{sh\cdot\cdot} = 0.15$
m $e_m = 207,557$	n	$\phi_{f,1}^{un\cdot n}$	$\phi_{f,1}^{sn\cdot n}$	$\phi_{f,1}^{uh\cdot n}$	$\phi_{f,1}^{sh\cdot n}$
	h	$0.35 - \phi_{f,1}^{un\cdot n}$	$0.35 - \phi_{f,1}^{sn\cdot n}$	$0.14 - \phi_{f,1}^{uh\cdot n}$	$0.15 - \phi_{f,1}^{sh\cdot n}$

Note: $\lambda_{g,1}^{ij\cdot\cdot}$ is the marginal distribution of labor income (i) – inheritance type (j) types for each gender (g) of married population for $i = u, s$, $j = n, h$ and $g = m, f$. $\phi_{g,1}^{ij\cdot k}$ is the the proportion of agents in the whole population with gender ($g = m, f$) whose earning ability is i, inheritance type is j and partner has inheritance type k for $i = u, s$, $j = n, h$ and $k = n, h$. e_g is the average inherited wealth for each gender ($g = m, f$).

Table 23: The observed and estimated matching distribution in the second stage on labor income given the marginal distribution $\lambda_{g,1}^{i|jk}$ conditional on inheritance type matching type (nn, hn, nh and hh presented in four blocks) settled in the first stage (case 2: inheritor determined by inheritance section and probit-based assignment of both inherited housing and future inheritance)

		$\lambda_{f,1}^{u\|nn}$=0.50	$\lambda_{f,1}^{s\|nn}$=0.50			$\lambda_{f,1}^{u\|hn}$=0.46	$\lambda_{f,1}^{s\|hn}$=0.54
$\lambda_{m,1}^{u\|un}$=0.54	obs	0.30	0.24	$\lambda_{m,1}^{u\|nh}$=0.47	obs	0.25	0.21
	est	0.30	0.25		est	0.24	0.23
$\lambda_{m,1}^{s\|un}$=0.46	obs	0.20	0.25	$\lambda_{m,1}^{s\|nh}$=0.53	obs	0.20	0.33
	est	0.21	0.25		est	0.22	0.32
		$\lambda_{f,1}^{u\|nh}$=0.48	$\lambda_{f,1}^{s\|nh}$=0.52			$\lambda_{f,1}^{u\|hh}$=0.52	$\lambda_{f,1}^{s\|hh}$=0.48
$\lambda_{m,1}^{u\|hn}$=0.41	obs	0.22	0.19	$\lambda_{m,1}^{u\|hh}$=0.40	obs	0.22	0.17
	est	0.22	0.18		est	0.24	0.16
$\lambda_{m,1}^{s\|hn}$=0.59	obs	0.26	0.34	$\lambda_{m,1}^{s\|hh}$=0.60	obs	0.30	0.30
	est	0.26	0.33		est	0.29	0.31

Table 24: The observed and estimated matching distribution on inheritance by allocating the marginal distribution of labor income (i) – inheritance type (j) types for each gender (g) $\lambda_{g,1}^{ij\cdot\cdot}$ to $\phi_{g,1}^{ij\cdot n}$ and $\phi_{g,1}^{ij\cdot h}$ for two heritor types of partner: male sorting choice in the left block and female sorting choice in the right block (case 2: inheritor determined by inheritance section and probit-based assignment of both inherited housing and future inheritance)

		$\phi_{m,1}^{ij\cdot h}$ obs	$\phi_{m,1}^{ij\cdot h}$ est			f			
						$\lambda_{f,1}^{un\cdot\cdot}$=0.35	$\lambda_{f,1}^{sn\cdot\cdot}$=0.35	$\lambda_{f,1}^{uh\cdot\cdot}$=0.14	$\lambda_{f,1}^{sh\cdot\cdot}$=0.15
m	$\lambda_{m,1}^{un\cdot\cdot}$=0.39	0.08	0.09						
	$\lambda_{m,1}^{sn\cdot\cdot}$=0.35	0.09	0.08	$\phi_{f,1}^{ij\cdot h}$	obs	0.07	0.08	0.06	0.06
	$\lambda_{m,1}^{uh\cdot\cdot}$=0.11	0.05	0.05		est	0.07	0.07	0.06	0.06
	$\lambda_{m,1}^{sh\cdot\cdot}$=0.16	0.07	0.07						

Note: $\phi_{g,1}^{ij\cdot n}$ is not shown which is just the residual of $\phi_{g,1}^{ij\cdot h}$.

Table 25: Aggregate flows (current €bn) of inheritane and gifts in Germany, 1961 - 2009

	1961	1973	1978	2002	2007	2009
Annual bequest flow	2.544	13.46	20.564	130.337	201.868	220.308

Source: Schinke (2012).

A Appendix

A.1 Additional contingency tables

This appendix provides the contingency tables for further analysis.

Table 26 presents the relative difference between observed and random mating for labor income, focusing on the working-age subsample. It presents a lower but still substantial level of assortative mating by current income. The other robustness check is to apply the analysis using wage rate instead of annual income on the working-age couples. This is shown in Table 27. It reassures us that, by avoiding the distortion from extensive margin and life cycle effects, sorting by wage rate should be higher than sorting by labor income without such correction as displayed in Table 26.

Combining labor income and inheritance status (under case 2), Table 30 presents what would have been a random mating in terms of cell proportions, taking as given the marginal distributions. Table 31 presents the observed weighted distribution of the couples according to their inheritance and current labor income status. These are the tables used to compute the relative difference between observed and random mating presented in Table 10. Table 32 presents the results for case 2 when future inheritance is not taken into account; results are quite similar to Table 10. Finally, Table 33 provides the counterpart of Table 31 under case 1. These two matching patterns look almost the same.

A.2 Estimation under case 1 (random) assignment

We repeat the estimation of our model using the inheritance type identified by case 1 random assignment of inherited housing and future inheritance. Using the data under case 1, Table 34 and Table 35 present the equilibrium matching distribution to be solved in the two stages given the marginal distributions, the average annual labor income $w_g^{x|jk}$, with $x = u, s$, $j = n, h$ and $k = n, h$, and the average inherited wealth e_g for each gender $(g = m, f)$. They are the counterparts of Table 21 and Table 22. Both distributional and value (wage and inheritance) parameters are rather close under each assignment. The t

and β estimates are also very similar to those under case 2.[59]

Table 26: Relative difference in cell proportion between observed and random mating for the working-age couples conditional on gender-specific income distribution

	Wife's labor income in bottom 50%	Wife's labor income in top 50%
Husband's labor income in bottom 50%	9.5%	-9.5%
Husband's labor income in top 50%	-9.4%	9.3%

Table 27: Relative difference in cell proportion between observed and random mating for the working-age couples conditional on gender-specific wage rate distribution after Heckman correction

	Wife's labor income in bottom 50%	Wife's labor income in top 50%
Husband's labor income in bottom 50%	19.9%	-19.9%
Husband's wage rate in top 50%	-19.9%	19.9%

[59]The estimated t is 30,133 and its sum of square appears to be U-shaped. The sum of square for β is a decreasing function of β between 0 and 0.76, after which point it is flat. Please note that we are not using the more rigorous iterative procedure for solving and estimating the model and 500 rounds of randomization may not be sufficiently accurate. Alternatively, the sum of square for β becomes U shaped and reach the minimal at 0.71 if we replace only the fitting target of the observed distributional parameters in the first stage by those from case 2 assignment (i.e. see them in Table 24). A U-shaped estimator can also be achieved through another small permutation which calibrates the fitting target of the observed distributional parameters in the first stage to follow the marginal distributions of income-inheritance type for each gender under case 2 assignment (more details can be provided upon request).

Table 28: Relative difference in cell proportion between observed and random mating for the whole couples population conditional on observed inheritance status for husbands and wives (case 1)

	Non-heiress (inheritance section+random assignment of inherited housing)	Heiress (inheritance section+random assignment of inherited housing)
Non-heir (inheritance section+random assignment of inherited housing)	9.1%	-27.3%
Heir (inheritance section+random assignment of inherited housing)	-28.2%	84.5%

Table 29: Relative difference in cell proportion between observed and random mating for the subpopulation of working-age couples conditional on inheritance status for husbands and wives (case 0)

	Non-heiress (inheritance section only)	Heiress (inheritance section only)
Non-heir (inheritance section only)	6.8%	-31.5%
Heir (inheritance section only)	-31.5%	146.6%

Table 30: Hypothetical cell proportion for the couple population in the random mating conditional on gender-specific income distribution and inheritance type for husbands and wives (case 2: inheritor determined by inheritance section, probit-based assignment of both inherited housing and future inheritance)

		Non-heiress		Heiress	
		Wife's labor income in bottom 50%	Wife's labor income in top 50%	Wife's labor income in bottom 50%	Wife's labor income in top 50%
Non-heir	Husband's labor income in bottom 50%	13.71%	13.71%	5.43%	5.78%
	Husband's labor income in top 50%	12.35%	12.34%	4.89%	5.21%
Heir	Husband's labor income in bottom 50%	3.79%	3.79%	1.50%	1.60%
	Husband's labor income in top 50%	5.64%	5.64%	2.24%	2.38%

Table 31: Observed cell proportion for the couples population in the observed mating conditional on gender-specific income distribution and inheritance type for husbands and wives (case 2: inheritor determined by inheritance section and probit-based assignment of both inherited housing and future inheritance)

		Non-heiress		Heiress	
		Wife's labor income in bottom 50%	Wife's labor income in top 50%	Wife's labor income in bottom 50%	Wife's labor income in top 50%
Non-heir	Husband's labor income in bottom 50%	16.96%	13.62%	4.37%	3.68%
	Husband's labor income in top 50%	11.42%	14.22%	3.49%	5.66%
Heir	Husband's labor income in bottom 50%	3.24%	2.77%	2.63%	2.05%
	Husband's labor income in top 50%	3.87%	4.87%	3.58%	3.57%

Table 32: Relative difference in cell proportion between observed and random mating for the whole population of couples conditional on gender-specific income distribution and inheritance status for husbands and wives (case 2: inheritor determined by inheritance section and probit-based assignment of *only* inherited housing)

		Non-heiress		Heiress	
		Wife's labor income in bottom 50%	Wife's labor income in top 50%	Wife's labor income in bottom 50%	Wife's labor income in top 50%
Non-heir	Husband's labor income in bottom 50%	22.04%	-1.57%	-24.79%	-36.01%
	Husband's labor income in top 50%	-5.33%	17.47%	-37.84%	0.26%
Heir	Husband's labor income in bottom 50%	-17.17%	-34.23%	111.09%	44.79%
	Husband's labor income in top 50%	-36.17%	-17.36%	91.24%	69.52%

Table 33: Observed cell proportion for the couple population in the observed mating conditional on gender-specific income distribution and heritor status for husbands and wives (case 1: inheritor determined by inheritance section and random assignment of both inherited housing and future inheritance)

		Non-heiress		Heiress	
		Wife's labor income in bottom 50%	Wife's labor income in top 50%	Wife's labor income in bottom 50%	Wife's labor income in top 50%
Non-heir	Husband's labor income in bottom 50%	16.96%	13.62%	3.67%	3.36%
	Husband's labor income in top 50%	11.42%	14.22%	3.62%	5.16%
Heir	Husband's labor income in bottom 50%	3.68%	2.88%	2.88%	2.26%
	Husband's labor income in top 50%	3.51%	5.09%	3.80%	3.87%

Table 34: The second stage of matching distribution $\phi_2^{xy|jk}$ on labor income given the marginal distribution $\lambda_{g,1}^{i|jk}$ conditional on inheritance type matching type (nn, hn, nh and hh presented in four blocks) settled in the first stage (case 1: inheritor determined by inheritance section and random assignment of both inherited housing and future inheritance)

	$\lambda_{f,1}^{u\mid nn} = 0.50$ $w_f^{u\mid nn} = 3,435$	$\lambda_{f,1}^{s\mid nn} = 0.50$ $w_f^{s\mid nn} = 27,436$		$\lambda_{f,1}^{u\mid hn} = 0.46$ $w_f^{u\mid hn} = 3,336$	$\lambda_{f,1}^{s\mid hn} = 0.54$ $w_f^{s\mid hn} = 28,759$
$\lambda_{m,1}^{u\mid nn} = 0.54$ $w_m^{u\mid nn} = 13,397$	$\phi_2^{uu\mid nn}$	$\phi_2^{us\mid nn}$	$\lambda_{m,1}^{u\mid nh} = 0.44$ $w_m^{u\mid nh} = 15,164$	$\phi_2^{uu\mid nh}$	$\phi_2^{us\mid nh}$
$\lambda_{m,1}^{s\mid nn} = 0.46$ $w_m^{s\mid nn} = 50,971$	$\phi_2^{su\mid nn}$	$\phi_2^{ss\mid nn}$	$\lambda_{m,1}^{s\mid nh} = 0.56$ $w_m^{s\mid nh} = 59,842$	$\phi_2^{su\mid nh}$	$\phi_2^{ss\mid nh}$
	$\lambda_{f,1}^{u\mid nh} = 0.47$ $w_f^{u\mid nh} = 3,073$	$\lambda_{f,1}^{s\mid nh} = 0.53$ $w_f^{s\mid nh} = 29,698$		$\lambda_{f,1}^{u\mid hh} = 0.52$ $w_f^{u\mid hh} = 3,988$	$\lambda_{f,1}^{s\mid hh} = 0.48$ $w_f^{s\mid hh} = 29,586$
$\lambda_{m,1}^{u\mid hn} = 0.43$ $w_m^{u\mid hn} = 16,288$	$\phi_2^{uu\mid hn}$	$\phi_2^{us\mid hn}$	$\lambda_{m,1}^{u\mid hh} = 0.40$ $w_m^{u\mid hh} = 12,524$	$\phi_2^{uu\mid hh}$	$\phi_2^{us\mid hh}$
$\lambda_{m,1}^{s\mid hn} = 0.57$ $w_m^{s\mid hn} = 60,572$	$\phi_2^{su\mid hn}$	$\phi_2^{ss\mid hn}$	$\lambda_{m,1}^{s\mid hh} = 0.60$ $w_m^{s\mid hh} = 55,231$	$\phi_2^{su\mid hh}$	$\phi_2^{ss\mid hh}$

Note:$\lambda_{g,1}^{x|jk}$ is the marginal distribution of labor income for each gender (g) of the married population conditional on the settled sorting male type-j and female type-k of inheritance type for $x = u, s$, $j = n, h$, $k = n, h$ and $g = m, f$. $\phi_2^{xy|jk}$ is the equilibrium proportion of male type-x and female type-y on labor income matching conditional on the settled sorting male type-j and female type-k of inheritance type for $x = u, s$, $y = u, s$, $j = n, h$ and $k = n, h$. $w_g^{x|jk}$ is the average annual labor income for $x = u, s$, $j = n, h$ and $k = n, h$ for each gender ($g = m, f$).

Table 35: The first stage of matching on inheritance by allocating the marginal distribution of labor income (i) – inheritance type (j) types for each gender (g) $\lambda_{g,1}^{ij\cdot\cdot}$ to $\phi_{g,1}^{ij\cdot n}$ and $\phi_{g,1}^{ij\cdot h}$ for two heritor types of partner: male sorting choice in the left block and female sorting choice in the right block (case 1: inheritor determined by inheritance section and random assignment of both inherited housing and future inheritance)

		f $e_f = 178,021$ n	h
m	$\lambda_{m,1}^{un\cdot\cdot} = 0.38$	$\phi_{m,1}^{un\cdot n}$	$0.38 - \phi_{m,1}^{un\cdot n}$
	$\lambda_{m,1}^{sn\cdot\cdot} = 0.34$	$\phi_{m,1}^{sn\cdot n}$	$0.34 - \phi_{m,1}^{sn\cdot n}$
	$\lambda_{m,1}^{uh\cdot\cdot} = 0.12$	$\phi_{m,1}^{uh\cdot n}$	$0.12 - \phi_{m,1}^{uh\cdot n}$
	$\lambda_{m,1}^{sh\cdot\cdot} = 0.16$	$\phi_{m,1}^{sh\cdot n}$	$0.16 - \phi_{m,1}^{sh\cdot n}$

		f			
		$\lambda_{f,1}^{un\cdot\cdot} = 0.36$	$\lambda_{f,1}^{sn\cdot\cdot} = 0.36$	$\lambda_{f,1}^{uh\cdot\cdot} = 0.14$	$\lambda_{f,1}^{sh\cdot\cdot} = 0.15$
m $e_m = 200,675$	n	$\phi_{f,1}^{un\cdot n}$	$\phi_{f,1}^{sn\cdot n}$	$\phi_{f,1}^{uh\cdot n}$	$\phi_{f,1}^{sh\cdot n}$
	h	$0.36 - \phi_{f,1}^{un\cdot n}$	$0.36 - \phi_{f,1}^{sn\cdot n}$	$0.14 - \phi_{f,1}^{uh\cdot n}$	$0.15 - \phi_{f,1}^{sh\cdot n}$

Note: $\lambda_{g,1}^{ij\cdot\cdot}$ is the marginal distribution of labor income (i) – inheritance type (j) types for each gender (g) of the married population for $i = u, s$, $j = n, h$ and $g = m, f$. $\phi_{g,1}^{ij\cdot k}$ is the the proportion of agents in the whole population with gender ($g = m, f$) whose earning ability is i, inheritance type is j and partner has inheritance type k for $i = u, s$, $j = n, h$ and $k = n, h$. e_g is the average inherited wealth for each gender ($g = m, f$).