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Trends in Educational Homogamy and Heterogamy – Analyzing the Roles of Assortative Mating and Structural Opportunities using a Novel Decomposition Method

A thesis submitted in fulfilment of the requirements for the degree of PhD

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Declaration of the author

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Declaration of co-authorship

This signed declaration describes the contribution of the candidate and the co-authors to each of the papers of this thesis in order to identify the candidate's independent contribution to each work.

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Paper I: A novel decomposition approach for analyzing differences between contingency tables

Julia Leesch is the first author of this paper, collaborating with Dr Jan Skopek. Julia Leesch identified the methodological gap, compiled the literature review, developed the main steps of the decomposition approach, conducted the analyses, and drafted the paper. In addition to providing feedback on drafts of the paper, Dr Jan Skopek provided guidance in developing the decomposition approach and the notation for the methodology.

Paper II: Decomposing trends in educational homogamy and heterogamy – The case of Ireland

Julia Leesch is the first author of this paper. The paper was co-authored with Dr Jan Skopek and was published in *Social Science Research* in January 2023. Julia Leesch formulated the research questions, compiled the literature review, developed the theoretical framework, refined the decomposition approach, conducted the statistical analyses, and wrote the drafts of the paper. In addition to providing feedback on drafts of the paper, Dr Jan Skopek assisted with formulating the notation for the methodology and the statistical analyses.

Paper III: Structural opportunities or assortative mating? – Decomposing trends and country differences in educational sorting outcomes in marriages

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Paper IV: Five decades of marital sorting in France and the United States – The role of educational expansion and the changing gender imbalance in education

Julia Leesch is the first author of this paper, co-authored with Dr Jan Skopek. Julia Leesch developed the research question, compiled the literature review, designed the theoretical framework, refined the decomposition approach, conducted the statistical analyses, and composed the paper drafts. Dr Jan Skopek assisted with refining the decomposition approach and provided advice and feedback on the paper drafts.

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Summary

Higher education expansion has reshaped the educational composition of partner markets. Despite this notable shift in *structural opportunities* for mating, our understanding of how these changes have influenced *marital sorting outcomes*, such as the proportion of educationally homogamous unions, remains limited. Instead of studying marital sorting outcomes, previous research has focused on *assortative mating*, the tendency of available candidates to match into unions and marriages non-randomly. This thesis integrates these two perspectives on marital sorting by investigating the impact of changes in (a) structural opportunities and (b) assortative mating on trends in marital sorting outcomes.

The first paper evaluates the strengths and limitations of existing methods used to study assortative mating and marital sorting outcomes. This assessment indicates that existing methods do not provide flexible tools to break down the influence of trends in structural opportunities and assortative mating on marital sorting outcomes. To address this methodological gap, this paper introduces a novel decomposition approach. The approach analyzes hypothetical scenarios, such as trends in marital sorting outcomes, if only assortative mating or structural opportunities had changed. This allows to isolate the impacts of these changes on marital sorting outcomes.

The second paper analyzes trends in marital sorting outcomes in Ireland (1991–2016). It investigates the extent to which these trends have been influenced by concurrent changes in three factors: educational attainment, the educational gradient in marriage, and assortative mating. Using Irish Census data, the study employs the decomposition method introduced in the previous paper to determine how these changes influenced marital sorting outcomes. The results indicate an increase in homogamy (both equally educated) and hypogamy (she more educated than he), as well as a decline in hypergamy (she less educated than he). These trends were largely driven by changes in women's and men's

educational attainment. In contrast, shifts in the educational gradient in marriage had a moderate influence, while trends in assortative mating scarcely impacted sorting outcomes.

The third paper examines trends and cross-country differences in marital sorting outcomes and investigates the role of structural opportunities and assortative mating in explaining these patterns. Using vital statistics data on all marriages contracted from 2000 to 2020 in Sweden, the Czech Republic, and Italy, the paper decomposes trends and cross-country differences in marital sorting outcomes into these two components. Findings show stable or rising rates of homogamy and hypogamy, and declining hypergamy. Despite similar trends, countries differ in the extent to which changes in structural opportunities and assortative mating explain these trends. Overall, Italy is characterized by high homogamy and low heterogamy, while Sweden displays the opposite pattern, and the Czech Republic falls in between. These variations between countries are primarily linked to differences in assortative mating.

The final paper improves our understanding of the relationship between changing structural opportunities and trends in marital sorting outcomes. Using French (1962–2011) and US (1960–2015) census data, this paper disentangles the impact of two simultaneous developments on marital sorting outcomes: educational expansion and changes in the education-gender association. Decomposition results indicate that changes in the education-gender association have contributed to rising hypogamy and declining hypergamy. Educational expansion is associated with homogamy and heterogamy trends, with fewer unions involving low-educated individuals and more involving highly educated individuals. This study advances previous research by linking not only the changing gender imbalance in education but also higher education expansion to hypogamy and hypergamy trends. Overall, this thesis makes substantial contributions to our understanding of the structural drivers of trends and differences in marital sorting outcomes.

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List of abbreviations

BIC	Bayesian information criterion
COVID-19	Coronavirus disease 2019
CR	Czech Republic
H	High
IPF	Iterative proportional fitting
IPUMS-I	Integrated Public Use Microdata Series, International
ISCED	International Standard Classification of Education
IT	Italy
L	Low
LI	Lower intermediate
MCMC	Markov Chain Monte Carlo
MW	Association between husbands' and wives' education
OECD	Organisation for Economic Co-operation and Development
SE	Sweden
UI	Upper intermediate

1 Trends and cross-country differences in marital sorting outcomes – theoretical framework and research gaps

1.1 Introduction

1.1.1 Research question

Marriages and cohabiting unions are intimate and stable relationships between individuals, offering various benefits such as companionship, emotional support, and improved well-being (Kohler et al., 2005). Furthermore, union formation can lead to economic advantages, for example, by pooling resources and taking advantage of economies of scale. However, romantic relationships can also bring undesirable outcomes such as increased responsibilities, financial hardship, and stress (Geist & Ruppanner, 2018; Potarca & Rossier, 2021).

To what extent union formation is linked to desirable and undesirable outcomes depends on the traits and resources of both partners. For instance, when husbands and wives pool and share their resources, marriage between individuals with different economic resources can result in upward mobility for the partner with fewer resources and downward mobility for the other one. Thus, the answer to the question '*Who marries whom?'* can offer insights into the distribution of advantageous and disadvantageous traits and resources within and between couples. Therefore, investigating 'who marries whom' can improve our understanding of the consequences that union formation and marriage have for individuals.

To explore sorting by advantageous resources, scholars have studied 'who marries whom' based on socioeconomic resources, such as education or occupation (C. R. Schwartz et al., 2021; C. R. Schwartz & Mare, 2005). This thesis contributes to a large body of research that focuses on *educational* sorting in unions and marriages (De Hauw et al., 2017; Domański & Przybysz, 2007; Esteve et al., 2016; C. R. Schwartz & Mare, 2005).

In contrast to a large part of sociological research that primarily examines micro-level outcomes, this thesis adopts an approach that begins with observing a phenomenon at the macro-level and seeks to uncover its underlying causes. The phenomenon under investigation in this thesis is the changing educational composition of opposite-sex marriages and cohabiting unions. I use the term *marital sorting outcomes*[1] to describe this educational composition, meaning the joint distribution of husbands' and wives' education. Thereby, the present chapter uses the terms 'marriages' and 'unions' interchangeably to enhance readability.

Over the past few decades, these changes in the educational composition of marriages and unions have followed a clear pattern. In many countries, homogamy rates have shown an upward trend. This means that the percentage of couples in which women and men are equally educated has risen (Katrňák & Manea, 2020; Nomes & Van Bavel, 2017; Permanyer et al., 2019). Additionally, among couples with different educational backgrounds, there has been an increase in hypogamy (she is more educated than he), while hypergamy (he is more educated than she) has declined (Erát, 2021; Esteve et al., 2016). Furthermore, although countries tend to exhibit similar trends in these marital sorting outcomes, their levels differ substantially between countries (Domański & Przybysz, 2007). This thesis explores the mechanisms driving these trends and cross-country variations by addressing the question, *'Why do marital sorting outcomes differ over time and across countries?'*.

[1] Throughout this thesis the terms 'marital sorting outcomes' and 'educational sorting outcomes' are used interchangeably.

In particular, I focus on the impact of two main forces that may have shaped time trends and cross-country differences in marital sorting outcomes – *structural opportunities* and *assortative mating*. Structural opportunities refer to the educational composition of available women and men on the partner market, while assortative mating describes to the non-randomness by which available women and men sort into unions and marriages.

1.1.2 Motivation for studying marital sorting outcomes

A key motivation for studying marital sorting outcomes is the expected impact of these outcomes on social inequalities. Marital sorting in opposite-sex couples can shape *gender inequalities* as they reflect the earnings potential and bargaining power of women and men within couples (Lundberg & Pollak, 1996; Manser & Brown, 1980). For example, an increase in the proportion of unions in which women are more educated than men can empower women in decision-making processes and enhance their autonomy, e.g. in employment-related choices (Caldwell, 1980). However, women surpassing men in earnings potential and power challenges traditional gender roles. Attempts to restore these gender roles could restrict women's autonomy and power in decision-making, particularly in gender-traditional contexts (Urbina, 2022).[2]

Furthermore, marital sorting can affect *intragenerational social mobility*. When partners pool their resources, individuals can experience social mobility depending on the socioeconomic resources of their spouse. Kim and Sakamoto (2017) found that in recent decades the returns to education through marriage have been declining for women and increasing for men. Possibly, the decline in hypergamy (where he is more educated than she) and the rise in hypogamy (where she is more educated than he) that took place in

[2] For instance, according to relative resource theory, men with less power than their partners may resort to violence to regain power (Atkinson et al., 2005; Goode, 1971).

recent decades (Esteve et al., 2016; Katrňák & Manea, 2020) contributed to shifting gender inequalities in the link between marriage and intragenerational social mobility.

Marital sorting outcomes can also affect *economic inequalities between couples* (Blossfeld & Timm, 2003; C. R. Schwartz, 2013). Since education is closely linked to earnings (Psacharopoulos & Patrinos, 2018), the degree of educational homogamy can influence economic inequalities between couples. That means a positive relationship between educational homogamy and economic inequalities has been expected (Blossfeld & Timm, 2003; Breen & Andersen, 2012). However, empirical evidence suggests that observed changes in marital sorting outcomes have limited explanatory power for trends in economic inequalities between couples (Boertien & Permanyer, 2019a; Breen & Andersen, 2012; Breen & Salazar, 2011). Only extreme hypothetical changes in educational homogamy were found to affect household income inequality (Boertien & Permanyer, 2019a).

Moreover, marital sorting outcomes can contribute to *intergenerational mobility*. Extensive research has demonstrated a link between the socioeconomic attainment of parents and their children (Breen & Jonsson, 2005; Erikson & Goldthorpe, 1992; Shavit & Blossfeld, 1993). Marital sorting outcomes can, therefore, shape intergenerational mobility by influencing children's access to educated parents and their resources. For example, higher levels of heterogamous sorting would allow more children to have access to at least one highly educated parent. Additionally, the *reproduction of social inequalities between generations* can depend on marital sorting outcomes; but also on the selection into couples, differential fertility, and intergenerational mobility (Corti & Scherer, 2022; Skopek & Leopold, 2020). To summarize, marital sorting outcomes have the potential to shape various forms of social inequality, highlighting the importance of studying trends and cross-country variations in marital sorting outcomes.

1.1.3 Knowledge gaps

Despite the possible impact of marital sorting outcomes on social inequalities, our understanding of the factors contributing to their variation over time and across countries remains limited. The mechanisms that may explain these variations in marital sorting outcomes can be categorized into two groups: *structural opportunities* and *assortative mating*. Structural opportunities refer to the availability of women and men with different educational levels on the partner market. Assortative mating describes the non-randomness in marital sorting outcomes. This non-randomness arises from choice and matching mechanisms that shape how available candidates sort into unions.

Structural opportunities and assortative mating have changed over time and vary between countries. However, the specific impact of these changes on marital sorting outcomes remains poorly understood. The expansion of education and the reversal of the gender gap in education have transformed the educational composition of partner markets (De Hauw et al., 2017; Schofer & Meyer, 2005). Assortative mating patterns may have also shifted, for example, due to the rising popularity of online dating, which has broadened the chances of meeting potential partners from diverse educational backgrounds (Potarca, 2017). Additionally, social changes, such as rising economic inequalities and growing gender equality, may influence preferences for a partner with a higher level of education and assortative mating outcomes (C. R. Schwartz, 2013). Therefore, the limited understanding regarding the impact of trends in structural opportunities and assortative mating on marital sorting outcomes represents a substantial knowledge gap.

Research lacks adequate methodologies that would allow disentangling the influences of structural opportunities and assortative mating on marital sorting outcomes, which contributes to the persistent knowledge gap in this area. Existing research primarily employs two approaches: studying assortative mating using log-linear models (e.g., Kalmijn, 1991b; C. R. Schwartz & Mare, 2005), and examining the association between characteristics of the opportunity structure and marital sorting outcomes (e.g., De Hauw et al., 2017; Esteve et al., 2016). However, neither approach adequately examines the separate impacts of structural opportunities and assortative mating on marital sorting outcomes. Log-linear models, which aim to model patterns of associations between the education levels of husbands and wives, are inadequate to analyze marital sorting outcomes directly. The other approach, relating opportunity structures and sorting outcomes, examines correlation-based measures. For example, Esteve et al. (2016) studied the country-level correlation between women's educational advantage and the proportion of heterogamous couples in which women are more educated than men. De Hauw et al. (2017) use regression models to investigate the association between the cohort-specific sex ratio in the tertiary educated population and marital sorting outcomes. However, these approaches cannot analyze the relationship between structural opportunities and marital sorting outcomes net of assortative mating.

In summary, marital sorting outcomes vary across time and space, yet more specific analyses that pinpoint the factors responsible for this variation are largely absent. A lack of appropriate methodologies for analyzing marital sorting outcomes has contributed to this knowledge gap. Acquiring a better understanding of the causes of changing marital sorting outcomes is crucial, as these sorting outcomes may shape social inequality and social mobility.

1.1.3 Marital sorting by education

This thesis investigates marital sorting outcomes based on *education* rather than other socioeconomic characteristics. Education is a good predictor for earnings and occupational success, which makes education an important stratifying dimension on the partner market and justifies choosing education as the primary variable of interest (Psacharopoulos & Patrinos, 2018; Shavit & Müller, 1998).

Furthermore, education offers advantages compared to other measures of socioeconomic attainment, such as earnings or social class. Individuals typically complete their education during young adulthood, and educational levels remain relatively stable thereafter. This stability is an advantage compared to earnings, which can fluctuate significantly throughout the life course. Consequently, especially for young adults, education may serve as a better proxy for future earnings than current earnings. Thus, education may govern the partner search process more than earnings. Moreover, analyzing marital sorting based on earnings would require data on newly established unions since earnings often change after union formation. In addition, in modern societies characterized by the expansion of higher education and rapid technological changes, absolute mobility in terms of social class may have changed considerably. Therefore, education seems to be a more precise indicator of socioeconomic attainment than social class.

In addition, education can serve as an indicator of values, attitudes, and cultural similarities. That is why couples, in which both partners have similar educational backgrounds, may experience greater agreement and more opportunities for joint activities (Beck & González-Sancho, 2009; Kalmijn, 1998). Therefore, educational homogamy may be associated with higher levels of relationship quality and agreement, which can have positive effects, for example, on children’s outcomes (Beck & González-Sancho, 2009; Rauscher, 2020). In summary, this thesis investigates marital sorting based on education due to the stability of educational attainment over the life course and its close relationship with various social and economic outcomes.

1.1.4 Causality

'Why do marital sorting outcomes differ over time and across countries?' is a causal question. According to D. Lewis (1973, p. 557) "we think of a cause as something that makes a difference, and the difference it makes must be a difference from what would have happened without it". Thus, one way to empirically approach questions that ask 'why something happened' is to construct counterfactual scenarios (D. Lewis, 1973; Pearl & Mackenzie, 2019).

This thesis, therefore, compares counterfactual with observed marital sorting outcomes, in order to study the drivers of trends and cross-country differences in marital sorting outcomes. The counterfactual outcomes are obtained by simulating what would have happened if assortative mating or structural opportunities had not changed or would not vary between countries. By comparing these counterfactual outcomes with the observed ones, I investigate the extent to which variations in assortative mating and structural opportunities drive trends and differences in marital sorting outcomes.

It is important to note that while the questions studied in this thesis are causal in nature, the empirical analyses have limitations when it comes to establishing causality. A relationship might exist between assortative mating and structural opportunities, making it challenging to completely disentangle the two components. For example, if preferences for highly educated partners have increased over time, individuals might pursue higher education more frequently, as it heightens the chances of meeting and matching with a highly educated partner. Such a dynamic can alter both assortative mating and structural opportunities.

Moreover, assortative mating is a descriptive concept that portrays the association between the education levels of husbands and wives. Factors such as changes in partner preferences or the opportunities to meet available candidates might account for trends and differences in assortative mating patterns. The analyses presented in this thesis cannot unravel the causes of this association.

1.1.5 Scope of this thesis

In three empirical chapters, I investigate marital sorting outcomes in Western countries since the 1960s. This period witnessed a rapid expansion in higher education (Schofer & Meyer, 2005), which transformed the structural opportunities in the partner market. Moreover, this timeframe coincides not only with economic growth and rising economic inequalities (Stiglitz, 2015), but also with the second demographic transition (Lesthaeghe, 2020). Thus, the second half of the last century is characterized by the development of "sub-replacement fertility, a multitude of living arrangements other than marriage, the disconnection between marriage and procreation, and no stationary population" (Lesthaeghe, 2010, p. 211). Despite significant changes in union formation and fertility, the drivers behind trends in marital sorting outcomes during this period are poorly understood.

Each empirical chapter focuses on specific countries and time periods within this context. The chosen time and country contexts exhibit considerable variation in structural opportunities and assortative mating. In each chapter, I selected countries that highlight specific aspects of these variations. The objective of the first empirical chapter, Chapter 3, is to explore the impact of changing structural opportunities on trends in marital sorting outcomes. Therefore, I chose Ireland (1991-2016), a country that underwent a rapid expansion in higher education, which profoundly altered structural opportunities on the partner market. Given Ireland's rapid expansion in higher education, studying the influence of changing structural opportunities in this context is particularly interesting.

Chapter 4 expands upon this initial case study by comparing theoretically interesting cases. In this chapter, I investigate trends and cross-country differences in marital sorting outcomes over the first two decades of this millennium, focusing on Sweden, the Czech Republic, and Italy. The selection of these countries aims to explore diverse contexts, not only in terms of their higher education expansion but also with respect to assortative mating patterns. The chosen countries exhibit considerable variations in cultural and economic backgrounds, as well as welfare regimes, featuring unique family policy configurations. This diversity suggests corresponding differences in assortative mating patterns. For instance, in social-democratic welfare states, such as Sweden, which are characterized by high levels of de-commodification and de-familization, the partner search might be less influenced by economic considerations, given that welfare is largely detached from education and occupational success (Esping-Andersen, 1999). Conversely, Italy, with its comparatively traditional gender role attitudes (Lomazzi et al., 2018) and a family-centric welfare system (Esping-Andersen, 1999), represents a context fostering matches between more educated women and less educated men. Lastly, the Czech Republic, resembling many post-socialist welfare states, witnessed a retrenchment of benefits and a re-familization of welfare policies (Saxonberg & Sirovátka, 2009). This suggests that educational attainment increasingly dictates economic success and, consequently, plays a growing role in governing the partner search process.

Chapter 5 examines trends in marital sorting outcomes spanning from the 1960s to the 2010s, focusing on France and the United States. The objective of this chapter is to examine the entire duration of higher education expansion, commencing in the 1960s when only few individuals attained tertiary education. Only by studying the complete process of educational expansion, scholars can gain comprehensive insights into the impact of higher education expansion on marital sorting outcomes. However, data on marital sorting outcomes covering such a long timeframe are rare. The United States and France are among the few countries for which data on marital sorting outcomes are available over such an extended period. This enables a comprehensive examination of the impact of women's and men's educational expansion on trends in marital sorting outcomes, considering the shift from a majority of low-educated individuals in the 1960s to a majority of highly educated individuals in the 2010s. Additionally, the two countries are relevant cases due to differences in the timing of higher education expansion and the sociohistorical context, including variations in gender role attitudes, social stratification, and educational inequalities. Moreover, this case selection allows for a comparison of two of the most populous countries in Europe and North America, advancing our understanding of similarities and differences in the drivers of trends in marital sorting outcomes in these contexts.

Furthermore, this thesis examines marital sorting outcomes within opposite-sex marriages and cohabiting unions. Chapter 4 exclusively studies incidence data on marriages, while Chapters 3 and 5 investigate cohabiting unions, regardless of the couple's marital status. Both of these perspectives are essential for social stratification research. On the one hand, sorting outcomes can influence inequalities, such as the social reproduction of inequalities between generations, irrespective of the couples' marital status. On the other hand, the marital status might moderate some of these effects. For instance, differences in taxation between married and cohabiting couples could impact economic disparities between couples.

1.2 Theoretical background

1.2.1 The partner search framework

The partner search framework (England & Farkas, 1986; Oppenheimer, 1988) suggests that individuals prefer partners with specific traits and search for them on the partner market. However, the likelihood of finding a partner with the desired traits is influenced by the opportunities to meet candidates who possess those traits. Moreover, one's own traits, and how the partner market values them, constrain the opportunities to marry a partner with the preferred traits. In the following, I discuss how partner search processes may affect marital sorting outcomes via structural opportunities and assortative mating.

Structural opportunities. In line with prior research on assortative mating, my conceptualization of structural opportunities refers to macrostructural meeting opportunities. Thus, structural opportunities are determined by the educational composition in populations of women and men on the partner market. These structural opportunities can influence meeting opportunities and marital sorting outcomes. For example, if there were no women with low levels of education on the partner market, men would not have the opportunity to meet and marry a low-educated woman. Also, when the number of candidates with the desired traits is very limited, the likelihood of meeting and marrying one of them is comparatively low. Therefore, the larger the relative size of a specific group within a population, the greater the probability of meeting and marrying a member of that group (Blau, 1977; Blau et al., 1982). For instance, a higher proportion of tertiary-educated individuals within a population indicates a greater chance of meeting and marrying someone with tertiary education.

Assortative mating. According to the partner search framework, partner *preferences* influence the behavior of men and women on the partner market. Various theories propose that individuals seek partners who maximize their well-being or utility (Becker, 1973; Blau, 1964; England & Farkas, 1986). However, not all candidates are equally suitable for maximizing individuals' utility, as the costs and benefits of marriage depend on factors such as wealth, income, interests, and skills.

The 'new home economics' (Becker, 1973, 1981a) also predicts that the gain from marrying and establishing a joint household depends on the traits of both partners. According to Becker (1973, 1981a), households produce commodities, such as companionship and children, that cannot be purchased on the market. Similarity in *complementary* traits enhances the efficient production of these commodities, reinforcing the benefits of marriage. For instance, partners with the same religion often share values and experiences, leading to greater agreement and more opportunities for joint activities. On the other hand, dissimilarity in *substitutable* traits maximizes the gain from marriage. Traits related to productivity in the labor market or household are typically substitutable, as income from market work can be exchanged for domestic work. Consequently, an individual with high market productivity may benefit more from a partner with high household productivity than one with high labor market productivity, and vice versa. Education exhibits characteristics of both complementary and substitutable traits, as it is associated with values, attitudes, and lifestyles but also with wage rates.

Since the development of the 'new home economics' in the 1960s (Becker, 1960; Mincer, 1963), the substitutability of certain traits may have changed. Factors such as labor-saving domestic technology, policies (e.g., subsidized childcare), and increased returns on the labor market for women (e.g., through educational expansion) have reduced the attractiveness of exchanging paid and domestic labor (DiPrete & Buchmann, 2006; Schofer & Meyer, 2005).[3] In contemporary societies, pooling two incomes might be more desirable than a specialized division of labor. Some studies suggest a shift in preferences, indicating a decline in men's reported preferences for domestic skills and an increase in preferences for financial prospects in the United States (Buss et al., 2001). In contrast, preferences revealed in speed dating experiments and online dating often reflect more

[3] Technological progress (e.g., dishwashers and washing machines) and social policies (e.g., subsidised childcare, taxation policies and parental leave) freed women, at least partially, from domestic responsibilities (Jaumotte, 2003). Moreover, anti-discrimination policies and the expansion in women's educational attainment increased their returns on the labour market (Long, 2010). These changes made dual-earner unions more attractive, compared to male breadwinner and female homemaker arrangements.

traditional partner preferences (Fisman et al., 2006; Hitsch et al., 2010; Skopek et al., 2011).

Furthermore, education is associated with non-monetary characteristics, such as values and lifestyles, which are relevant in the partner search process. Therefore, education may indicate what kind of person someone is (Kalmijn, 1998, p. 400). Thus, educational homogamy might be, at least partially, a by-product of sorting along other characteristics (Kalmijn, 1998).

In addition, opportunities and constraints on the *partner market* can prevent individuals from marrying someone with the preferred traits. That means, whether an individual achieves a match with a candidate who has the preferred traits depends on the number of encounters with such candidates and the willingness of these candidates to marry them. Although assortative mating patterns are not affected by structural opportunities on the macro-level, 'who meets whom' can impact assortative mating because meeting opportunities depend not solely on the educational composition on the macro-level. Opportunities to meet a potential spouse, can also be influenced by the spatial distribution of women and men with different traits within a country. As the spatial distribution of more and less educated women and men within a country does not influence macrostructural meeting opportunities, it may affect assortative mating patterns. It is well-known that specific regions within countries are more affluent and have higher levels of educational attainment (e.g., Local Burden of Disease Educational Attainment Collaborators, 2020), and neighborhoods tend to be socioeconomically segregated as well (Owens, 2010). This indicates that the geographical context can hinder individuals from meeting preferred candidates.

The socioeconomic composition of social contexts where individuals interact, known as foci of activities, also constrains 'who meets whom' (Feld, 1981, 1982). These foci of activities include, for example, workplaces, universities, and sports clubs. For instance, even if there were plenty of low-educated individuals in the partner market, someone who primarily engages in highly educated social contexts, such as universities, will have limited interactions with low-educated individuals. The educational composition in foci of activities can, therefore, influence the assortativeness in marital sorting outcomes.

Furthermore, it is important to note that individuals may not be able to marry their desired candidate because union formation requires *mutual consent* from both parties. This can affect assortative mating and marital sorting outcomes because the partner market is competitive since social norms and time constraints make it impossible to have an unlimited number of partners. In the countries that are analyzed in this thesis, it is a strong norm to have only one partner (Green et al., 2016). Therefore, educational homogamy can occur when individuals seek a partner with similar educational attainment, but it can also arise from the competition in the partner market when individuals search for a partner with the highest possible educational level. Thus, marital sorting outcomes are influenced by dynamic matching processes (Bruch & Newman, 2018; Logan et al., 2008).

Moreover, *third parties*, such as the family, the church or the state, may affect partner preferences and impose structural constraints that prevent individuals from marrying their preferred candidate (Kalmijn, 1998). On the one hand, third parties have the potential to shape partner preferences through feelings of group identification. For example, the extent to which social networks are educationally homogeneous may affect the degree to which individuals identify with their educational group and, in turn, also preferences for an equally educated partner. On the other hand, third parties can impact marital sorting outcomes by imposing group sanctions. For example, historically several religious institutions and states banned religious or racial intermarriage (Cretser & Leon, 1985; Kalmijn, 1998). Also, in the context of marital sorting by education group sanctions exist, even though they do not prohibit certain marital sorting outcomes. For example, some counties provide tax benefits to spouses with different incomes (Bach et al., 2011). In relative terms, this sanctions spouses with similar incomes and to the extent that education and income correlate, it also imposes sanctions for educationally homogamous couples.

In summary, marital sorting outcomes depend on structural opportunities and assortative mating. Several processes related to preferences, partner markets, and third parties, can affect assortative mating patterns.

1.2.2 Within-country trends in marital sorting outcomes

In recent decades, several social changes have potentially influenced the outcome of the partner search process. This section provides a brief overview of these social changes and their potential impact on marital sorting outcomes.

Educational expansion. The expansion of higher education had a profound impact on the structural opportunities on the partner market. The worldwide expansion of higher education since the 1960s, has led to an increase in the educational attainment of both women and men (Schofer & Meyer, 2005). As a result, the likelihood of matches involving highly educated individuals has increased. Furthermore, there has been a notable trend of women outpacing men in educational attainment, leading to a reversal of the gender gap in higher education in many Western countries (De Hauw et al., 2017). This shift suggests that the probability of matches between highly educated women and less educated men has increased.

Partner search. The digital revolution has fundamentally transformed the process of searching for a partner. Since the beginning of the 21st century, online dating has gained popularity, especially with the introduction of dating apps in the early 2010s. Evidence from the United States indicates that approximately 40% of newly formed couples have met online (Rosenfeld et al., 2019). Research also indicates that couples who met online tend to be educationally more heterogamous than couples who met offline (Potarca, 2020; Thomas, 2020). This suggests that the diverse social contexts available through online dating platforms may influence marital sorting outcomes.

Gender equality. During the 'gender revolution', women have increasingly entered the workforce and achieved financial independence (England, 2010). In addition, there has been a shift towards more egalitarian gender role attitudes (Cotter et al., 2011; Scarborough et al., 2019). This rise in gender equality has the potential to influence partner preferences. Particularly, the increase in women's labor force participation may have led men to prioritize women's education and earning prospects (Mare, 1991). In addition, trends in gender role attitudes may have changed what women and men search in a partnership. Individuals with egalitarian gender role attitudes could seek for educationally homogamous unions as they may provide the ideal foundation to establish an egalitarian division of labor.

Economic inequalities. In recent decades, many Western countries have experienced a rise in economic inequalities, including income and wealth inequality (Cingano, 2014; Piketty & Saez, 2014). This may have increased the competition for individuals with higher socioeconomic status, as marrying someone with lower socioeconomic attainment may come at a higher cost (Fernandez et al., 2005). Given that education is a strong predictor of earnings (Psacharopoulos & Patrinos, 2018), the competition for highly educated individuals may have intensified (C. R. Schwartz & Mare, 2005).

Modernization. Many studies examining assortative mating have drawn on modernization theory (Kalmijn, 1991a; Smits et al., 1998a, 2000; Smits, 2003). The theory argues that as societies undergo modernization and industrialization, they increasingly rely on skilled workers, and education becomes a more significant predictor of socioeconomic success than family background (Smits et al., 1998a). As a result, scholars expected an increase in assortative mating. In addition, Smits et al. (1998a), propose that in later stages of modernization, the importance of status characteristics should diminish due to a decline in parental control over partner choice and increased contact between individuals from different status groups. Thus, they anticipate trends in assortative mating by education to follow an inverted U-shape. However, in the context of this dissertation, which focuses on changes in recent decades in Western countries, the predictions of modernization theory may be somewhat outdated. For instance, it is unlikely that declining parental control over the partner search process is the main driver of trends in marital sorting outcomes in recent decades in the Western world.

Educational gradient in marriage. Trends and differences in 'who marries at all' can impact variations in 'who marries whom'. In recent decades, the increasing over-selection of more educated women and men into unions and marriages (Bertrand et al., 2016; Kalmijn, 2013) may have shaped marital sorting outcomes. For instance, when highly educated women marry more frequently, we can expect to see a rise in the proportion of marriages that involve a highly educated woman.

The effects of these social changes on marital sorting outcomes can reinforce or counteract each other. For example, one would expect that the introduction of online dating is associated with declining homogamy rates since couples who met online were found to be more heterogamous than couples who met offline (Potarca, 2020; Thomas, 2020). However, the increase in income inequality could potentially be associated with higher homogamy rates due to heightened competition for highly educated partners. In such a case, the effects of these mechanisms on homogamy would counterbalance each other. That means, various mechanisms may have influenced trends in marital sorting outcomes, but our understanding of these mechanisms remains limited.

1.2.3 Between-country differences in marital sorting outcomes

Marital sorting outcomes have not only changed over time; they also differ across countries (Domański & Przybysz, 2007; Katrňák & Manea, 2020). For example, Domański and Przybysz (2007) find that in the early 2000s, homogamy rates in European countries varied from over 70% (e.g., in Slovakia) to approximately 40% (e.g., in Iceland). However, we still have a poor understanding of the mechanisms explaining these cross-country differences in marital sorting outcomes.

Countries vary in characteristics that could explain the observed differences in homogamy and heterogamy. One such factor is the presence of diverse social policies. Marital sorting outcomes may differ between welfare regimes because social policies influence the degree to which individual welfare is decoupled from the labor market and family (Domański & Przybysz, 2007). For example, an individual might be more likely to marry someone with fewer socioeconomic resources if the state provides an encompassing and individualized social protection system (e.g., unemployment benefits and free elderly care) that lowers the financial risks of marrying ‘down’.

Moreover, countries vary in the timing of social changes described earlier (e.g., educational expansion, rising gender equality). At a given point in time, cross-country differences in these characteristics can account for variations in marital sorting outcomes. For example, in 2021, the share of tertiary educated 25-34-year-olds amounts to 63% in Ireland and 51% in the United States (OECD, 2022a). That means the structural opportunities that highly educated women and men encounter are higher in Ireland than in the United States. In addition, the start and speed of the expansion of higher education differ among countries. For example, between 2000 and 2021, the percentage of tertiary-educated 25-34-year-olds increased from 30% to 63% in Ireland and from 38% to 51% in the United States (OECD, 2022a). Hence, the role of structural opportunities in explaining cross-country differences in marital sorting outcomes depends on the temporal context. Similarly, other characteristics like the level of gender equality and economic inequalities can also contribute to cross-country variations in assortative mating and marital sorting outcomes (Domański & Przybysz, 2007; Fernandez et al., 2005; Monaghan, 2015; Smits, 2003; Smits et al., 2000). For example, Fernandez et al. (2005) find a positive correlation between wage inequality and the assortativeness of marital sorting outcomes on the country level.

In conclusion, countries differ in characteristics that are expected to influence marital sorting outcomes, such as economic inequalities and social policies. However, we still have limited knowledge about how much cross-country variation in these characteristics contributes to variations in marital sorting outcomes.

1.3 Strengths and limitations of previous research

Despite the potential implications of marital sorting outcomes for social inequalities, we know little about why they differ across time and space. One reason for this knowledge gap is the scarcity of available data on the partner search process. Typically, only data on existing unions is accessible. Questions such as 'Who met whom?' and 'Who wants to marry whom?' cannot be addressed using data on existing unions.

Another reason is the lack of suitable methodologies. Most studies analyzing data on existing unions have utilized log-linear models to examine assortative mating patterns (e.g., Kalmijn, 1991b; Mare, 1991; C. R. Schwartz & Mare, 2005). These studies analyze non-random matching, which assesses the extent to which observed sorting outcomes deviate from what would be expected if women and men were to match randomly. That means, these models control for macrostructural meeting opportunities, measured by the overall educational attainment of husbands and wives. Due to this feature, scholars regarded log-linear models as the ‘gold standard’ for studying marital sorting (Qian & Lichter, 2007). This line of research made significant progress in describing trends and cross-country variations in assortative mating using data on existing unions. Previous studies revealed that an over-selection into educationally homogamous unions takes place in nearly all contexts (e.g., Katrňák & Manea, 2020; C. R. Schwartz & Mare, 2005; Smits et al., 1998a). Moreover, assortative mating varies between countries and has changed over time (e.g., Mare, 1991; C. R. Schwartz & Mare, 2005; Smits et al., 1998a). Studies from the United States indicate increasing odds of homogamy in recent decades, while evidence from European countries has been inconsistent (see Blossfeld, 2009; C. R. Schwartz, 2013).

Despite the progress enabled by log-linear models, the approach has limitations. All mechanisms except macrostructural meeting opportunities (e.g., geographical segregation, partner preferences and matching mechanisms) affect assortative mating patterns. As a result, the precise mechanisms driving the association between women’s and men’s education remain a black box.

Moreover, previous research suffers from a lack of methods that allow analyzing marital sorting outcomes, such as homogamy rates. While log-linear models can describe variations in the association between husbands’ and wives’ education, they do not allow to quantify the impact of trends or cross-country differences in assortative mating on marital sorting outcomes. Furthermore, log-linear models control for structural opportunities, making them unsuitable for studying the influence of structural opportunities on trends and differences in marital sorting outcomes. Therefore, log-linear models cannot contribute to answering the guiding question of this thesis 'Why do marital sorting outcomes differ over time and across countries?'.

Furthermore, some studies employed regression models to examine the association between structural opportunities and marital sorting outcomes (Corti & Scherer, 2021; De Hauw et al., 2017; S. K. Lewis & Oppenheimer, 2000). Research indicates, for example, an association between the gender gap in higher education on the partner market and the occurrence of unions in which women are more educated than men (Corti & Scherer, 2021; De Hauw et al., 2017). However, these regression approaches do not control for assortative mating. Therefore, the relationship between women's and men's education and marital sorting outcomes could be partly caused by other factors than structural opportunities. For example, the gender gap in education might correlate with levels of gender equality and the acceptance of 'non-traditional' unions (Han, 2022). That means, the extent to which trends and cross-country differences in assortative mating and structural opportunities impact marital sorting outcomes remains an open question. This represents a significant knowledge gap, considering the substantial changes in structural opportunities in recent decades.

In conclusion, our understanding of why marital sorting outcomes vary across time and space is limited due to data constraints and methodological limitations. Typically, we only have access to data on existing couples, which has been used in previous research to examine assortative mating patterns. However, the specific effects of trends and cross-country differences in assortative mating and structural opportunities on marital sorting outcomes remain unclear. This thesis aims to address this gap by developing an approach that separates the influence of trends and differences in assortative mating and structural opportunities on marital sorting outcomes.

1.4 Contributions

This thesis makes several contributions. The first contribution is the development of a decomposition approach that can be used to disentangle the influence of assortative mating and structural opportunities on trends and differences in marital sorting outcomes. The approach, which will be introduced in the second chapter of this thesis, addresses a substantial methodological gap in assortative mating research. Existing methodologies are inadequate for studying the impact of trends and cross-country differences in assortative mating and structural opportunities on marital sorting outcomes. The proposed decomposition approach overcomes this limitation by breaking down differences in cell frequencies between two contingency tables into differences in odds ratios and marginal distributions.[4] This approach enables an investigation of the extent to which differences in observed matches are influenced by variations in (a) the availability of individuals with different educational levels (structural opportunities) and (b) the mechanisms determining how available women and men match into unions (assortative mating).

In contrast to log-linear models, the approach of this thesis investigates more relevant counterfactuals. Log-linear models begin with comparing observed matches to those that would occur if matching were random (i.e., no assortative mating) – a counterfactual that does not occur in reality. In this thesis, I compare observed matches to matches that would occur if the assortative mating patterns or structural opportunities of another time or country had been in place. Moreover, this decomposition method is not limited to studying marital sorting outcomes. For example, in social mobility research, which has a long tradition of applying log-linear models, the suggested methodology can help to contextualize the relationship between relative and absolute mobility.

[4] In a marriage table, cell frequencies reflect marital sorting outcomes, odds ratios indicate assortative mating, and marginal distributions provide insights into structural opportunities.

By applying this approach, this thesis sheds light on the factors contributing to variations in marital sorting outcomes across different periods and countries. This thesis quantifies the extent to which trends and cross-country differences in marital sorting outcomes can be attributed to distinct components. The first component is *assortative mating*, which has been extensively studied but not thoroughly examined in relation to its impact on marital sorting outcomes. Chapters 3 to 5 enhance our understanding of trends and cross-country differences in marital sorting outcomes by investigating the association between assortative mating and marital sorting outcomes. Furthermore, these chapters advance existing research by examining the association between *structural opportunities* and marital sorting outcomes. Unlike previous studies, the methodology used in this thesis allows controlling for assortative mating when studying the link between structural opportunities and marital sorting outcomes.

This thesis also contributes to the growing body of research that investigates the relationship between the reversal of the gender gap in education and marital sorting outcomes. Chapter 5 disentangles the roles of *educational expansion* (i.e., the educational composition of individuals in the partner market) and the *education-gender association*. As a result, this chapter advances previous research that provided only limited insights into the distinct influences of these concurrent trends on marital sorting outcomes.

In addition, Chapters 3 and 5 present novel findings on the extent to which trends in marital sorting outcomes are driven by changes in the *educational gradient in marriage*. By addressing this aspect, I overcome a limitation of previous studies that often implicitly assume that there are no differences in educational composition between partnered and unpartnered individuals (e.g., Mare, 1991; Permanyer et al., 2019; C. R. Schwartz & Mare, 2005). In addition to these empirical contributions, the developments and results of this thesis offer valuable insights for policymakers which I discuss in chapter 6.5.

1.5 Structure

The remainder of this thesis is organized as follows. Chapter 2 introduces a novel decomposition approach to analyze the factors influencing changes and cross-national differences in marital sorting outcomes. Within this chapter, I first review the strengths and limitations of methodologies previously employed in assortative mating and marital sorting research. Subsequently, I introduce the decomposition approach, specifically designed to address a key limitation of earlier methods: the inability to assess the distinct contributions of trends and differences in assortative mating and structural opportunities to marital sorting outcomes.

The following three chapters present empirical studies that utilize this methodology. Focusing on the period from 1991 to 2016, Chapter 3 examines the impact of trends in structural opportunities, assortative mating, and the educational gradient in union formation on changing patterns of marital sorting outcomes in Ireland. The results indicate that shifts in structural opportunities are the primary driver behind the growing proportion of unions in which women are either as educated as men or more educated and the declining share of unions in which women are less educated than men. While changes in the educational gradient in union formation have influenced these trends, their impact has been less pronounced. Changes in assortative mating barely affected trends in marital sorting outcomes.

Chapter 4 analyzes the roles of assortative mating and structural opportunities in shaping trends and cross-country differences in marital sorting outcomes in Sweden, the Czech Republic, and Italy. The findings indicate that the degree to which changes in assortative mating and structural opportunities account for observed trends in marital sorting outcomes varies across countries. However, in Sweden and Italy, changes in assortative mating have led to rising homogamy rates. In contrast, changing structural opportunities mainly drive the growth in hypogamy and the decline in hypergamy. Moreover, the differences in marital sorting outcomes between countries can be traced back to differences in assortative mating patterns.

Chapter 5 examines the impact of (a) educational expansion and (b) changes in the association between gender and education on trends in marital sorting outcomes in France and the United States over five decades. The decomposition analysis suggests that educational expansion has resulted in a decrease in unions involving low-educated individuals and an increase in unions with highly educated women or men. These dynamics have influenced the observed trends in homogamy, hypogamy, and hypergamy outcomes. Furthermore, the shift in the relationship between gender and education has contributed to the increasing prevalence of hypogamous unions and the decline in hypergamous unions.

Chapter 6 concludes the thesis by summarizing the main findings and shedding light on their contributions to our understanding of trends and differences in marital sorting outcomes. In this chapter, I also discuss the thesis’s limitations, evaluate the broader implications, and provide directions for potential areas of future research.

2 A novel decomposition approach for analyzing differences between contingency tables

2.1 Introduction

Sociologists, demographers, and economists have long been interested in matched pairs. Matched pairs occur, for example, when individuals find partners on the marriage market or when employees and jobs match on the labor market. Scholars have focused specifically on studying the distribution of traits within samples of matched pairs, such as the joint distribution of husbands' and wives' education. We refer to this distribution of traits within matched pairs as *sorting outcomes* because it represents the result of a sorting process.

Various disciplines in the social sciences have examined sorting outcomes. For example, sociologists investigated sorting outcomes in the marriage market to understand their impact on socioeconomic inequalities within and between couples (Blossfeld & Timm, 2003; McLanahan, 2004; Van Bavel et al., 2018). Demographers studied sorting outcomes in marriages and unions, as both partners' traits, such as education and gender role attitudes, influence fertility (Hudde, 2018; Nitsche et al., 2018). Moreover, economists examined mismatches in the labor market, as they can lead to productivity losses in national economies (McGuinness, 2006). Understanding *how* and *why* sorting outcomes differ across groups and change over time is, therefore, a crucial concern for social scientists.

In general, two factors can influence sorting outcomes: structural opportunities and assortative matching. Structural opportunities refer to the availability of entities in the market, while assortative matching denotes the mechanisms by which these entities form pairs. For example, in the partner market, structural opportunities describe the availability of individuals with specific traits, and assortative matching or mating[5] refers to the mechanisms by which available individuals match into couples.

To gain a deeper understanding of variations in sorting outcomes over time and across groups, researchers should explore questions such as, “What factors led to the observed variation in sorting outcomes?” and, more specifically, “To what extent is the observed variation in sorting outcomes explained by differences in structural opportunities and assortative mating?”. Despite the importance of these questions, only a few studies have investigated them, resulting in a considerable knowledge gap (e.g., Permanyer et al., 2019; Raymo & Iwasawa, 2005).

Since a lack of suitable methodologies could be the underlying reason for this knowledge gap, the first part of this paper reviews the methodological approaches that have been employed to study sorting outcomes and assortative mating. Specifically, we evaluate the suitability of these methodologies for studying the aforementioned questions. Our review identifies a lack of methods for analyzing the influence of varying levels of structural opportunities and assortative mating on sorting outcomes.

In the second part of this paper, we formally introduce a decomposition approach that disentangles the influence of structural opportunities and assortative mating on sorting outcomes. We then illustrate the application of this method with an empirical example, that decomposes differences in educational homogamy rates in unions and marriages in Ireland between the years 1991 and 2016. The approach involves constructing counterfactual tables, allowing us to explore theoretically relevant *what-if* scenarios. For example, when investigating trends in sorting outcomes, we explore changes that would have occurred if structural opportunities or assortative mating had remained unchanged. While we draw

[5] Scholars studying sorting in unions and marriages usually use the term *assortative mating* (Lichter & Qian, 2019; C. R. Schwartz & Mare, 2005). As this paper focuses mainly on educational sorting in marriages, we will use the term assortative mating henceforth.

heavily on educational sorting in marriages as an example,[6] our method is versatile enough to analyze a wide range of contingency tables that describe the outcomes of sorting processes, including matching outcomes in the labor market and intergenerational mobility.

2.2 Previous approaches to study marital sorting outcomes

2.2.1 Percentages and odds ratios

Researchers have used various measures and methods to study assortative mating and marital sorting outcomes. First, descriptive statistics, such as percentages, have been employed to describe marital sorting outcomes. For instance, we can describe absolute marital sorting outcomes by the percentages of couples in which women and men are equally educated (homogamy), women are more educated than men (hypogamy), or women are less educated than men (hypergamy) (e.g., Katrňák & Manea, 2020; Nomes & Van Bavel, 2017; C. R. Schwartz & Mare, 2005). For example, in Table 2.1 we see that 35% (25+10/100) of all marriages are between equally educated husbands and wives.

Furthermore, researchers have employed odds ratios in marriage tables to measure assortative mating. Odds ratios capture the association between husbands' and wives' education net of their overall educational attainment, displayed in the tables' marginal distributions. This association can be represented by the ratio of the odds that an *i*-educated woman is in a union with an *i*-educated man to the odds that a *j*-educated woman is in a union with an *i*-educated man. For example, Table 2.1 shows that the odds of a low-educated woman marrying a low-educated man are 1 (25/25), whereas, for a highly

[6] In the partner market, structural opportunities change relatively slowly. Therefore, we anticipate that structural opportunities and assortative mating have little impact on each another. In contrast, in the labor market, an increase in the share of workers with certain skills can boost related industries, thereby raising the demand for those skills. Thus, marital sorting outcomes are well-suited for analytically distinguishing the influences of structural opportunities and assortative mating on sorting outcomes.

educated woman, the odds of marrying a low-educated man are 4 (40/10). This results in an odds ratio of .25 (1/4).

If husbands and wives matched randomly, all odds ratios in a marriage table would be 1. That means the odds that an *i*-educated woman is in a union with an *i*-educated man equal the odds that a *j*-educated woman is in a union with an *i*-educated man. Therefore, the odds ratios are independent of the number of *i*-educated and *j*-educated wives and husbands. To conclude, while measures, such as percentages and odds ratios, can be used to describe assortative mating and marital sorting outcomes, they are not suitable for studying the drivers of trends and differences in these outcomes.

Table 2.1. Exemplary marriage table

	Husbands		
Wives	Low	High	Total
Low	25	25	50
High	40	10	50
Total	60	40	100

2.2.2 Log-linear models

Log-linear models aim to represent the complex association patterns observed in the odds ratio structures of marriage tables in a parsimonious manner. To achieve this, log-linear models compare observed marital sorting outcomes with those that would be expected according to different matching hypotheses. For example, researchers may compare the observed sorting outcomes to an independence model that assumes random matching. Another example are homogamy models. They allow for the interaction between equally educated wives and husbands but assume that heterogamous couples match randomly (Lichter & Qian, 2019). The goodness of fit of these models is evaluated using statistics such as the likelihood-ratio chi-squared statistic or the Bayesian Information Criterion (BIC).[7]

Researchers have regarded log-linear models as the gold standard for studying assortative mating due to their ability to control for variation in marginal distributions (Lichter & Qian, 2019). Therefore, national and cross-national analyses of assortative mating widely utilized this approach (e.g., C. R. Schwartz et al., 2021; C. R. Schwartz & Mare, 2005; Uchikoshi, 2022). However, log-linear modeling has faced criticism on several grounds. First, odds-ratio-based measures typically rely on individuals who are already matched. Thus, log-linear models control for the educational distributions of married individuals but not for the distributions of all individuals, including those who are unmarried (Gullickson, 2021). This limitation can lead to biased results if the relationship between education and selection into unions varies over time or across groups.

Second, log-linear models compare observed sorting outcomes to a theoretical minimum of assortative mating (random matching) but do not consider the theoretical maximum of assortative mating. Similar to the theoretical minimum, the theoretical maximum depends on the marginal distributions, for example, it is shaped by the proportion of equally educated men and women (Shen, 2020). To address this, scholars developed alternative models that evaluate observed sorting outcomes against random and perfect matching scenarios, considering the distance between the theoretical minimum and maximum (Liu & Lu, 2006; Naszodi & Mendonca, 2023; Shen, 2020).

Third, log-linear models do not account for spillover effects. Spillover effects occur when changes in the size of one educational group impact all cells in a marriage table due to market competition (Chiappori, 2017; Choo & Siow, 2006). Even though odds ratios

[7] G^2, the likelihood-ratio chi-squared statistic, equals $-2(L_r^2 – L_u^2)$ with L_r^2 being the log-likelihood of the restricted model and L_u^2 the log-likelihood of the unrestricted model. Compared to G^2, BIC favors more parsimonious models: $BIC = G^2 – DF \log n$.

are unaffected by changes in the group sizes of *i* and *j*-educated women and men, it is possible that changes in the size of one educational group affect *all* cells in a marriage table (Chiappori, 2017). For example, due to competition on the market, the percentage of unions between medium-educated men and low-educated women might be influenced by the number of highly educated women.

Fourth, log-linear models can analyze only a limited number of variables. The complexity of the models increases rapidly with the number of variables because low- and high-order interactions need to be modeled (Lichter & Qian, 2019).

Fifth, log-linear models are not suitable for investigating the extent to which differences in assortative mating affect variations in marital sorting outcomes. This is a substantial limitation, given that marital sorting outcomes may play a crucial role for social inequalities and demographic outcomes.

In sum, scholars have used log-linear models as an effective tool to model the association patterns of husbands' and wives' education. However, log-linear models are not suitable for studying the impact of trends and differences in assortative mating and structural opportunities on marital sorting outcomes.

2.2.3 Iterative proportional fitting

Researchers have occasionally used iterative proportional fitting (IPF) to examine the relationship between assortative mating and marital sorting outcomes (e.g., Kalmijn, 1993; Katrňák & Manea, 2020; Mc Farland, 1975). Thus, IPF overcomes a limitation of log-linear models by making it possible to study sorting outcomes.

IPF recovers the cell frequencies in a contingency table based on two inputs: the table's odds ratio structure and its marginal distributions. That allows researchers to estimate the expected cell frequencies (sorting outcomes) if different odds ratio structures (assortative mating) or marginal distributions (structural opportunities) had been in place (Deming & Stephan, 1940; Lomax & Norman, 2016). IPF achieves this by rescaling cell frequencies iteratively to new row and column totals while maintaining a constant odds ratio structure. This process continues until the cell frequencies align with the predefined odds ratios and marginal distributions.

IPF is useful for exploring the effects of assortative mating and structural opportunities on sorting outcomes through counterfactual scenarios. However, it is not sufficient to understand *to what extent* trends and differences in assortative mating and structural opportunities explain marital sorting outcomes. Therefore, IPF alone cannot uncover the specific factors contributing to observed variations in 'who marries whom'.

2.2.4 The harmonic mean model

The harmonic mean model (Schoen, 1981) is another approach researchers have used to study the impact of variations in assortative mating and structural opportunities on sorting outcomes (Qian & Preston, 1993; Raymo & Iwasawa, 2005).[8] This model offers a solution to account for the composition of women and men in the partner market when analyzing marital sorting outcomes. In contrast to the previously discussed approaches, the harmonic mean model accounts for the educational distributions of married and unmarried individuals. This ensures that the measure of structural opportunities is not biased by excluding unmarried individuals from the analysis.

[8] Schoen (1981) developed the harmonic mean model in response to the 'two-sex problem'. When demographic outcomes are modeled separately for women and men, the two-sex problem arises because the composition of women and men in the population influences these outcomes. For example, if we assume a marriage rate of 0.1 for men and women in a population of 100 each, we would observe 10 marriages. However, if the male population size doubled to 200, applying the same male marriage rate would result in 20 marriages, while applying the female rate would still yield 10 marriages. This discrepancy highlights the need to understand how marriage rates would change for women and men individually when the population composition changes (Schoen, 2015).

Compared to the previous approaches, the harmonic mean model does not use the odds ratios in a contingency table to measure assortative mating. In the context of marital sorting by education, the model describes trends in the number of unions between *i*-educated men and j-educated women (N_{ij}) as a function of the distribution of educational levels among women and men who have been available on the partner market (M_i and F_j) and a_{ij}, which represents the 'force of attraction' between the two educational groups *i* and *j* (cf. Qian & Preston, 1993; Song & Mare, 2017):

$$N_{ij} = a_{ij} \frac{M_i\, F_j}{M_i + F_j} \tag{2.1}$$

Even though there have been notable applications of the harmonic mean model (Esteve et al., 2009; Fukuda et al., 2020; Jarvis et al., 2023; Qian & Preston, 1993; Raymo & Iwasawa, 2005), the approach did not gain widespread popularity in marital sorting research. A possible reason for this development is the lack of a standardized approach for incorporating multiple variables in the harmonic mean model (Gullickson, 2021).[9] Eventually, log-linear models may have gained more popularity than the harmonic mean model because they offer a more straightforward approach to examining multiple variables (Gullickson, 2021).

Moreover, harmonic mean and log-linear models use different measures for assortative mating. This makes it difficult to compare the results of harmonic mean models with the large body of assortative mating research that has applied log-linear models. While log-linear models utilize the odds ratio structure in marriage tables, the harmonic mean

[9] Schoen and Wooldredge (1989) tried to address this limitation; however their strategy is comparatively complex. They used harmonic mean models to calculate age, race, and education-specific forces of attraction. Then they applied a log-linear model to investigate variations in these 'forces of attraction'.

model employs the 'force of attraction' a_{ij} to measure assortative mating. In summary, the harmonic mean model is an effective method for studying factors that lead to variation in sorting outcomes. However, it has limitations in handling multiple variables, and its measures are not directly comparable to those of log-linear models.[10]

2.2.5 Decompositions

A recent study by Permanyer et al. (2019) developed a decomposition approach to examine how changes in assortative mating and structural opportunities have influenced trends in educational homogamy. Their method offers an analytical solution to dissect changes in the joint distribution of husbands' and wives' education into trends in three distinct factors: individuals' educational attainment, the gender gap in higher education, and assortative mating. The method provides an effective tool to study the factors that led to the observed variation in sorting outcomes.

Although the approach by Permanyer et al. (2019) advances previous methods by introducing a method to decompose observed variations in marital sorting outcomes, it involves some limitations. The analytical solution is constrained to 2 x 2 tables. Therefore, examining marriage tables that differentiate between more than two educational levels is not possible. Moreover, they measure assortative mating by the absolute difference between observed sorting outcomes and the outcomes that would emerge from random matching. This measurement differs from the odds ratio structure, which scholars typically use to quantify assortative mating in a marriage table. Thus, this approach has the same

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[10] McFarland (1975) and Schoen (1981) provide a more comprehensive discussion and empirical examples of iterative proportional fitting (IPF), the harmonic mean model, and also Henry's (1972) model of panmictic circles. The model of panmictic circles provides a framework for examining the randomness in marital sorting outcomes. Henry assumes that social groups, which he calls circles, exhibit panmictic properties in terms of age. This means that the sorting of spouses based on age occurs randomly within these circles. Essentially, the model suggests that the correlation between husbands' and wives' age is explained by the homogeneity of the social circles to which individuals belong. This allows for the decomposition of the marriage table into panmictic components and a residual. We did not include a detailed discussion of the model of panmictic circles in this overview because there have been hardly any empirical applications of this approach.

shortcomings as the harmonic mean model – the comparability of these results with those of log-linear models is limited.

To conclude, Permanyer et al. (2019) provide a method for studying factors that led to variation in sorting outcomes. However, there is a need for a more flexible method that can investigate patterns of marital sorting outcomes in larger marriage tables and employ assortative mating measures comparable to those from log-linear models.

2.2.6 Regressions

Binary and multinomial regressions. In addition to the previously described methods that analyze contingency tables, researchers have also employed binary and multinomial logistic regressions to analyze marital sorting outcomes (De Hauw et al., 2017; S. K. Lewis & Oppenheimer, 2000). These methods view marital sorting as a one-sided choice influenced by the characteristics of the person choosing a partner. For example, we could use logistic regressions to study the relationship between women's education and their likelihood of being married to a highly educated man. However, these regressions do not account for variations in the availability of highly educated men on the partner market. Therefore, they cannot effectively separate the influence of trends and differences in assortative mating and structural opportunities on marital sorting outcomes.

Nonetheless, some studies have applied logistic regressions to examine the relationship between structural opportunities and marital sorting outcomes (De Hauw et al., 2017; S. K. Lewis & Oppenheimer, 2000; Qian et al., 2018). These studies included characteristics of the opportunity structure, such as the sex ratio in higher education, in their regression models. However, not only structural opportunities but also assortative mating patterns might influence these estimates. For example, in societies in which women are more educated than men, individuals may be more open to forming hypogamous unions. Furthermore, logistic regressions have been criticized for assuming a linear relationship between these compositional measures and the log odds of marital sorting outcomes (Gullickson, 2021).

Conditional logit models. Scholars have also employed conditional logit models to study marital sorting outcomes (Gullickson, 2021; Hoffman & Duncan, 1988; Jepsen & Jepsen, 2002; Nielsen & Svarer, 2009). In conditional logit models, the explanatory variables represent traits of alternative partners, whereas in binary and multinomial logit models, the explanatory variables are characteristics of the individuals (Hoffman & Duncan, 1988). Conditional logit models involve working with a sample of alternative partners. For each partnered individual, a set of alternative partners is sampled from those who were available on the partner market, regardless of their current marital status. For every individual *i*, there are *j* possible partners. The set of possible partners includes the chosen partner and *J*–1 counterfactual partners. To estimate the probability that a specific union within this set of possible unions is the actual union (P_{ij}), a vector of characteristics $\mathbf{x}_{ij}$ is defined. This vector shows the characteristics (e.g., education, race, age) that result from matching individual *i* with the potential partners *j*. The probability of union formation is then estimated as a function of the β parameters and the explanatory variables $\mathbf{x}_{ij}$ (Gullickson, 2021; Nielsen & Svarer, 2009):

$$P_{ij} = \frac{e^{x_{ij}\beta}}{\sum_{k=1}^{J} e^{x_{ij}\beta}} \qquad (2.2)$$

The conditional logit model offers several advantages for studying marital sorting outcomes. It allows controlling for the availability of alternative candidates. Furthermore, incorporating control variables is straightforward, which makes conditional logit models a valuable tool for examining social exchange processes.

Despite these advantages, it is important to note that the conditional logit model treats marital sorting as a one-sided selection process, focusing solely on how individuals select among different options. However, marital sorting is a two-sided process in which both partners' preferences play a role. That means, neither binary and multinomial nor conditional logit models can analyze to what extent variations in assortative mating and structural opportunities influenced trends in marital sorting outcomes.

Two-sided logit and probit models. Logan (1996; 2008) introduced two-sided logit and probit models to study marital sorting as a two-sided matching process (Logan, 1996; Logan et al., 2008). These models overcome the main limitation of previous regression approaches that viewed marital sorting as a one-sided selection process.

Two-sided logit and probit models aim to estimate partner preferences based on observed matches. Similar to one-sided conditional logit models, two-sided models examine a counterfactual set of alternative unions. However, the number of alternatives is much larger when considering women's and men's alternatives simultaneously. To estimate partner preferences, Logan used a Markov Chain Monte Carlo (MCMC) algorithm (Logan et al., 2008) or an expectation-maximization algorithm (Logan, 1996), which iteratively calculates logit models and conditional logit models to estimate women's and men's decisions on the partner market.

Despite the potential of two-sided models, they have rarely been applied in empirical research. The complexity of these models, the need to compute a large set of alternative unions, which makes the method computationally challenging, and the lack of implementation in standard statistical packages could explain the scarcity of studies applying this approach.

In summary, several methods have been developed and applied to investigate assortative mating and marital sorting outcomes. Although some of these approaches attempt to isolate the impacts of partner preferences, assortative mating, or structural opportunities on sorting outcomes, none of them offers a flexible tool to disentangle the separate influences of trends and differences in assortative mating and structural opportunities on marital sorting outcomes.

2.3 A Decomposition approach for analyzing differences between contingency tables

This section introduces a novel decomposition approach to address the lack of methods for studying the separate influences of trends and differences in assortative mating and structural opportunities on sorting outcomes. We focus specifically on sorting outcomes in marriages as an example. Our approach aims to isolate the influence of structural opportunities and educational assortative mating by posing hypothetical questions, such as, “What level of homogamy would be observed if a marriage table had the structural opportunities of another table?”, and “What would be the level of homogamy if a marriage table had the assortative mating patterns of another table?”. By comparing counterfactual and observed marital sorting outcomes, we learn about the influence of assortative mating and structural opportunities on trends and differences in marital sorting outcomes.

Marital sorting outcomes

The analysis is based on marriage tables, which are $K \times K$ matrices that show the relative joint distributions of wives' (rows) and husbands' (columns) education:

$$\boldsymbol{M}_t = \begin{bmatrix} m_{11} & \dots & m_{1K} \\ \dots & \ddots & \dots \\ m_{K1} & \dots & m_{KK} \end{bmatrix} \qquad (2.3)$$

Index *t* denotes the subsample in which marital sorting outcomes are measured. This could represent a specific year, country, or group. In this section, we assume that *t* stands for years. K refers to the number of educational categories. A matrix element m_{ij} is the fraction of marriages with a wife with education level i and a husband with education level j. The sum of all elements in the matrix equals 1.

Marriage outcome Y at time *t* is a scalar function of $\boldsymbol{M}_t$:

$$Y_t = f(\boldsymbol{M}_t) \tag{2.4}$$

Sorting outcomes in marriages can be summarized by computing homogamy, hypogamy, and hypergamy rates from each matrix.

The homogamy rate equals the sum of the diagonal of $\boldsymbol{M}_t$:

$$Y^{W=H}(\boldsymbol{M}_t) = \sum_{k=1}^{K} m_{i=k,j=k} \tag{2.5}$$

We obtain female hypogamy rates (she is more educated than he) by taking the sum of the lower off-diagonals

$$Y^{W>H}(\boldsymbol{M}_t) = \sum_{k=2}^{K} \sum_{l=1}^{k-1} m_{i=k,j=l} \tag{2.6}$$

and female hypergamy rates (she is less educated than he) by calculating the sum of the upper off-diagonals

$$Y^{W<H}(\boldsymbol{M}_t) = \sum_{k=1}^{K-1} \sum_{l=k+1}^{K} m_{i=k,j=l} \tag{2.7}$$

Dissecting the marriage table

Our decomposition approach uses the information that cells in a marriage table (sorting outcomes) are a function of the table's marginal distributions (structural opportunities) and the table's odds ratio structure (assortative mating). If the marginal distributions and odds ratios are available, we can recover the cells in a marriage table using iterative proportional fitting (IPF) (Deming & Stephan, 1940). IPF modifies the cells in a table to match predefined row and column totals and odds ratio structures.

The marginal distribution of a table provides insights into the structural opportunities available in the partner market.[11] The row sum of $\boldsymbol{M}_t$ is equivalent to wives' educational distribution, and the column sum of $\boldsymbol{M}_t$ reflects husbands' educational distribution:

$$\boldsymbol{E}_t^W = \begin{bmatrix} m_{1\cdot} = \sum_k^K m_{1k} \\ \dots \\ m_{K\cdot} = \sum_k^K m_{Kk} \end{bmatrix}, \boldsymbol{E}_t^H = \begin{bmatrix} m_{\cdot 1} = \sum_k^K m_{k1} & \dots & m_{\cdot K} = \sum_k^K m_{kK} \end{bmatrix} \tag{2.8}$$

[11] However, the measure can be biased if the selection into marriages depends on education.

The odds ratios measure the association between wives' and husbands' education net of the marginal distributions. In a random matching scenario where men and women in a sample are paired randomly, all odds ratios in a table would be 1. Therefore, the odds ratio matrix depicts the deviation from this hypothetical random matching. From $\boldsymbol{M}_t$ we derive the matrix of odds ratios (of dimension $K \times K$):

$$\boldsymbol{OR}_t = \begin{bmatrix} 1 & 1 & \dots & 1 \\ 1 & \frac{m_{22}}{m_{21}} \Big/ \frac{m_{12}}{m_{11}} & \dots & \frac{m_{2K}}{m_{21}} \Big/ \frac{m_{1K}}{m_{11}} \\ \dots & \dots & \ddots & \dots \\ 1 & \frac{m_{K2}}{m_{K1}} \Big/ \frac{m_{12}}{m_{11}} & \dots & \frac{m_{KK}}{m_{K1}} \Big/ \frac{m_{1K}}{m_{11}} \end{bmatrix} \tag{2.9}$$

In the next step, we define an iterative proportional fitting operation $M(.)$, with x iterations, to adjust the cells of a table to a given odds ratio matrix, as well as the row and column totals. Hence, $\boldsymbol{M}_t$ is an asymptotic (as $x \to \infty$) IPF function of the marginal row and column vectors and the odds ratio matrix:

$$\boldsymbol{M}_t \underset{x \to \infty}{=} M(\boldsymbol{E}_t^W, \boldsymbol{E}_t^H, \boldsymbol{OR}_t) \tag{2.10}$$

Decomposing differences in marital sorting outcomes

Two marriage tables usually have different structural opportunities *and* assortative mating patterns. To disentangle the influence of these two components on marital sorting outcomes, we compute counterfactual marriage tables. This requires swapping structural opportunities between two marriage tables and using IPF to recreate the cells. From these counterfactual tables, we calculate counterfactual homogamy (or hypogamy or hypergamy) rates denoted as $\dot{Y}$.

For decomposing the difference in homogamy rates between Time 1 and Time 2, the following counterfactuals are required:

$$\dot{Y}_{21} = Y\big(M(\boldsymbol{E}_2^W, \boldsymbol{E}_2^H, \boldsymbol{OR}_1)\big) \tag{2.11}$$

and

$$\dot{Y}_{12} = Y\big(M(\boldsymbol{E}_1^W, \boldsymbol{E}_1^H, \boldsymbol{OR}_2)\big) \tag{2.12}$$

Next, we use factual (Y) and counterfactual ($\dot{Y}$) marital sorting outcomes to decompose the difference between observed marital sorting outcomes. For example, we can express the difference in homogamy rates between Time 2 and Time 1 as follows:

$$Y_{22} - Y_{11} = \big(Y_{22} - \dot{Y}_{12}\big) + \big(\dot{Y}_{12} - Y_{11}\big) \tag{2.13}$$

The equation consists of two parts. The first part represents the structural opportunity ‘effect’, which captures the difference between the two times if only the structural opportunity component had changed. Conversely, the second part represents the assortative mating ‘effect’, indicating the difference if only assortative mating had changed while keeping the structural opportunities constant.

However, it is also possible to examine a scenario where we fix the structural opportunities and assortative mating patterns at the other marriage table. In this case, we can describe the difference between Time 2 and Time 1 as the trend that would arise if only the structural opportunities had changed while keeping assortative mating patterns fixed at Time 1, and the trend if only the assortative mating patterns had changed while keeping the opportunities fixed at Time 2:

$$Y_{22} - Y_{11} = \left(\dot{Y}_{21} - Y_{11}\right) + \left(Y_{22} - \dot{Y}_{21}\right) \quad (2.14)$$

Because structural opportunity and assortative mating components may differ on the arbitrary decision on a reference category (fixing the structural opportunities at Time 1 or Time 2), we take the average of these two structural opportunity 'effects' and the assortative mating 'effects':

$$Y_{22} - Y_{11} = \frac{1}{2}\left(Y_{22} - \dot{Y}_{12} + \dot{Y}_{21} - Y_{11}\right) + \frac{1}{2}\left(\dot{Y}_{12} - Y_{11} + Y_{22} - \dot{Y}_{21}\right) \quad (2.15)$$

We generalize the notation by writing

$$\Delta_{ij}^{T} = \Delta_{ij}^{O} + \Delta_{ij}^{A} \quad (2.16)$$

with Δ_{ij}^{T} representing the total difference in a marital sorting outcome between *i* and *j*, Δ_{ij}^{O} denoting the structural opportunity 'effect' (the difference expected if only opportunities differed between marriage tables) and Δ_{ij}^{A} indicating the assortative mating 'effect' (the difference expected if only assortative mating differed between marriage tables).

Standard errors

When applying our technique to sample data, it is essential to consider that the true decomposition result in the population remains unknown. Consequently, calculating standard errors is necessary to measure the uncertainty in the results. However, since there is no sampling distribution for the decomposition results, it is not feasible to determine the standard errors analytically. Therefore, we employ bootstrapping to obtain the standard errors (Efron, 1979).

Bootstrapping involves drawing multiple random samples, with replacements, from the original sample, allowing us to create a sampling distribution for our results. Scholars recommend drawing 100 to 500 bootstrap samples (Efron & Tibshirani, 1993; Wehrens et al., 2000). For each bootstrap sample, we perform the decomposition. Subsequently, we calculate the standard errors of the decomposition results from the resulting sampling distribution. By employing bootstrapping, we effectively estimate the standard errors and account for the uncertainty in our decomposition results.

2.4 Empirical example: Decomposing differences in homogamy rates between 1991 and 2016 in Ireland

2.4.1 Data

This section illustrates the application of the decomposition approach using an empirical example. We illustrate how to decompose differences in the percentage of homogamous couples between the years 1991 and 2016 in Ireland. Therefore, we employ samples of Irish censuses provided by IPUMS-International (Minnesota Population Center, 2020).

In this analysis, we focused on a sample of women aged between 25 and 34. By excluding women younger than 25, we ensured that all women in the sample had enough time to complete tertiary education, thereby avoiding the underrepresentation of highly educated women. Additionally, setting the upper bound at 34 years minimizes the influence of union dissolution and remarriage on the results.

Women's and men's education levels were classified using a four-level scale: primary or less, lower secondary, higher secondary, and tertiary education. This scale was chosen because it aligns with the main degrees attainable in the Irish educational system. Moreover, these four educational levels differ in their return to education in Ireland (McGuinness et al., 2009). Thus, education is a valuable indicator of future socioeconomic success, which shapes the partner search process.

2.4.2 Application of the decomposition procedure

Marriage Table and Sorting Outcomes

Matrix $\boldsymbol{M}_{1991}$ contains the relative joint distribution of wives' (rows) and their husbands' (columns) education in 1991 and $\boldsymbol{M}_{2016}$ contains the distribution in 2016 respectively.

$$\boldsymbol{M}_{1991} = \begin{bmatrix} .063 & .030 & .020 & .001 \\ .043 & .159 & .082 & .006 \\ .037 & .136 & .274 & .052 \\ .002 & .010 & .037 & .048 \end{bmatrix} \tag{2.17}$$

$$\boldsymbol{M}_{2016} = \begin{bmatrix} .017 & .004 & .008 & .002 \\ .007 & .020 & .022 & .004 \\ .017 & .059 & .259 & .068 \\ .005 & .023 & .185 & .299 \end{bmatrix} \tag{2.18}$$

The sorting outcome Y at time t is a scalar function of $\boldsymbol{M}_t$:

$$Y_t = f(\boldsymbol{M}_t) \tag{2.19}$$

For example, the probability of homogamy (spouses have the same education) in 1991 is the sum of the diagonal of $\boldsymbol{M}_{1991}$:

$$Y^{W=H}(\boldsymbol{M}_{1991}) = .063 + .159 + .274 + .048 = .544 \tag{2.20}$$

Accordingly, the probability of female hypergamy (she is more educated than he) is the sum of the upper off-diagonals

$$Y^{W<H}(\boldsymbol{M}_{1991}) = .030 + .020 + .001 + .082 + .006 + .052 = .191 \tag{2.21}$$

and the probability of female hypogamy (she is less educated than he) is the sum of the lower off-diagonals

$$Y^{W>H}(\boldsymbol{M}_{1991}) = .043 + .037 + .136 + .002 + .010 + .037 = .265 \tag{2.22}$$

Dissecting the Marriage Table

Wives' educational distribution is given by the row sum of $\boldsymbol{M}_{1991}$ and husbands' distribution by the column sum:

$$\boldsymbol{E}_{1991}^{W} = \begin{bmatrix} .113 \\ .291 \\ .499 \\ .097 \end{bmatrix}, \boldsymbol{E}_{1991}^{H} = [.145 \;\; .335 \;\; .413 \;\; .107] \tag{2.23}$$

The odds ratio matrix shows the association structure within the table. Below, we show the odds ratio matrix for the marriage table from 1991. As a convention, we depict the odds ratios relative to the first row and column; therefore, we see ones in those rows and columns.

$$\boldsymbol{OR}_{1991} = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 7.68 & 6.06 & 12.04 \\ 1 & 7.74 & 23.91 & 116.00 \\ 1 & 8.82 & 50.23 & 1685.01 \end{bmatrix} \tag{2.24}$$

For example, the odds of wives with tertiary education ($i = 4$) marrying a man with higher secondary education ($j = 3$) rather than primary education ($j = 1$, the first column as the reference category for the odds) are $\frac{.037}{.002} = 18.5$. In other words, highly educated wives are 18.5 times more likely to marry a higher secondary-educated husband than a primary-level educated husband. The corresponding odds for primary-level educated wives ($i = 1$, the first row as the reference category for the odds ratio) are $\frac{.020}{.063} = .317$.

Correspondingly, the odds ratio is $\frac{18.5}{.317} = 58.3$ (due to rounding issues slightly higher than the 50.23 shown in the table above).

The IPF function $\boldsymbol{M}_{1991}$ takes the odds-ratio matrix and row and column totals to fit the table's cells.

$$\boldsymbol{M}_{1991} \underset{x\to\infty}{=} M(\boldsymbol{E}_{1991}^{W}, \boldsymbol{E}_{1991}^{H}, \boldsymbol{OR}_{1991}) \tag{2.25}$$

In the same way, the marriage table in 2016 ($\boldsymbol{M}_{2016}$) can be dissected in row ($\boldsymbol{E}_{2016}^{W}$) and column totals ($\boldsymbol{E}_{2016}^{H}$) and an odds ratio matrix ($\boldsymbol{OR}_{2016}$).

Decomposition: Structural Opportunities and Assortative Mating

Both mechanisms – assortative mating and structural opportunities – shape sorting outcomes, but both have changed from 1991 to 2016. Based on the IPF function introduced above, counterfactuals are defined as sorting outcomes derived from hypothetical tables that we would observe if opportunities and assortative mating were swapped:

$$\dot{Y}_{2016,1991} = Y\big(\boldsymbol{M}_{t}(\boldsymbol{E}_{2016}^{W}, \boldsymbol{E}_{2016}^{H}, \boldsymbol{OR}_{1991})\big) = .603 \tag{2.26}$$

and

$$\dot{Y}_{1991,2016} = Y\big(\boldsymbol{M}_{t}(\boldsymbol{E}_{1991}^{W}, \boldsymbol{E}_{1991}^{H}, \boldsymbol{OR}_{2016})\big) = .550 \tag{2.27}$$

We can write the overall difference in homogamy between 2016 and 1991 as

$$.595 - .544 = (.595 - .550) + (.550 - .544) \tag{2.28}$$

In the same fashion, we could write

$$.595 - .544 = (.603 - .544) + (.595 - .603) \tag{2.29}$$

Adding both equations and rearranging terms leads to

$$\begin{aligned} .595 - .544 = & \frac{1}{2}(.595 - .550 + .603 - .544) \\ & + \frac{1}{2}(.550 - .544 + .595 - .603) \end{aligned} \tag{2.30}$$

The first term of the equation ($\frac{1}{2}(.595 - .550 + .603 - .544) = .052$) expresses the opportunity 'effect', and the second term ($\frac{1}{2}(.550 - .544 + .595 - .603) = -.001$) represents the assortative mating 'effect'.

Finally, we bootstrapped the standard errors by resampling 500 samples with replacement. The assortative mating component is not significant, while the structural opportunity component is significant at the .001 level.

2.5 Discussion

This article reviewed methodological approaches that have been used to study assortative mating and sorting outcomes. Building on this review, we introduced a novel approach for decomposing the extent to which differences in cells of two contingency tables (sorting outcomes) can be attributed to differences in their odds ratios (assortative mating) and marginal distributions (structural opportunities). The methodology involves two steps. First, we applied iterative proportional fitting (IPF) to generate counterfactual contingency tables that contain either the odds ratios or the marginal distributions of another table. Then, we used counterfactual and observed contingency tables to decompose the observed differences in sorting outcomes into structural opportunity and assortative mating components.

Researchers can apply our methodology to various areas. For example, the method can be used to investigate to what extent changes in the occupational distribution and relative social mobility explain trends in absolute occupational mobility (cf. Altham & Ferrie, 2007). Furthermore, changes in the percentage of over- or undereducated employees depend on fluctuations in the supply of workers and jobs in the labor market and the mechanisms by which they match. The proposed methodology can disentangle the influence of these two drivers on changing sorting outcomes in the labor market.

Moreover, our method has the potential to go beyond the scope of marriage tables as it can account for processes that lie outside the marriage table but shape their marginal distributions. For instance, trends and differences in selection into marriage may shape marital sorting outcomes, a fact that is frequently overlooked in log-linear analyses that solely focus on married individuals. Chapter 3 of this thesis illustrates how researchers can use our methodology to account for changes in the selection into marriages.

One limitation of the presented methodology is the assumption of independence between differences in the odds ratio structure and the marginal distributions. Variations in assortative mating and structural opportunities could potentially be intertwined. For instance, the rise in tertiary education might have shaped preferences for highly educated partners, thus influencing odds ratio structures. However, the assumption is necessary to analytically disentangle the influence of these two components.

Furthermore, most of the critique of log-linear models, discussed in section 2.2, also applies to our method, as we use the odds ratio structure of a marriage table to measure assortative mating. For example, like log-linear models, our approach cannot account for spillover effects. However, given the widespread use of log-linear models in assortative mating research, we argue that the odds ratio structure is appropriate for operationalizing assortative mating in our context. Hence, our approach helps to contextualize previous studies employing log-linear models. Nonetheless, future research might explore and evaluate alternative measures of assortative mating.

Moreover, research may advance the presented methodology. For example, scholars could explore alternative decomposition procedures. Our method fixes the odds ratios and marginal distributions in both tables and takes the average of the two possible decomposition results. An alternative approach could keep each component constant in just one table, generating ‘effects’ for the odds ratios and marginal distributions and an interaction ‘effect’ representing changes in sorting outcomes due to concurrent changes in odds ratios and marginal distributions. Moreover, enhancing our decomposition approach to multidimensional contingency tables would be essential for improving our understanding of marital sorting outcomes by multiple characteristics.

3 Decomposing trends in educational homogamy and heterogamy – the case of Ireland

3.1 Introduction

Educational sorting in unions and marriages[12], meaning the level of educational homogamy and heterogamy, can be consequential for social inequality and mobility because 'who marries whom' determines the distribution of socioeconomic resources within and between couples (Blossfeld, 2009; Breen & Andersen, 2012; McCall & Percheski, 2010; McLanahan, 2004; C. R. Schwartz & Mare, 2005). Within couples, educational homogamy and heterogamy may contribute to gender inequality by shaping spouses' relative bargaining power in joint decisions, such as the division of paid and unpaid labor (Lundberg & Pollak, 1996; Manser & Brown, 1980). In addition, rising levels of educational homogamy may contribute to intragenerational socioeconomic inequality between couples and households (e.g., Boertien & Permanyer, 2019b; Breen & Andersen, 2012), but also intergenerational inequality by creating unequal opportunities for offspring (e.g., Corti & Scherer, 2022; Mare & Schwartz, 2006; Rauscher, 2020). As educational attainment is one of the most profound predictors of socioeconomic attainment, examining trends in educational sorting outcomes is crucial for understanding change in social inequalities (C. R. Schwartz, 2013).

Our conceptual framework distinguishes two main forces that drive trends in educational sorting outcomes, such as the percentage of educationally homogamous couples: assortative mating and structural opportunities. In the context of our study and in line with previous literature, assortative mating refers to mechanisms of matching that

[12] Note that we analyse cohabiting opposite-sex couples regardless of whether they are formally married or not. To improve readability, we use the terms marriage, partnership, and unions interchangeably.

generate an association between husbands' and wives' education net of structural opportunities. The degree of assortative mating thus indicates to what extent observed sorting outcomes deviate from sorting outcomes that would occur if matching were random (Katrňák & Manea, 2020; Permanyer et al., 2019; C. R. Schwartz, 2013). Structural opportunities, on the other hand, correspond to the educational composition of the population of men and women available for marriage (Katrňák & Manea, 2020; Permanyer et al., 2019). It is important to note that structural opportunities have changed continuously over the past decades as a result of educational expansion.

When examining trends in 'who marries whom', previous research routinely focuses on investigating trends in assortative mating while netting out the effect of structural opportunities (Kalmijn, 1991b; C. R. Schwartz & Mare, 2005; Smits, 2003). One shortcoming of studies focusing on assortative mating is that they cannot quantify the separate contributions of changing educational assortative mating and structural opportunities to changes in sorting outcomes (e.g., absolute levels of homogamy). We argue that this is not only a methodological but also a substantive shortcoming since it is absolute sorting outcomes that matter for the social fabric of unions and related social inequalities. Our study intends to address this gap.

To our knowledge, only one recent study, by Permanyer et al. (2019), has tried to disentangle the contribution of changing assortative mating and structural opportunities to trends in educational sorting outcomes. Decomposing trends in educational homogamy across various countries, Permanyer and colleagues found that a general rise in college education was the most significant contributor to rising levels of educational homogamy in terms of college and non-college education. Changes in educational assortative mating and the gender gap in education hardly contributed to the growth of homogamy.

A major drawback of Permanyer et al.'s (2019) study – shared by most previous studies on assortative mating – consists of the analytical restriction to couples. Consequently, previous research routinely neglects the demographic fact that entry into unions is not random but a process that is shaped by educational attainment. For example, in several western countries, including Ireland, the educational gradient in marriage and union formation among women has reversed, implying that more educated women are now more likely to be married or cohabiting than less educated women (Bertrand et al., 2020; Goldstein & Kenney, 2001; Lundberg et al., 2016). Such a shift in the educational gradient of marriage and union formation shapes the distribution of educational attainment of married and partnered women and men and, therefore, presumably also marital sorting. For example, if more partnered women are highly educated, we expect fewer couples in which women are less educated than their partners. Yet it is still unclear to what extent the changing educational gradient in marriage and union formation drives sorting outcomes.

For the case of Ireland, and focusing on marital as well as cohabiting unions, our study aims to address the aforementioned research gaps by considering the following two questions: (1) How have educational sorting outcomes changed over time? (2) How do concurrent changes in educational attainment, the educational gradient in union formation, and educational assortative mating contribute to changing outcomes in educational sorting?

This study contributes to previous research in several ways. First, to address the second research question, we present a novel decomposition technique that quantifies the separate contributions of changing structural opportunities and assortative mating to trends in sorting outcomes. Second, to our knowledge, our study is the first to quantify how changes in marriage gradients shape marital sorting outcomes. Moreover, for examining and decomposing trends in educational homo- and heterogamy, we employed highly representative and large microdata samples from Irish censuses (Minnesota Population Center, 2020), covering 25 years from 1991 to 2016. Finally, our study is the first study examining recent trends in marriage patterns in Ireland; the country represents an interesting case due to its massive educational expansion over the past three decades.

3.2 Theoretical background

3.1 Assortative mating

Changes in the assortativeness of mating are one potential cause of changing outcomes in marital sorting. Women's and men's partner preferences can shape assortative mating. Those preferences may be subject to change, for example, if economic development, economic inequalities, and gender inequality have altered the utility of having a more or less educated partner (Fernandez et al., 2005; Smits et al., 1998a, 2000; Sweeney, 2002). In addition, changes in partner search may have a bearing on educational assortative mating if search increasingly takes place in social contexts that are either more or less homogeneous in terms of education (Mare, 1991).

In Ireland, a profound increase in gender equality (e.g., concerning employment, occupational segregation, and earnings) over the past decades (England et al., 2020) may have altered assortative mating with regard to education. Therefore, our theoretical discussion focuses on the role of gender inequality for trends in assortative mating.

Becker's (1981b) economic approach to marriage provides a common theoretical framework for explaining marriage and assortative mating. Assuming individuals to be utility-maximizing actors, Becker argues that the main gain from marriage arises from a specialized division of labor among spouses in order to maximize a joint household utility function. The partner market, which consists of the population at risk of marriage, is competitive since both partners' traits enter the joint utility function. Becker argues that positive assortative mating (homogamy) is optimal for complementary traits and negative assortative mating (heterogamy) is optimal for substitutable traits. Hence, to the degree that education is a cultural trait related to attitudes, values, and lifestyles where the educational levels of partners complement each other, economic theory would expect similarity in mating with respect to education. However, dissimilarity mating would be expected to the degree that education is related to labor market productivity (e.g., hourly wage). Thus, specialization gains from marriage are the highest if individuals with high market productivity are married to individuals with high household productivity (Becker, 1981b; Blossfeld, 2009; Blossfeld & Timm, 2003; C. R. Schwartz, 2013).

As female labor force participation increased and dual-earner couples became the new norm, scholars expected convergence in women's and men's educational preferences. Husbands increasingly benefit from the education of their wives since educated women have better employment and earnings prospects (Mare, 1991). For women, education remains a desirable trait in potential male partners, but the growth in female employment has resulted in declining dependency on male education and earnings, which gives women the freedom to choose a partner who offers other desirable traits (Oppenheimer, 1994). Thus, the benefits of positive assortative mating may increasingly outweigh the specialization gains of negative assortative mating.

Several studies suggest a shrinking gap in women's and men's preferences for education. Gender differences in partner preferences have been diminishing over time (Bech-Sørensen & Pollet, 2016; Buss et al., 2001) and were found to be smaller in gender-egalitarian contexts (Zentner & Mitura, 2012). Also, the reduction of union formation and marriage rates among low-educated women in gender-egalitarian countries (Bertrand et al., 2020; Goldstein & Kenney, 2001; Kalmijn, 2013) might indicate that men have developed a preference for more educated women. We expect converging preferences for education to contribute to declines in women marrying partners more educated than themselves, and, therefore, a rising proportion of women with an equally or less educated partner.

3.2.2 Structural opportunities

Opportunity structures matter for marital sorting outcomes, as the relative size of a group indicates the likelihood of meeting a member of this group (Blau, 1977; Blau et al., 1982). Hence, the distribution of educational attainment among men and women on the partner market shapes marital sorting outcomes – the larger an educational group, the higher the probability of meeting and marrying a member of this group. Several studies have supported the hypothesis that the partner market composition in the population (Blau et al., 1982; Blum, 1985) and local partner markets (S. K. Lewis & Oppenheimer, 2000) is linked to sorting outcomes.

Over the course of educational expansion, the relative sizes of educational groups have changed dramatically. It is most likely that, as a result of the shift from a population characterized by predominantly low levels of education to one with high levels of education, the variation in educational levels exhibits an inverted U-shape pattern. Low levels of variation in educational attainment, which occur at the beginning and end of the process of educational expansion, facilitate higher rates of homogamy and limit heterogamous matching (Katrňák & Manea, 2020). Indeed, the growth in partnered women's and men's educational attainment has been found to be the key driver of trends in educational homogamy (Katrňák & Manea, 2020; Permanyer et al., 2019). We expect a general improvement in educational levels to have led to a decline in educational variation over the last decades in Ireland, and thus to have contributed to declining heterogamy and rising homogamy.

The gender gap in education matters for structural opportunities too. Women's educational attainment has been rising faster than men's (Esteve et al., 2016), and in most European countries, this has resulted in a reversed gender gap in education (De Hauw et al., 2017; Esteve et al., 2016). If matching were random and structural opportunities were determined only by the gender gap in education, the absence of a gender gap in education would maximize matches between equally educated candidates. Consequently, the emergence of a female educational advantage may have contributed to an increase in women marrying down in education and a declining percentage of women marrying up in education. By analyzing partnered women and men, Esteve et al. (2012, 2016) and Erát (2021) show a country-level association between the reversing gender gap in education and the increase in the percentage of heterogamous couples in which women are more educated than men. Yet Permanyer et al. (2019) find that the reversing gender gap in education scarcely counteracted the rise in educational homogamy.

In research practice, this structuralist perspective on the relationship between the partner market and marital sorting is, however, incomplete. Studies typically measure structural opportunities on the partner market by the distribution of education among those who are married. Thereby, those studies ignore the fact that not all men and women marry, and that entry to marriage depends on educational attainment. This educational gradient in marriage may be subject to change, thereby influencing trends in structural opportunities for homogamous and heterogamous sorting through the educational composition of husbands and wives.

Although it has been established that the highly educated marry later in life[13] (Blossfeld & Huinink, 1991; Goldstein & Kenney, 2001; Thornton et al., 2007), women's

[13] Also, the partner's level of education has been found to be associated with the time of union formation (Henz & Jonsson, 2003). Blossfeld and Huinink (1991) point out that more educated people may marry later in life because economic dependency and normative expectations prevent them from marrying before they complete their degree. On the other hand, for more educated men and women, postponing marriage can be

educational gradient of ever being married has reversed (Bertrand et al., 2020; Goldstein & Kenney, 2001; Kalmijn, 2013; Torr, 2011). This means that, in the past, highly educated women had lower marriage rates than less educated women, whereas now, highly educated women have higher marriage rates than less educated women. This pattern has also been observed in Ireland (Bertrand et al., 2020). At the same time, the disadvantage which less educated men experience in terms of marriage rates has intensified in many western countries over the last decades (Bertrand et al., 2016).

Change in the marriage gradient could stem from changes in the 'supply' and 'demand' of women and men with a specific educational level. Someone may want to marry, but the currently available candidates might not meet their aspirations. Individuals who aspire to marry may remain unmarried if the demand for their own traits is too low. On the other hand, individuals may choose not to marry regardless of their options on the partner market. In that case, trends in the marriage gradient would be independent of the educational composition of the partner market.

Because the ratio of low-educated women to men has been declining, partner market conditions have been improving for less educated women. Now, for every low-educated women more than one equally educated candidate is available. The observed reversal of women's educational gradient in marriage therefore seems not to be a direct consequence of the rising imbalance in women's and men's education. This is in line with Oppenheimer's (1988) work, which suggests that stable occupational career is a signal for future socioeconomic status, as required in the partner search process and for partnership-specific investments such as setting up a joint household. In the modern knowledge- and

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a strategic decision: Partner search theory (Oppenheimer, 1988) suggests that more educated individuals marry later because better education is linked to greater returns for a prolonged partner search, as highly educated men and women are the most desirable candidates on the market.

skill-based economies of today, low-educated men and women may fail to provide certainty about their potential to establish stable careers.

Whatever mechanisms were causing the shift in the marriage gradient, the changing gradient itself may shape trends in sorting outcomes. Because the marriage rates of low-educated men and women have been declining, the married population is, on average, more highly educated than the full population. We, therefore, expect change in the marriage gradient to lead to an increase in educational similarity of married men and women that drives rising educational homogamy.

The link between the marriage gradient and sorting outcomes also depends on how the marriage gradient has shaped the gender gap in education of married women and men. For example, if the change in the marriage gradient had been more pronounced for women, the educational level of married women would have increased more than the one of married men. This may reinforce the reversal of the gender gap in education in the partnered population. We expect that this would be linked to a rise in the share of women marrying down in education, at the expense of a declining share of women with an equally or less educated partner.

3.2.3 The Irish context

The social changes we discussed as potential causes of changing marital sorting outcomes are particularly pronounced in Ireland compared to other European countries. The labor force participation and employment of Irish women have risen sharply in recent decades (Bercholz & FitzGerald, 2016; Thévenon, 2013). In 1980, women's employment in the prime working age of 25 to 54 was under 30%, far below the OECD average of 54%. Afterwards, women's employment increased rapidly and almost met the OCED average of 71% in 2010 (Thévenon, 2013). The remarkable growth in female employment indicates a rising contribution of women's earnings to household incomes.

Educational expansion in Ireland has also been much greater than in other OECD countries. Among 25- to 34-year-old men and women, tertiary education has risen rapidly, from 14% in 1996 to 63% in 2021 (OECD, 1999, 2022a). Within this age group, Ireland has been among the OECD countries with the most substantial growth in tertiary education between 2000 and 2021 – the share of tertiary education has risen by over 30% (OECD, 2022a). Because women's educational levels have been growing faster than men's, from the mid-1990s onwards, more Irish women than men were enrolled in tertiary education (De Hauw et al., 2017; Vincent-Lancrin, 2008).

Moreover, Bertrand et al. (2020) found that among the European countries where the educational gradient in women's union formation has reversed since the mid-1990s, the difference in marriage rates between more and less educated women is the largest in Ireland. The fact that the social changes we are interested in are exceptionally pronounced in Ireland makes the Irish case well suited for studying the consequences of these changes for marital sorting.

3.3 Data

3.3.1 Sample

Our analysis is based on data from the 'International Public Use Microdata Series, International' (IPUMS-I). IPUMS-I provides samples of harmonized census data. For our analysis, we used 10% samples from the Irish censuses of 1991, 1996, 2002, 2006, 2011 and 2016, which provides the study with highly representative data. Sample sizes are large, and the samples do not suffer from sampling bias since they were randomly drawn from full population data.

We restricted the census samples to 25- to 34-year-old women of the de facto population for three theoretical and methodological reasons. First, it is within this age range when young Irish women typically complete the transition to adulthood and lay the foundations for family life. By age 25, most women in Ireland have finished their education and are in the process of establishing their careers. Thus, young adulthood is an important phase in the partner search process as the predictability of women's future socioeconomic attainment increases. At the same time, the age before 35 is crucial in terms of childbearing, as women's fecundity and the socially accepted age for childbearing drop rapidly between the age of 35 and 50 (Billari et al., 2011; Leridon, 2004). Second, the age range criterion corresponds approximately to the period in which first-time marriages occur. Excluding women older than 34 reduces the effect of assortative union dissolution, remarriage, and educational upgrades within marriages on the results (Permanyer et al., 2019; C. R. Schwartz & Mare, 2012). However, since women's age at first marriage has been increasing (Central Statistics Office, 2015, 2021), sorting outcomes in this age group may also reflect trends in the timing of marriage and union formation. Third, the limited age interval of ten years minimizes cohort overlap, which is advantageous for analyzing between-cohort trends.

We analyzed sorting outcomes of women in cohabiting unions regardless of whether they are formally married or not because trends in educational homogamy and heterogamy can have consequences for social mobility and inequality, irrespective of marriage status. Just like married couples, unmarried cohabitors have children (Kiernan, 2001a), they profit from the economy of scale and, albeit to a lesser extent than married couples, they pool their income (Hiekel et al., 2014).

Finally, we dropped cases list-wise if either the woman's or their partner's education data was missing. That also included cases of women with partners living in another household for whom education data was not available. In all samples, the number of missing values was low (below 6%). Table B3.1 in the Appendix shows case numbers by census year at each stage of the sample selection after subtracting the indicated cases.

For the decomposition analysis, we created contingency tables that show sorting outcomes and the number of married and unmarried men and women per educational level. Since we selected a sample of women, the initial tables indicate women's educational level, whether they had a partner, and if so, what level of education he had. To investigate how educational gradients in marriage shape trends in sorting outcomes, we also require information about the education of unpartnered men. We, therefore, had to approximate the educational distribution of unpartnered men by a reference sample of men[14] who would have been available in principle for partnering with the women in our sample. Based on that male reference sample, we calculated ratios of unpartnered and partnered men in each census year and educational level. Within each educational category, the ratio was multiplied with the number of men who are married to the women in our sample.

3.3.2 Measures

Our measure of education is based on the International Standard Classification of Education (ISCED-11) (UNESCO, 2012). We collapsed the nine-level scale into a classification of four categories which is widely used for distinguishing between educational levels in Ireland (e.g., Halpin & Chan, 2003; Whelan & Layte, 2002). The scale differentiates between primary or less, lower secondary, higher secondary, and tertiary education. Tertiary education (ISCED 5 and higher) is equivalent to any tertiary degree. Higher secondary education (ISCED 3 and 4) indicates that secondary education was completed with the Leaving Certificate. Lower secondary education (ISCED 2) is equivalent to the Junior, Group, or Intermediate Certificate. Lower qualifications

[14] Ideally, the age gap between the sample of women and the reference sample of men should coincide with the observed age gaps of a high proportion of couples. We use a sample of 27- to 36-year-old men to approximate the partner market of 25- to 34-year-old women because, throughout the observation period, husbands are on average two years older than wives (Central Statistics Office, 2015, 2021). Because data on age is provided in five-year categories, we approximated the group of 27- to 36-year-old men with all 30- to 34-year-old men, 60% of 25- to 29-year-old men and 40% of 35- to 39-year-old men.

(secondary education without any qualifications, primary education, less than primary education) fall into the 'primary or less' (ISCED 0 and 1) category.

We believe that our measure discriminates well in terms of the socioeconomic consequences of different educational levels because it reflects not only the Irish educational system, i.e., the educational degrees that can be obtained upon completing a cycle in the education system, but also differences in the returns to education. McGuinness et al. (2009) found that returns to education differ substantially between these four categories.[15]

3.4 Methods

Our analysis examines trends in marital sorting outcomes based on year-specific marriage tables. The primary aim of our study is to identify the structural forces that drive those trends in marital sorting outcomes. For that purpose, we employ a novel decomposition method that can estimate the separate contributions of changes in our three analytical components – educational distributions, marriage gradients, and assortative mating patterns – to changes in sorting outcomes. The analysis decomposes differences between sorting outcomes in a given year ($t = 2$) and the reference year 1991 ($t = 1$), for example, the difference between 2016 and 1991 in the fraction of homogamous unions.

Our decomposition technique builds on a counterfactual approach that constructs hypothetical (henceforth counterfactual) sorting outcomes (e.g., fraction of homogamy) under the assumption that only one of the three components had changed between 1991 and the comparison year. Comparing counterfactual with observed outcomes provides information on the relevance of change in the respective component for change in the

[15] McGuinness et al. (2009) also found differences within different levels of tertiary education. Because our data does not allow distinguishing finer levels of tertiary education, for the purpose of our study, a four-level scale appears to be the best possible solution to represent educational differences that are substantively meaningful in Ireland.

sorting outcome. For example, we may ask how much homogamy we might have observed in 2016 if the marriage gradient and educational distributions had not changed (i.e., were fixed at level of 1991), but only assortative mating had changed. We compare this counterfactual homogamy outcome with the actual homogamy outcome observed in 2016. From that comparison, we learn about the role changes in assortative mating may have played for changing homogamy outcomes.

Technically, constructing counterfactual outcomes involves constructing counterfactual marriage tables by swapping marginal distributions and odds ratio structures across observed marriage tables. This rests on the insight that cells in a marriage table can be recovered solely from the table's marginal distributions (the educational distributions of husbands and wives respectively) and the table's odds ratio structure (reflecting the degree of association between husband's and wife's education) via iterative proportional fitting (IPF) (Deming & Stephan, 1940). IPF is a widely used algorithmic procedure that allows the cells in one table to be adjusted to row and column totals (marginals) of another table without changing the odds ratio structure of the initial table (e.g., see Lomax and Norman 2016).

In the following, we formally introduce the basic elements and steps of our analysis and the associated decomposition approach.

3.4.1 Marriage table and sorting outcomes

In the first part of our analysis, we investigate how marital sorting outcomes have changed over time. Analyzed are trends in the proportion of married women who are married either to an equally, more, or less educated man. To calculate sorting outcomes, we sum entries in a marriage table, represented by a $K \times K$ matrix that contains the relative joint distribution of wives' and their husbands' education:

$$\boldsymbol{M}_t = \begin{bmatrix} m_{11} & \dots & m_{1K} \\ \dots & \ddots & \dots \\ m_{K1} & \dots & m_{KK} \end{bmatrix} \tag{3.1}$$

In our case, $K = 4$ since we have four educational categories. Index t denotes the year of the census. A table cell (or matrix element) m_{ij} is the fraction of marriages that involve a wife with educational level i and a husband with educational level j. Hence, all cells sum up to 1.

Sorting outcome Y at time t is a scalar function of $\boldsymbol{M}_t$:

$$Y_t = f(\boldsymbol{M}_t) \tag{3.2}$$

For example, the probability of homogamy (spouses with the same education) is just the sum over the diagonal of $\boldsymbol{M}_t$:

$$Y^{W=H}(\boldsymbol{M}_t) = \sum_{k=1}^{K} m_{i=k,j=k} \tag{3.3}$$

Accordingly, the probability of female hypergamy (wives married upward) is the sum of the upper off-diagonals

$$Y^{W<H}(\boldsymbol{M}_t) = \sum_{k=1}^{K-1} \sum_{l=k+1}^{K} m_{i=k,j=l} \qquad (3.4)$$

and the probability of female hypogamy (wives married downward) is the sum of the lower off-diagonals

$$Y^{W>H}(\boldsymbol{M}_t) = \sum_{k=2}^{K} \sum_{l=1}^{k-1} m_{i=k,j=l} \qquad (3.5)$$

In total, we constructed six marriage tables, $\boldsymbol{M}_1$ to $\boldsymbol{M}_6$ corresponding to census years 1991 to 2016, and calculated all three outcomes for each table. The point of reference for evaluating trends in outcomes is the first time point, or table $\boldsymbol{M}_1$.

3.4.3 Dissecting the marriage table

Marginals and odds ratios capture different mechanisms driving marital sorting outcomes. In our context, the marginals of the marriage table correspond to the supply of men and women in different education categories among those who marry. These 'opportunity structures' influence the probability of certain sorting outcomes and might explain why they change. For example, if gender differences in the distribution of education decrease, the structural probability of homogamous marriages increases. In our formalization, wives' educational distribution is given by the row sum of $\boldsymbol{M}_t$ and husbands' distribution by the column sum:

$$\boldsymbol{E}_t^W = \begin{bmatrix} m_{1\cdot} = \sum_k^K m_{1k} \\ \cdots \\ m_{K\cdot} = \sum_k^K m_{Kk} \end{bmatrix}, \boldsymbol{E}_t^H = \begin{bmatrix} m_{.1} = \sum_k^K m_{k1} & \cdots & m_{.K} = \sum_k^K m_{kK} \end{bmatrix} \tag{3.6}$$

Odds ratios are margin-free measures of a categorical association. They measure the association structure within the table and, therefore, the joint distribution's departure from the distribution under independence, a hypothetical distribution expected to be realized if husbands and wives were to match randomly along the lines of education. Past research has frequently interpreted odds ratios as educational assortative mating, emphasizing the fact that men and women are actors who make non-random choices about their partners within given opportunities. In our case, the odds ratios represent the ratio between *i*-educated women's probability of marrying a *j*-educated husband over marrying a *1*-educated husband (odds of a *j*-husband) and *1*-women's odds of marrying *j*-husbands. For the general case of $K > 2$ (we have $K = 4$), we derive from $\boldsymbol{M}_t$ the matrix of odds ratios (of dimension $K \times K$):

$$\boldsymbol{OR}_t = \begin{bmatrix} 1 & 1 & \cdots & 1 \\ 1 & \frac{m_{22}}{m_{21}} \Big/ \frac{m_{12}}{m_{11}} & \cdots & \frac{m_{2K}}{m_{21}} \Big/ \frac{m_{1K}}{m_{11}} \\ \cdots & \cdots & \ddots & \cdots \\ 1 & \frac{m_{K2}}{m_{K1}} \Big/ \frac{m_{12}}{m_{11}} & \cdots & \frac{m_{KK}}{m_{K1}} \Big/ \frac{m_{1K}}{m_{11}} \end{bmatrix} \tag{3.7}$$

In that respect, we define $M(.)$ as being an iterative proportional fitting operation (with x iterations) that takes the odds-ratio matrix on the one hand and row and column totals (marginals) on the other hand as inputs to fit the same table's cells. Hence, we rewrite $\boldsymbol{M}_t$ as an asymptotic (as $x \rightarrow \infty$) IPF function of the marginal row and column vectors and the matrix of odds ratios:

$$\boldsymbol{M}_t \underset{x \rightarrow \infty}{=} M(\boldsymbol{E}_t^W, \boldsymbol{E}_t^H, \boldsymbol{OR}_t) \tag{3.8}$$

3.4.4 Two-fold decomposition: Opportunities and assortative mating

Both mechanisms – assortative mating and opportunities to marry – shape marriage patterns, but both may have changed from time $t = 1$ (e.g., year 1991) to time $t = 2$ (e.g., year 2016). To better understand changes in marriage patterns, our analysis proposes to isolate the potential influence of either mechanism on the observed changes. Applied illustratively for homogamy, we ask the following hypothetical questions: How much homogamy would we have observed at Time 2 if only opportunities, but not assortative mating, had changed from Time 1 to Time 2? And, vice versa, what would the extent of homogamy be at Time 2 if only assortative mating but not opportunities had changed? Hence, our approach to isolate the influence of the different mechanisms involves calculating counterfactual homogamy outcomes ($\dot{Y}$) and comparing them with the actual homogamy outcomes observed (Y). Table B3.2 in the Appendix summarizes observed and counterfactual homogamy outcomes.

Based on the IPF function from above, counterfactuals are defined as hypothetical tables that we would observe if opportunities (marginals) and assortative mating (association structure) were swapped between time points:

$$\dot{Y}_{21} = Y\big(M(\boldsymbol{E}_2^W, \boldsymbol{E}_2^H, \boldsymbol{OR}_1)\big) \tag{3.9}$$

and

$$\dot{Y}_{12} = Y\big(M(\boldsymbol{E}_1^W, \boldsymbol{E}_1^H, \boldsymbol{OR}_2)\big) \tag{3.10}$$

Having factual and counterfactual rates allows us to decompose elements of changes in marriage patterns formally. The overall differences between sorting outcomes (e.g., homogamy if Y is the homogamy function) at Time 2 and Time 1 can be written as

$$Y_{22} - Y_{11} = \big(Y_{22} - \dot{Y}_{12}\big) + \big(\dot{Y}_{12} - Y_{11}\big) \tag{3.11}$$

which is the sum of the 'opportunity effect', the hypothetical difference if only opportunities had changed, but assortative mating were fixed to the level of Time 2 ($Y_{22} - \dot{Y}_{12}$), and the 'assortative mating effect', the hypothetical difference if only assortative mating had changed, but opportunities were fixed at the level of Time 1 ($\dot{Y}_{12} - Y_{11}$). In the same fashion, we could write

$$Y_{22} - Y_{11} = \big(\dot{Y}_{21} - Y_{11}\big) + \big(Y_{22} - \dot{Y}_{21}\big) \tag{3.12}$$

which is the sum of the hypothetical difference if only opportunities had changed but assortative mating were fixed to the level of Time 1 ($\dot{Y}_{21} - Y_{11}$), and the hypothetical difference if only assortative mating had changed, but opportunities were fixed at the level of Time 2 ($Y_{22} - \dot{Y}_{21}$). Consequently, there are two opportunity and two assortative mating effects depending on whether Time 1 or Time 2 is taken as a reference point to fix the other component. Adding (3.11) and (3.12) and rearranging terms leads to

$$Y_{22} - Y_{11} = \frac{1}{2}\left(Y_{22} - \dot{Y}_{12} + \dot{Y}_{21} - Y_{11}\right) + \frac{1}{2}\left(\dot{Y}_{12} - Y_{11} + Y_{22} - \dot{Y}_{21}\right) \quad (3.13)$$

Equation (3.13) expresses the difference in homogamy rates as the sum of two components: the average opportunity effect (first term) and the average assortative mating effect (second term). We generalize the notation by writing

$$\Delta_{ij}^{T} = \Delta_{ij}^{O} + \Delta_{ij}^{A} \quad (3.14)$$

with Δ_{ij}^{T} denoting the total outcome difference between Time *i* and *j*, Δ_{ij}^{O} the opportunity effect (the difference in outcomes expected if only opportunities differed between times), and Δ_{ij}^{A} the assortative mating effect (the difference in outcomes expected if only assortative mating differed between times).

Similar counterfactual approaches have been applied to understand changing patterns of social mobility (Breen, 2010) and the relationship between trends in educational assortative mating and economic inequalities (Breen & Andersen, 2012; Breen & Salazar, 2011). Breen (2010) simulated trends in the association between class origin and class destination using different counterfactual distributions of cohort, education, class origin, and class destination that were produced with log-linear models. Breen and

Andersen (2012) and Breen and Salazar (2011) used IPF to calculate counterfactual trends in homogamy that would have occurred if only assortative mating or structural opportunities had changed. In contrast to our study, the authors used those counterfactuals not for decomposing trends in marital sorting outcomes, but for decomposing trends in economic inequality.

Moreover, Permanyer et al. (2019) developed a counterfactual decomposition technique that is similar to our method. They identified the extent to which trends in marital sorting are driven by the level of college education, the gender gap in college education, and assortative mating. Their approach offers an analytical solution to measure the contribution of those three components, whereas our method is based on numerical approximations of counterfactual sorting outcomes (via IPF). However, their method is restricted to 2x2 tables, while the method proposed here can easily handle multiple educational categories. Hence, the method we introduce offers greater flexibility, as it imposes fewer restrictions. In addition, both methods differ in their approach to measuring educational assortative mating. Permanyer et al. (2019) measure the level of assortative mating by the absolute difference between observed sorting outcomes and the outcomes that can be expected under random matching. Our method relies on odds ratios, a relative measure of the association between husbands' and wives' education net of marginal distributions. We believe that in the context of our study – with an approach which disentangles the contribution of the marginal distributions from a component that is independent of marginal distributions – odds ratios provide a purer measure of educational assortative mating. In addition, using odds ratios enhances the comparability to the bulk of literature that applies log-linear models, which are based on odds ratio parameters.

3.4.5 Three-fold decomposition: Education expansion and changing marriage gradient

Although in much of previous research, marginal distributions in the marriage table analytically represent opportunities in the marriage market (e.g., Permanyer et al., 2019; C. R. Schwartz & Mare, 2005; Smits et al., 1998a), this conceptualization is not without problems. Since not all young men and women marry, the marginal distributions of education in the marriage table do not accurately reflect the distribution of education in the actual population that had been at risk of marriage. Consequently, changes in marginal distributions of education (in marriage tables) reflect both changing educational distributions in the overall population and changing education-specific propensities to marry (the educational gradient in marrying). We therefore extend the two-fold decomposition by distinguishing two components of opportunities: educational distributions of all men and women and their education-specific marriage rates (reflecting educational gradients in marriage).

Just as with marital sorting outcomes, the educational gradient in marriage can be understood as a possible outcome of the partner search process that depends on structural opportunities and assortative mating. However, in the context of our analysis, which is interested in decomposing trends in sorting outcomes among partnered women, the educational gradient in marriage represents a part of the opportunity component. Hence, changes in the marginal distribution could be partly attributed to changes in partner search behavior. We refer to the 'marginal distribution effect' as the 'opportunity effect' since the marginal distributions are an analytical representation of who is available for marriage.

Formally, wives' relative education distributions are the product of women's education distribution and women's education-specific probabilities of being married (marriage rates):

$$\boldsymbol{E}_t^W = \boldsymbol{G}_t^F \boldsymbol{E}_t^F \cdot \frac{1}{SUM(\boldsymbol{G}_t^F \boldsymbol{E}_t^F)} \tag{3.15}$$

with $\boldsymbol{G}_t^F$ being a diagonal $K \times K$ matrix with elements g_{ii} denoting the probabilities of being married for women with education level i

$$\boldsymbol{G}_t^F = \begin{bmatrix} g_{11} & 0 & 0 \\ 0 & \dots & 0 \\ 0 & 0 & g_{KK} \end{bmatrix} \tag{3.16}$$

and $\boldsymbol{E}_t^F$ being a $K \times 1$ column vector containing the education distribution among women (analogously to the education distribution among wives $\boldsymbol{E}_t^W$). Thus, the product $\boldsymbol{G}_t^F \boldsymbol{E}_t^F$ yields a column vector containing the education distribution of married women. To get the relative distribution $\boldsymbol{E}_t^W$, we divide all vector elements by the number of married women given by $SUM(\boldsymbol{G}_t^F \boldsymbol{E}_t^F)$.[16] Consequently, we can rewrite wives' relative education distribution as a function $E(.)$ defined by women's education distribution[17] and marriage rates:

$$\boldsymbol{E}_t^W = E(\boldsymbol{G}_t^F, \boldsymbol{E}_t^F) \tag{3.17}$$

[16] The operation SUM(.) generates the sum of the matrix elements, which is a scalar.

[17] We use women's and men's education distribution to measure the educational distribution of women and men who have been available on the partner market. The measure might be biased to the extent that the educational composition of those who seek an opposite-sex partner differs from the educational composition of those who are not interested in opposite-sex marriage.

For the education distribution of husbands, we proceed analogously.[18] Based on that, we redefine the marriage table t as a function of five inputs

$$\boldsymbol{M}_t = M[E(\boldsymbol{G}_t^F, \boldsymbol{E}_t^F), E(\boldsymbol{G}_t^M, \boldsymbol{E}_t^M), \boldsymbol{OR}_t] \tag{3.18}$$

Since we now have three main components in the table – education distributions, the marriage gradients, and assortative mating – we can construct $2^3 = 8$ outcomes, two factual and six counterfactual outcomes, extending the previous table (Table B3.3, Appendix).

In line with Equation 3.13 (see above), we write the difference in sorting outcomes between Time 1 and 2 as the sum of the average opportunity and assortative mating effect:

$$\begin{aligned} Y_{222} - Y_{111} = &\frac{1}{2}\left(Y_{222} - \dot{Y}_{112} + \dot{Y}_{221} - Y_{111}\right) \\ &+ \frac{1}{2}\left(\dot{Y}_{112} - Y_{111} + Y_{222} - \dot{Y}_{221}\right) \end{aligned} \tag{3.19}$$

The first index refers to educational expansion, the second to the marriage gradient, and the third to assortative mating. Now, the opportunity effects can be further

[18] Because husbands' education distribution is a row vector, we have $\boldsymbol{E}_t^H = \boldsymbol{E}_t^M \boldsymbol{G}_t^M \cdot \frac{1}{SUM(\boldsymbol{E}_t^M \boldsymbol{G}_t^M)}$ accordingly.

disentangled into an 'educational expansion' effect and a 'marriage gradient' effect. The first part of the opportunity effect is

$$Y_{222} - \dot{Y}_{112} = Y_{222} - \dot{Y}_{122} + \dot{Y}_{122} - \dot{Y}_{112} \qquad (3.20)$$

and

$$Y_{222} - \dot{Y}_{112} = \dot{Y}_{212} - \dot{Y}_{112} + Y_{222} - \dot{Y}_{212} \qquad (3.21)$$

and combined

$$Y_{222} - \dot{Y}_{112} \qquad (3.22)$$

$$= \frac{1}{2}\left(Y_{222} - \dot{Y}_{122} + \dot{Y}_{122} - \dot{Y}_{112} + \dot{Y}_{212} - \dot{Y}_{112} + Y_{222} - \dot{Y}_{212}\right)$$

$$= \underbrace{\frac{1}{2}\left(Y_{222} - \dot{Y}_{122} + \dot{Y}_{212} - \dot{Y}_{112}\right)}_{educational\ expansion}$$

$$+ \underbrace{\frac{1}{2}\left(\dot{Y}_{122} - \dot{Y}_{112} + Y_{222} - \dot{Y}_{212}\right)}_{marriage\ gradient}$$

Accordingly, the second part is

$$\dot{Y}_{221} - Y_{111} = \dot{Y}_{221} - \dot{Y}_{121} + \dot{Y}_{121} - Y_{111} \tag{3.23}$$

and

$$\dot{Y}_{221} - Y_{111} = \dot{Y}_{211} - Y_{111} + \dot{Y}_{221} - \dot{Y}_{211} \tag{3.24}$$

and combined

$$\begin{aligned}\dot{Y}_{221} - Y_{111} &= \underbrace{\frac{1}{2}\left(\dot{Y}_{221} - \dot{Y}_{121} + \dot{Y}_{211} - Y_{111}\right)}_{educational\ expansion} \\ &+ \underbrace{\frac{1}{2}\left(\dot{Y}_{121} - Y_{111} + \dot{Y}_{221} - \dot{Y}_{211}\right)}_{marriage\ gradient}\end{aligned} \tag{3.25}$$

Hence, the overall opportunity effect is composed of two sub-components, the average educational expansion effect and the average marriage gradient effect.

$$\begin{aligned}\Delta^{O} &= \underbrace{\frac{1}{2}\left(Y_{222} - \dot{Y}_{112} + \dot{Y}_{221} - Y_{111}\right)}_{opportunity} \\ &= \underbrace{\frac{1}{4}\left(Y_{222} - \dot{Y}_{122} + \dot{Y}_{212} - \dot{Y}_{112} + \dot{Y}_{221} - \dot{Y}_{121} + \dot{Y}_{211} - Y_{111}\right)}_{educational\ expansion\ \Delta^{E}} \\ &+ \underbrace{\frac{1}{4}\left(\dot{Y}_{122} - \dot{Y}_{112} + Y_{222} - \dot{Y}_{212} + \dot{Y}_{121} - Y_{111} + \dot{Y}_{221} - \dot{Y}_{211}\right)}_{marriage\ gradient\ \Delta^{G}}\end{aligned} \tag{3.26}$$

Finally, we arrive at the threefold decomposition model:

$$\Delta_{ij}^{T} = \Delta_{ij}^{O} + \Delta_{ij}^{A} = \Delta_{ij}^{E} + \Delta_{ij}^{G} + \Delta_{ij}^{A} \quad (3.27)$$

We conducted pairwise decomposition analyses for each census year from 1996 to 2016 compared to the first observation in 1991. We applied the same methodology for decomposing trends in homogamy and trends in women marrying up and down in education. The analysis was conducted in Stata 16.

3.5 Results

3.5.1 Marital sorting outcomes

Figure 3.1 shows trends in women's sorting outcomes. The share of women in homogamous unions has been rising slightly, from 54.4% in 1991 to 59.5% in 2016. The share of women marrying down in education rose from 26.5% in 1991 to 31.0% in 2011, followed by a decline to 29.7% in 2016. Accordingly, the percentage of 'traditional marriages', i.e., women marrying up in education, has been declining considerably. In 1991 roughly one out of five unions featured such a 'traditional' pattern. However, in 2016, this was true for just one out of ten unions. Taken together, over our 25-year window of observation, we see a rise of homogamous and 'non-traditional' unions and a steady crowding out of 'traditional' unions among young Irish women.

In addition to observed values, the dashed lines in Figure 3.1 depict trends in marital sorting that would have occurred if male and female education were independent – that is, if sorting outcomes had been solely determined by structural opportunities. In this hypothetical scenario, we would observe substantially lower homogamy rates and higher hypergamy and hypogamy rates. Hence, this exercise demonstrates that assortative mating (i.e., non-random mating) has a significant impact on marital sorting outcomes.

Nonetheless, trends in these hypothetical sorting outcomes are strikingly parallel to the observed trends, which in itself suggests that trends in structural opportunities are more important than trends in assortative mating for explaining trends in sorting outcomes.

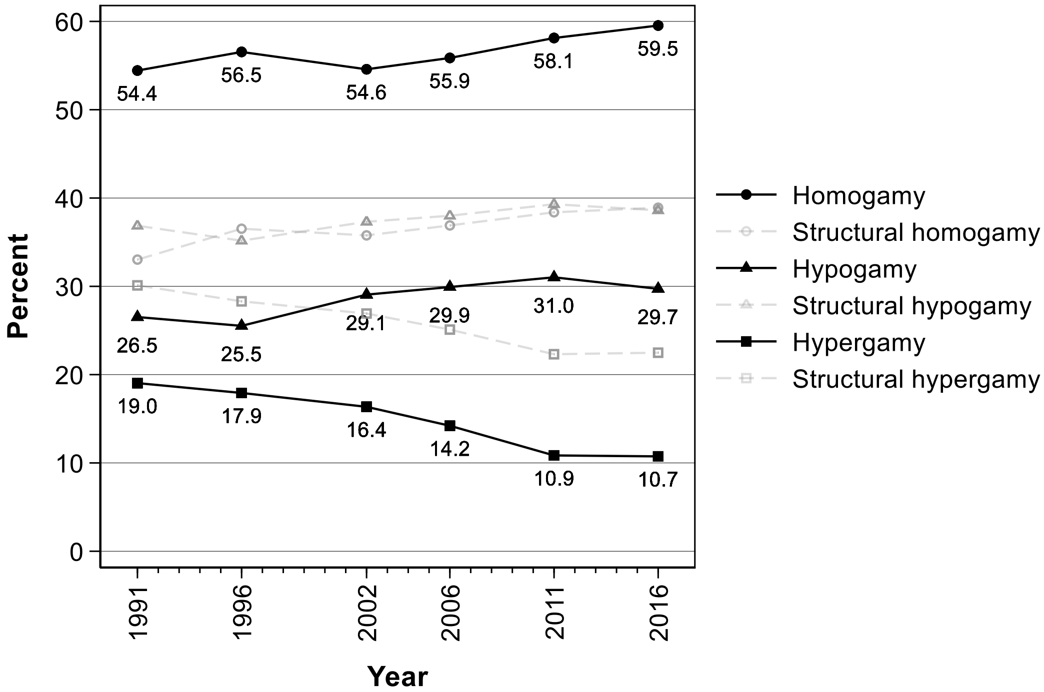

Fig. 3.1 Partnered women's (age 25–34) observed marital sorting outcomes (solid lines) and hypothetical marital sorting outcomes if there were no association between spouses' education (dashed lines)

3.5.2 Educational expansion

Figure 3.2 illustrates time trends in educational attainment among young Irish women, as well as in the matched population of men. The substantial educational expansion Ireland has witnessed over the last three decades is reflected by those numbers. Back in 1991, most women and men had some higher secondary education, and each educational group represented a least a 10% share of the total population. Just 25 years later, the picture has changed drastically, especially for women. The share of tertiary-educated women has more than quadrupled, growing from 12.4% to 51.3%, and educational degrees below higher secondary education have become very rare. Less than 10% of the population had an educational degree below higher secondary education in 2016.

Educational expansion among the matched male population has been remarkable too, albeit somewhat less pronounced than for women. Throughout the 25-year window, higher secondary education comprised the largest share, between 40 and 50%. As with women, the share of men attaining lower secondary education or less has been declining substantially. Among men, tertiary education more than tripled, rising from 11.7% in 1991 to 39.0% in 2016.

The expansion in educational attainment is accompanied by an increase in educational concentration at the upper end of the educational spectrum. One way to express concentration is by calculating the dissimilarity index (dashed line in the figure), which indicates the fraction of cases that need to be redistributed to achieve an equal distribution, i.e. one in which each educational category is represented by an equal share.[19] Figure 3.2 reveals, for both men's and women's educational distributions, a rising departure from equal distribution, which underlines the increasing concentration of educational degrees. As a result, structural opportunities for matches between ever higher and, therefore, equally educated men and women are enlarging.

To explore trends in structural opportunities further, we evaluated gender gaps in educational levels. Figure 3.3 plots trends in sex ratios, standardized for the samples of men and women per year, at each educational level. A sex ratio below 1 indicates a surplus of men, and values above 1 show a surplus of women. In 1991, women already had an

[19] The dissimilarity index is defined as D = $\frac{1}{2}\sum_{i=1}^{N} |\frac{a_i}{A} - \frac{b_i}{A}|$, where a_i is the number of individuals in with the educational level i, A is the number of all individuals, and b_i is the hypothetical number of individuals with the educational level i if educational attainment were distributed equally across all educational levels i.

educational edge. The sex ratio for higher secondary and tertiary education was above 1, and for lower educational attainment below 1. Thus, if there were no differences in educational concentration, for women, the structural probability of meeting less educated men was higher than meeting equally or more educated men. Until 2011, this gender imbalance in educational attainment had been rising. We observe growth in the ratio of tertiary-educated women to men and declining ratios of women to men at lower educational levels. Hence, the shortage of equally educated men was growing for tertiary-educated women, while less educated women experienced an increasing surplus of equally educated men. From 2011 to 2016, trends in sex ratios have been reversing for all levels except higher secondary education.

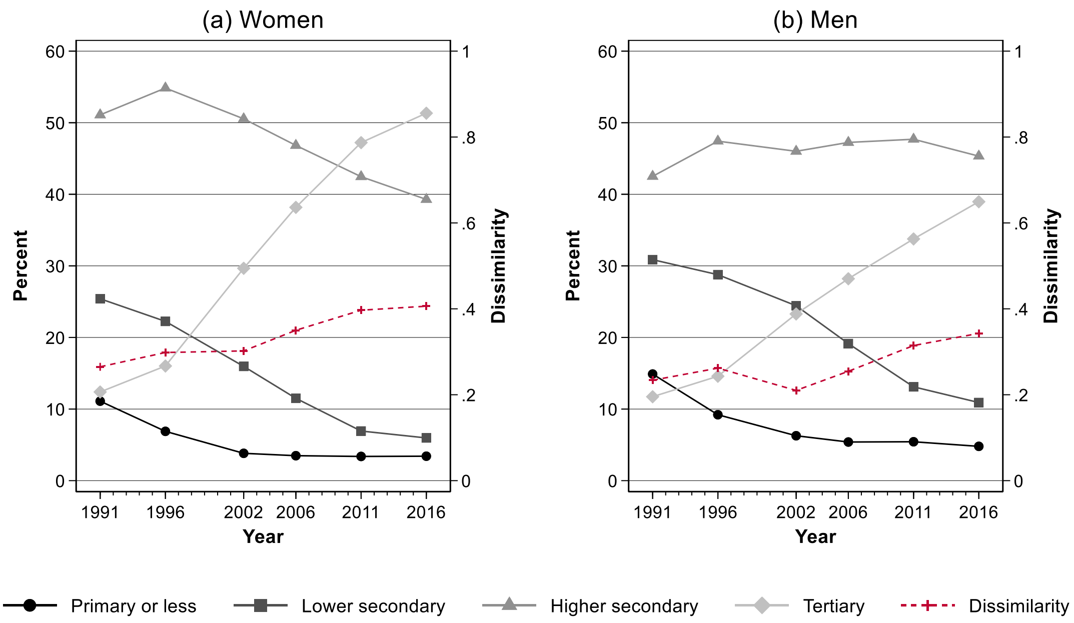

Fig. 3.2 Educational attainment and dissimilarity index, women (age 25–34) and men (age 27–36)

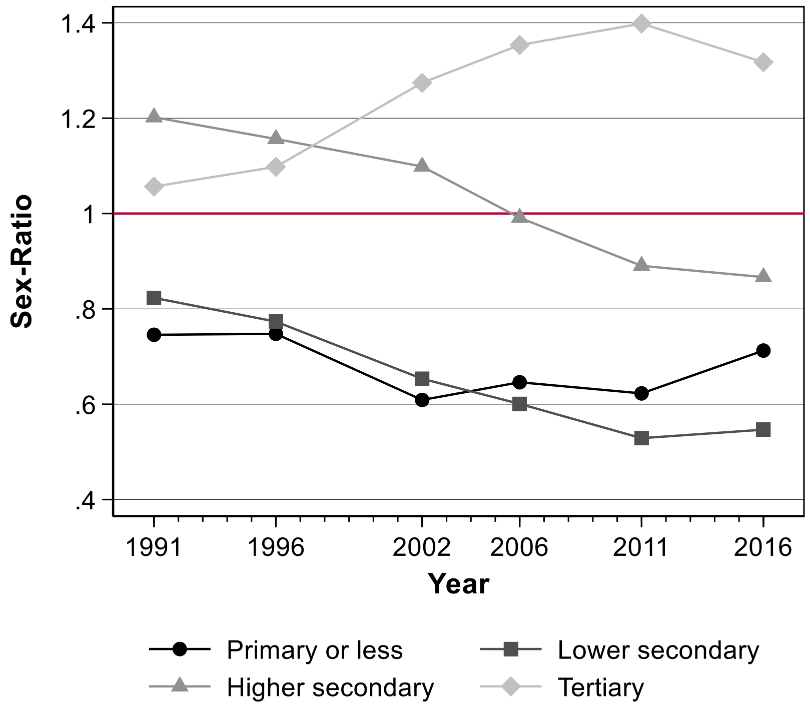

Fig. 3.3 Sex-ratios (women/men) in educational attainment, women (age 25–34) and men (age 27–36)

3.5.3 Marriage gradient

The educational marriage gradient has reversed for women and men (Figure 3.4). Although various mechanisms may have contributed to trends in the educational marriage gradient (i.e., postponement, forgoing or dissolution of unions), the figure provides a snapshot of how being married is structured by education that is sufficient for our analysis. In 1991, the share of married women was the lowest among tertiary-educated women, but between 2002 and 2011, it had risen substantially from 43.8% to 53.8%. Among women with higher secondary education, the share of married women has changed comparatively little. There have been substantial declines in marriage rates for less educated women, levelling off in 2011 for women with lower secondary education, and bouncing back since

2006 for women with primary or less education. For men, we find similar trend patterns, albeit less pronounced.

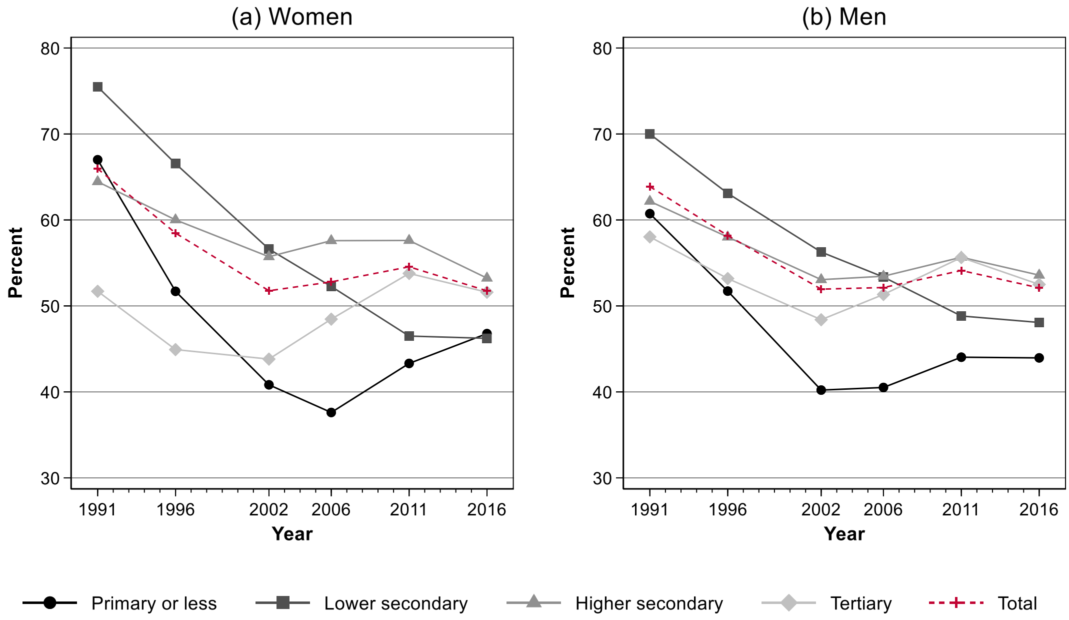

Fig. 3.4 Share of married women (age 25–34) and men (age 27–36) by education

3.5.4 Assortative mating

Figure 3.5 illustrates trends in educational assortative mating by showing changes in log-odds ratios measuring the 'over-selection' and 'under-selection' into homogamous unions, for women marrying down (wife more educated) or up (husband more educated) in education. Log-odds ratios were obtained from log-linear models that control for changes in the educational distributions of husbands and wives. The models estimate the ratio by which observed sorting outcomes differ from the odds of a hypothetical model of independence in which sorting outcomes are solely determined by marginal distributions. Odds ratios greater than one (log-odds ratios greater than 0) indicate over-selection; odds ratios smaller than one (log-odds ratios smaller than 0) under-selection of a sorting outcome. Odds ratios were estimated for single educational groups and over all educational groups (dashed line). In general, as the figure demonstrates, homogamous unions occur more often than expected under independence and both types of heterogamous unions occur less often than expected under independence.

The overall trend of educational assortative mating into homogamous unions changed very little over time. However, distinguishing between four educational levels reveals a tendency towards more homogamy among the less educated and towards less homogamy among those with higher secondary education.

Under-selection into female downward marriage became substantially smaller after 1996. In recent years, downward marriage is nearly in line with the structural expectation (independence model) for higher secondary educated women, and lower secondary educated women even tend to have more downward marriages than predicted by the independence model. The tendency of tertiary-educated women to marry down in education has been rising, but is still substantially below the structural expectations.

Under-selection into upward marriage declined after 2002. This general trend is consistent for different levels of female education, although a lower educational level makes upward marriage for women less likely.

In summary, we find mixed trends in assortative mating. The chances for having an equally educated partner, net of trends in the marginals, increased at the lower end of the educational spectrum, but declined or remained stable at the higher end. The chances of marrying down in education increased and chances of marrying up in education declined across all educational groups.

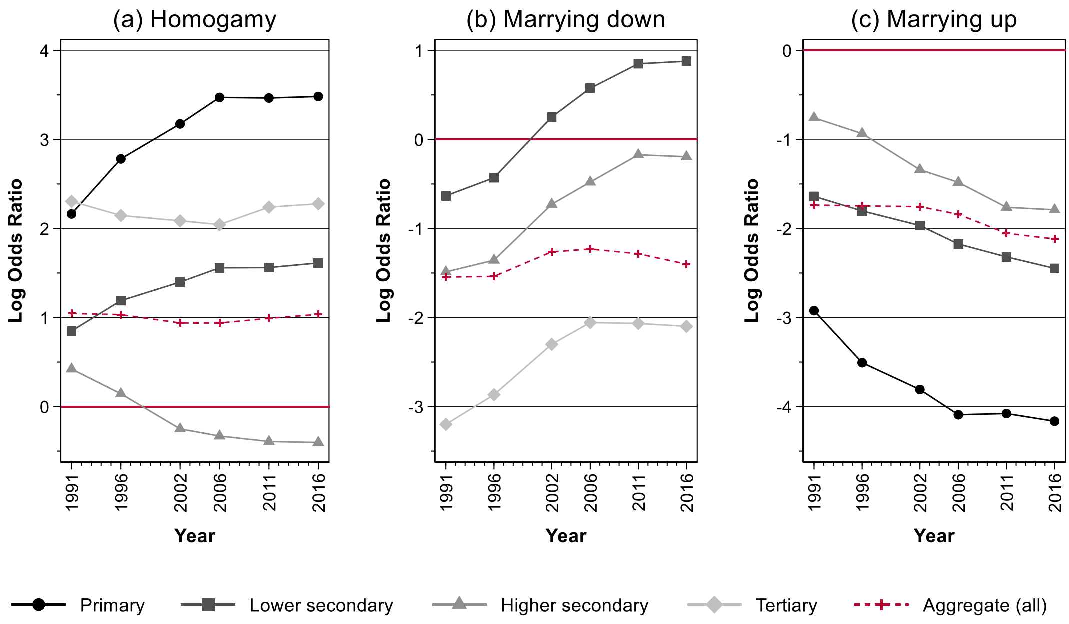

Fig. 3.5 Trends in educational assortative mating in unions of young Irish women (age 25–34)

Note: Outcomes: *Homogamy* (wife and husband equally educated), *marrying down* (wife more educated), *marrying up* (husband more educated).

3.5.5 Decomposition

Table 3.1 presents results from the decomposition analysis on changes in 25–34-year-old women's marital outcomes. The findings reveal the extent to which changes in marital sorting outcomes (Figure 3.1) are attributable to changes in educational assortative mating (Figure 3.5), the educational structure (Figure 3.2 and Figure 3.3), and male and female educational gradients of marriage (Figure 3.4). Standard errors for decomposition terms and differences in sorting outcomes were estimated via bootstrapping by resampling 500 samples with replacement.

The first section of Table 3.1 shows results for homogamy. As we observed earlier, homogamy became slightly more prevalent from 1991 (about 54.44% of women's marriages) to 2016 (about 59.53%). The table reveals that this rise in homogamy was predominantly driven by educational expansion. For example, educational expansion accounted for 4.60 percentage points of the increase in homogamy from 1991 to 2016.

Since we expect the growing gender gap in education to counteract the rise in homogamy findings suggest that rather rising concentration in educational degrees explains that educational expansion is the main driver of rising homogamy rates. Furthermore, we see that a small share of the rise in homogamy is attributable to changes in the educational gradient in marriage (significant for 2011 and 2016 compared to 1991). In 2016, the marriage gradient accounted for 0.60 percentage points of the increase in homogamy. Since we observed a reversing educational gradient in marriage for women and men, the resulting increase in highly educated married men and women may explain the link between the educational marriage gradient and rising homogamy. Assortative mating coefficients are mostly negative, which indicates that changes in assortative mating had counteracted the rise in homogamy. However, these coefficients are negligibly small, and from 2006 onwards not statistically significant.

The second section of Table 3.1 shows trends and decomposition results for the ‘non-traditional’ pattern of women marrying downward in education. All three components contributed to the rise in those non-traditional unions. Nevertheless, as with homogamy, it is educational expansion and associated changes in the distribution of educational attainment that explain the majority of that rise. This pattern is most pronounced when comparing 2011 with 1991: About 70% (0.0314/0.0450=0.6977) of the overall rise of female downward marriage was explained by educational expansion. A possible reason for the diminishing contribution of trends in the educational structure in 2016 could be the flattening of the gender gap in education, which stopped the growth in the surplus of highly educated women. Trends in the educational marriage gradient also account for the rise in non-traditional unions. Yet the gradient effect is only statistically significant for the contrast 2006–1991. Finally, changes in assortative mating account for a small (significant for 2002 and 2006 compared to 1991) rise in women marrying down in education.

We turn now to the last outcome, women marrying more educated men. The third section of Table 3.1 reveals that distributional changes in education explain most of the decline in those ‘traditional’ unions (e.g., 77% of the difference between 2016 and 1991). Two mechanisms may explain the strong link between the changing educational distribution and the decline in women marrying upward. Growing educational concentration is linked to better meeting opportunities among equally educated individuals, and the reversing gender gap in education facilitates matching between more educated women and less educated men. Trends in the marriage gradient account for a substantial share of the decline in traditional unions (e.g., 19% for the 2016–1991 contrast). That suggests that the reversing marriage gradient is linked to a rise in more educated married women who establish unions with equally or less educated men. The contribution of trends in educational assortative mating is almost nil.

Taken together, our decomposition demonstrates that trends in marital sorting are mainly driven by changes in women’s and men’s educational attainment. Changing rates of marriage by education (the marriage gradient) explain observed trends in sorting outcomes too, yet to a lesser extent. Finally, we see that changes in assortative mating play a negligible role in shaping sorting outcomes.

Table 3.1. Decomposition of changes in marital sorting outcomes

Outcome	T1 1991	T2 1996	2002	2006	2011	2016
Homogamy						
Level	0.5444***	0.5655***	0.5458***	0.5586***	0.5812***	0.5953***
	(0.0040)	(0.0041)	(0.0041)	(0.0037)	(0.0035)	(0.0039)
Difference T2-T1	–	0.0211***	0.0014	0.0143**	0.0369***	0.0510***
		(0.0056)	(0.0054)	(0.0054)	(0.0051)	(0.0052)
Decomposition						
Assort. mating	–	0.0108*	-0.0111*	-0.0080	-0.0040	-0.0010
		(0.0054)	(0.0055)	(0.0053)	(0.0056)	(0.0058)
Educ. expansion	–	0.0088***	0.0095***	0.0193***	0.0326***	0.0460***
		(0.0013)	(0.0021)	(0.0027)	(0.0034)	(0.0036)
Marriage gradient	–	0.0015	0.0030	0.0029	0.0082**	0.0060*
		(0.0019)	(0.0021)	(0.0022)	(0.0026)	(0.0026)
Marrying down						
Level	0.2652***	0.2553***	0.2906***	0.2992***	0.3102***	0.2972***
	(0.0035)	(0.0036)	(0.0037)	(0.0035)	(0.0033)	(0.0036)
Difference T2-T1	–	-0.0100*	0.0254***	0.0340***	0.0450***	0.0320***
		(0.0051)	(0.0050)	(0.0051)	(0.0046)	(0.0049)
Decomposition						
Assort. mating	–	-0.0055	0.0075*	0.0067*	0.0048	0.0045
		(0.0029)	(0.0029)	(0.0029)	(0.0032)	(0.0032)
Educ. expansion	–	-0.0061	0.0123*	0.0143**	0.0314***	0.0180**
		(0.0044)	(0.0049)	(0.0054)	(0.0057)	(0.0058)
Marriage gradient	–	0.0016	0.0056	0.0129*	0.0087	0.0094
		(0.0061)	(0.0065)	(0.0065)	(0.0066)	(0.0070)
Marrying up						
Level	0.1904***	0.1793***	0.1636***	0.1421***	0.1085***	0.1074***
	(0.0031)	(0.0031)	(0.0030)	(0.0026)	(0.0022)	(0.0024)
Difference T2-T1	–	-0.0111*	-0.0268***	-0.0483***	-0.0818***	-0.0829***
		(0.0044)	(0.0045)	(0.0040)	(0.0036)	(0.0038)
Decomposition						
Assort. mating	–	-0.0053	0.0036	0.0012	-0.0009	-0.0036
		(0.0029)	(0.0030)	(0.0029)	(0.0029)	(0.0031)
Educ. expansion	–	-0.0028	-0.0218***	-0.0336***	-0.0640***	-0.0640***
		(0.0036)	(0.0039)	(0.0038)	(0.0039)	(0.0041)
Marriage gradient	–	-0.0031	-0.0086	-0.0159***	-0.0169***	-0.0154**
		(0.0049)	(0.0049)	(0.0047)	(0.0044)	(0.0049)
N	15767	14961	15068	17598	19650	16231

Notes: Standard errors in parentheses. Standard errors for difference and decomposition terms were estimated via bootstrapping with 500 replications. Outcomes: *Homogamy* (equal education level for wife and husband), *marrying down* (wife more educated), *marrying up* (husband more educated). Significance: * p < .05, ** p < .01, *** p < .001.

3.5.6 Sensitivity analyses

We carried out further analyses to test the sensitivity of the results against alternative sample selections. Since changes in the timing of marriage and union formation may have shaped the results, we replicated the analysis with a sample of 35- to 44-year-old women. Although the share of unpartnered women is substantially smaller in this age group (Figure A3.4, Appendix), trends in sorting outcomes are similar to those in the younger sample (Figure A3.1, Appendix). Figures A3.2 – A3.4 in the Appendix show descriptive results and Table B3.4 (Appendix) shows the decomposition analysis based on this sample. Overall, we find similar results within this age category, although the increase in downward marriage and the decline in upward marriage is somewhat higher.

In addition, migration may have contributed to the observed patterns. The educational attainment of migrants differs from the non-migrant population. These differences could shape trends in marital sorting – for example if, compared to the native population, unions between migrants show higher levels of homogamy, or partnerships between migrants and natives are educationally more heterogamous. To examine if this was the case, we excluded unpartnered individuals whose previous residence was abroad and those couples where at least one partner had their previous residence abroad (Table B3.5, Appendix).

In the sample that does not include migrants, we observe similar directions of trends in sorting outcomes, although the increase in women marrying down in education is higher and the increase in homogamy is smaller than in the full sample. Although migration affects marital sorting outcomes, the main conclusions of the study hardly change. In most census years, trends in the educational structure are still the main driver of trends in sorting outcomes and trends in assortative mating explain the observed trends only to a very small extent. However, in the native sample, trends in the marriage gradient were slightly more important for explaining trends in heterogamy.

3.6 Discussion

Our study examines trends in marital sorting outcomes in Ireland and the structural causes that have been driving those trends. More specifically, we study the extent to which changes in educational assortative mating, the educational structure, and the educational gradient in marriage contribute to the rise in homogamy and women marrying down in education, as well as to the decline in women marrying up in education. We developed a counterfactual decomposition method that quantifies the relevance of the three components for observed changes in sorting outcomes. We were thus able to identify educational expansion as the primary driver of trends in marital sorting outcomes. To a lesser extent, the changing educational gradient in marriage also contributed to the observed trends. Trends in educational assortative mating accounted for only a small component of trends in women marrying down in education, and they did not contribute to the rise in homogamy and the decline in marrying upward.

Our results support previous research in finding that changes in couples' educational similarity are mainly driven by 'structural constraints', i.e. the availability of married men and women in different educational groups, rather than by educational assortative mating (Permanyer et al., 2019). Moreover, this study advances previous findings by demonstrating that the component that has previously been considered to correspond to 'structural constraints' is also shaped by the educational marriage gradient, which contributed slightly to trends in sorting outcomes. We hope further research will analyze the generalizability of our results to other contexts, particularly to countries in which educational expansion and the marriage gradient have developed differently.

The findings of this study have implications for the debate about the consequences of trends in educational assortative mating and sorting outcomes, particularly for the question of whether changes in educational homogamy have been large enough to affect macro-level characteristics such as earnings inequality (Breen & Salazar, 2011; C. R. Schwartz, 2013). We found considerable changes in marital sorting outcomes, which could be a driver of social changes. However, it is unlikely that trends in educational assortative mating are a substantial driver of these consequences, since they scarcely contributed to trends in sorting outcomes.

The methodology we propose here offers a wide range of applications. It is not only a flexible tool for decomposing differences between two contingency tables (e.g., between years or countries) but also for forecasting macrostructural outcomes, which can be relevant for social policy. In this study, we decomposed trends in sorting outcomes that were aggregated over all educational levels. However, this methodology also allows us to decompose differences in individual cells in a marriage table, such as trends in highly educated homogamous couples. For a more detailed understanding of how structural changes shape sorting outcomes, future research should analyze, for example, education-specific trends in marital sorting.

When interpreting our results, several limitations should be considered. Due to the cross-sectional nature of the data, the observed trends provide only a snapshot of ‘who is married with whom’ and ‘who is married at all’. Thus, the results could be affected by education-specific changes in postponing or forgoing marriage and in union dissolution.

Further limitations arise in relation to causality. Our results rely on the assumption that trends in educational assortative mating, the educational structure, and the marriage gradient are independent of each other, although this may not reflect reality. For example, the marriage gradient could be affected by the gender gap in education because a reversing gender gap in education could be linked to an increase in highly educated women who postpone union formation. Also, changes in meeting opportunities may partly be driven by changing partner preferences; individuals may consider their returns to education not only in the labor market but also in the marriage market when they make decisions regarding educational attainment (Chiappori et al., 2017). Although our method cannot account for such causal interdependencies, we believe that an analytical distinction between the drivers of trends in sorting outcomes improves our understanding of the processes that generate these trends.

Although we showed that changes in the educational composition of the marriage market are a key driver of trends in sorting outcomes, it is unclear how much of the change is linked to declining educational variation or the reversing gender gap in education. The same holds for trends in the educational marriage gradient, since changes in the marriage gradient affect educational variation and the gender gap in education among married men and women. Moreover, it remains unclear how much of the educational marriage gradient is driven by a structural component (e.g., postponing union formation due to a limited supply of suitable candidates) and how much by a behavioral component (e.g., postponing union formation because of educational preferences).

The results of our study and most studies on educational assortative mating depend on the chosen educational categories (Gihleb & Lang, 2016). Since we are not able to distinguish between longer and shorter tertiary degrees, we disregard the relevance of the socioeconomic differences that might emerge from the difference in returns on these degrees for the partner search process. However, even if the chosen educational categories discriminate between socioeconomic differences at one point in time, they may not predict the same socioeconomic differences at another point in time. The socioeconomic outcomes which are linked to an educational level may change over time, which can affect the comparability of sorting outcomes across time.

4 Structural opportunities or assortative mating? – Decomposing trends and country differences in educational sorting outcomes in marriages

4.1 Introduction

In recent decades, the homogamy rate – the percentage of opposite-sex couples in which women and men have the same educational level – has increased in many countries (Katrňák & Manea, 2020; Nomes & Van Bavel, 2017; Permanyer et al., 2019). Moreover, among couples in which women and men have different educational levels, hypergamy (he is more educated than she) has decreased and hypogamy (she is more educated than he) has increased (Erát, 2021; Esteve et al., 2016).[20] However, despite similar *trends* in homogamy, hypergamy, and hypogamy rates, these educational sorting outcomes vary considerably *across countries* (Domański & Przybysz, 2007).

It is crucial to understand why educational sorting outcomes – such as homogamy, hypogamy, and hypergamy rates – vary over time and across countries, because these outcomes indicate how educational resources are distributed between wives and husbands. Because education is an indicator for earnings potential, differences in wives' and husbands' education could influence gender inequalities, for example, by affecting the gendered division of labor within couples (García Román, 2021). Moreover, 'who marries whom' in terms of education may affect inequalities between couples. For instance, high proportions of low- and high-educated homogamous couples may indicate high levels of

[20] Katrňák & Manea (2020) analyzed data on marriages. Permanyer et al. (2019), Erát (2021) and Esteve et al. (2016) examined a pooled sample of married and unmarried cohabiting couples.

educational inequality and earnings inequality between couples (Blossfeld & Timm, 2003; Breen & Andersen, 2012; C. R. Schwartz, 2013).

Despite the potential implications of educational sorting outcomes for social inequalities, our knowledge of why these outcomes have changed over time and differ across countries is incomplete. Instead of investigating educational sorting outcomes, research typically applied log-linear models to examine patterns of *assortative mating*, which is the degree of non-randomness by which available women and men form couples (e.g., Kalmijn, 1991b; C. R. Schwartz & Mare, 2005; Smits, 2003). However, these studies do not reveal *to what extent* trends and differences in assortative mating shape educational sorting outcomes, such as the homogamy rate. Moreover, log-linear models control for structural opportunities, which is the availability of women and men with different educational levels on the partner market. Therefore, the relationship between changing structural opportunities and educational sorting outcomes is under-researched.

Although some research has explored the relationship between structural opportunities and educational sorting outcomes these studies typically did not control for assortative mating (Corti & Scherer, 2021; Erát, 2021; Esteve et al., 2016). Furthermore, Katrňák and Manea (2020) showed that observed trends in educational sorting outcomes correlate with those that would have emerged if husbands and wives had been matched randomly. However, to our knowledge, only two studies have attempted to disentangle the separate influence of *changes* in assortative mating and structural opportunities on trends in educational sorting outcomes (Leesch & Skopek, 2023; Permanyer et al., 2019). These studies found that trends in homogamy and heterogamy are primarily linked to changing structural opportunities. However, the existing evidence remains fragmented because previous research either investigated comparatively short periods, used rough measures for education (college versus no-college education), or analyzed trends in educational sorting only in one country. Moreover, previous research has not examined the role of assortative mating and structural opportunities in explaining cross-country differences in educational sorting outcomes.

Our study addresses these knowledge gaps by analyzing the extent to which cross-national and cross-temporal variation in educational sorting outcomes of opposite-sex marriages (i.e., homogamy, hypogamy, and hypergamy rates) can be attributed to trends and differences in structural opportunities and assortative mating. For this purpose, we use a decomposition approach that compares observed educational sorting outcomes with hypothetical outcomes that would have occurred if the assortative mating patterns or structural opportunities of another year or country had been in place (Leesch & Skopek, 2023).

The analysis exploits unique population data on all marriages contracted in Sweden, the Czech Republic, and Italy from 2000 to 2020. These cases are theoretically interesting as they differ substantially in their structural opportunities due to variations in the start and speed of the expansion of higher education. Furthermore, they display economic and cultural differences, and belong to different welfare regimes, which could influence partner search behavior.

Our study makes several contributions to the literature. In contrast to the majority of research that analyzed assortative mating, our study focuses on educational sorting outcomes in marriages. While a few studies have explored trends in educational sorting outcomes (Leesch & Skopek, 2023; Permanyer et al., 2019), we advance this perspective by studying trends and cross-country differences in these outcomes. Moreover, rather than examining the prevalence of unions or marriages (stock of marriages), we investigate the incidence of marriages (contracted marriages in a given year). This is a preferable measure because women's and men's education in the stock of marriages can change due to educational upgrading and assortative divorce and mortality. In addition, our study examines trends in educational sorting in marriages over the past 20 years following the start of the Bologna process[21] in 1999, updating the literature with evidence on recent trends in assortative mating and educational sorting outcomes.

4.2 Theoretical background

4.2.1 The partner search framework

Partner search theory (England & Farkas, 1986; Oppenheimer, 1988) assumes that the outcome of the partner search process depends on three factors: women's and men's preferences for candidates with specific traits, the availability of preferred candidates on the partner market, and partner search behavior. The macrostructural availability of preferred candidates and partner search behavior influences 'who meets whom'. For example, extending the duration of the partner search can increase the chances of meeting preferred candidates. Moreover, the distribution of preferred candidates across space (e.g., regions or neighborhoods) and social contexts (e.g., workplaces or sports clubs) may affect meeting opportunities too (Feld, 1981; Van Bavel, 2021). Furthermore, since union formation is not an individual but a mutual decision that requires both parties' agreement, women's and men's preferences, and two-sided matching mechanisms influence educational sorting outcomes in the final stage of the partner search process (Van Bavel, 2021).

Several concepts of this framework, such as partner preferences or search behavior, have proved difficult to measure because data are usually only available on existing unions. Therefore, a large body of research studies variation in educational assortative mating, the

[21] The aim of the Bologna process was to increase the comparability and quality of higher-education qualifications in Europe. Several agreements were made between European countries to (a) introduce a three-cycle higher education system (bachelor's, master's, and doctoral studies), (b) ensure the recognition of study periods abroad, and (c) strengthen the quality of teaching and learning. The reforms were followed by a rapid expansion of tertiary educational attainment (Crosier & Parveva, 2013).

degree of non-randomness in educational sorting outcomes. As these studies control only for structural opportunities on the macro level, all other mechanisms in the partner search process (e.g., partner preferences, the spatial distribution of candidates, and two-sided matching) shape assortative mating patterns. To allow comparability with this framework, we discuss why structural opportunities and assortative mating might vary over time and across countries, and how these variations could have influenced educational sorting outcomes.

4.2.2 Structural opportunities

According to Blau's structural theory, the relative *size of a group* in a population determines the probability of meeting members of this group (Blau, 1977; Blau et al., 1982). That means the likelihood of meeting and marrying someone with a specific educational level depends on the relative size of that educational group in the population. For example, if few people were highly educated, the probability of meeting and marrying a highly educated person would be low.

The relative sizes of educational groups on the partner market changed profoundly in recent decades due to the global expansion of higher education (Schofer & Meyer, 2005). Blau's structural theory suggests high chances of matches between equally educated individuals when there is a large pool of equally educated candidates on the partner market. This typically occurs in the early and late stages of the process of educational expansion when most people are either low-educated or highly educated (Katrňák & Manea, 2020; Michielutte, 1972).

Although nearly all countries have experienced an expansion of higher education, they differ in the starting point and speed of this process (OECD, 2022c). As a result, in a given year, countries display different partner market compositions. We expect higher homogamy rates in countries with a higher proportion of equally educated candidates in the partner market. In conclusion, when analyzing trends and cross-country differences in educational sorting outcomes, we anticipate a positive relationship between the share of equally educated candidates on the partner market and the homogamy rate.

In addition, *gender gaps in education*, meaning the ratios of women and men within educational levels, shape structural opportunities. Generally, we expect a greater similarity in women's and men's education to be associated with higher chances of meeting and marrying equally educated candidates. However, in most Western countries, the gender gap in tertiary education reversed in recent decades (De Hauw et al., 2017; DiPrete & Buchmann, 2013; Esteve et al., 2016). This improved, ceteris paribus, structural meeting opportunities between tertiary educated women and less educated men.[22] In addition, country differences in gender gaps in education could explain why educational sorting outcomes vary between countries. When analyzing trends and cross-country differences in educational sorting outcomes, we therefore assume that gender gaps in higher education favoring women are associated with higher hypogamy and lower hypergamy rates.

To conclude, we expect not only a relationship between the share of equally educated candidates and the homogamy rate, but also a link between women's educational advantage and hypogamy and hypergamy rates. However, the effects of trends and differences in educational expansion and gender gaps in education could have offset or reinforced each other since they coincided empirically.

4.2.3 Assortative mating

Many studies have demonstrated the non-random nature of marital sorting along various socio-demographic and socio-cultural characteristics, including educational attainment

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[22] Our perspective focuses only on structural meeting opportunities. Scholars also assumed that individuals have preferences for equally or more educated candidates. Then, the reversal of the gender gap in education creates an education specific mating squeeze that can push men and women in hypogamous unions due to a lack of preferred candidates (Van Bavel, 2012).

(Kalmijn, 1991b, 1998; C. R. Schwartz & Mare, 2005; Smits et al., 2000). We briefly discuss four mechanisms that could explain trends and country differences in assortative mating in the first two decades of this millennium.

First, the rising popularity of *online dating* (Potarca, 2020; Rosenfeld et al., 2019; Rosenfeld & Thomas, 2012) changed the social contexts in which women and men meet each other. Online dating provides diverse contexts where opportunities for meeting candidates with different educational levels are high. However, it also reduces search costs and provides information about the available candidates on the partner market, which could contribute to rising homogamy rates (C. R. Schwartz, 2013). The available evidence suggests that even though online dating does not produce random couples, it tends to act as a social mixer, leading to more diverse couple sorting compared to traditional modes of partner search (Potarca, 2017, 2020; Thomas, 2020).

Second, rising *gender equality*, especially women's rising employment rates, may have led to converging partner preferences since men started benefiting from having highly educated partners with higher earnings prospects (Mare, 1991). Although women continue to benefit from a partner with high education and earnings, their growing economic independence allows them to choose partners based on desirable traits unrelated to economic success (Han, 2022; Oppenheimer, 1994; C. R. Schwartz, 2013). This could have contributed to a decline in hypergamy and rising homogamy and hypogamy.

Third, *economic inequalities* between educational groups may affect assortative mating because they indicate how much someone might lose when marrying 'down' in education (Fernandez et al., 2005; C. R. Schwartz, 2013). When marrying someone less educated is less affordable, homogamous matching might become more likely, as individuals may prioritize education over other attributes when choosing partners.

Fourth, *welfare regimes* could influence assortative mating (Domański & Przybysz, 2007). In social-democratic welfare states like Sweden, generous social benefits largely decouple welfare from the market and family (Esping-Andersen, 1999). In such contexts, status attainment might be less critical for choosing a partner, potentially weakening the association between husbands' and wives' education. Italy, as a Mediterranean welfare state, features a dualized protection system and limited policies supporting mothers' employment (e.g., public childcare for young children) (Del Boca & Vuri, 2007; Naldini & Saraceno, 2008). Therefore, men's socioeconomic position might be more important than women's in the partner search process. Similar to other post-communist welfare states, the Czech Republic experienced a retrenchment of benefits and a process of re-familization in the late 1990s and 2000s (e.g., by reducing spending for public childcare) (Saxonberg & Sirovátka, 2009; Saxonberg & Szelewa, 2007). The retrenchment of benefits suggests that women's and men's socioeconomic resources increasingly govern the partner search process, while re-familization may suggest that men's resources carry more weight than women's.

Taken together, assortative mating is shaped by multiple, jointly operating mechanisms of partner search and choice. Theoretical arguments from above would let us expect to observe both (a) change in assortative mating over time within countries and (b) differences between countries in patterns of assortative mating. Our study investigates the role of within-country trends and between-country differences in assortative mating and structural opportunities on trends and differences in educational sorting outcomes.

4.2.4 Structural opportunities and assortative mating in Sweden, the Czech Republic, and Italy

During the first 20 years of this millennium, Sweden, the Czech Republic, and Italy have experienced an expansion of higher education that profoundly changed structural opportunities on the partner market.[23] An early expansion of higher education characterizes Sweden. In 2000, already 33.6% of 25- to 34-year-olds attained tertiary education. In the subsequent 20 years, tertiary education continued to increase up to 49.1%, suggesting a rising concentration of individuals at the highest educational level (OECD, 2022c). In the Czech Republic and Italy, the overall educational attainment of 25- to 34-year-old men and women was comparatively low in 2000. In the Czech Republic, tertiary education increased rapidly from 11.2% in 2000 to 33.0% in 2020, and in Italy, tertiary education grew from 10.4% in 2000 to 28.9% in 2020 (OECD, 2022c). In all three countries, women's educational attainment has been rising faster than men's, leading to a reversal of the gender gap in higher education (De Hauw et al., 2017).

Moreover, partner choice and matching mechanisms may vary between the three countries, as each country represents different cultural, socioeconomic, and welfare contexts. In Sweden, several factors suggest that the odds of homogamy will be smaller than in other European societies. Sweden's social-democratic welfare state fosters individualism and gender equality, contributing to a high female employment rate (OECD, 2022b). Furthermore, income inequality is relatively low (OECD, 2020b), and high levels of interpersonal trust could make heterogamous matches more likely (Domański & Przybysz, 2007; Inglehart, 1999). For the other countries, the expectations are less straightforward. In Italy, high levels of income inequality (OECD, 2020b) provide incentives for homogamous matching. However, family-provided welfare and care, along with a low female employment rate of about 50% (OECD, 2022b) may promote hypergamous matching. In the Czech Republic, women's employment rate is high (OECD, 2022b), despite the reduction in public spending for childcare. Additionally, income inequality is low (OECD, 2020b), even though returns to education tend to be high

[23] For more information about the educational systems of Sweden, the Czech Republic, and Italy see Hörner et al. (2007).

(Montenegro & Patrinos, 2014), which may shape the perceived costs of marrying 'down' in education.

Empirically, assortative mating was found to be substantially lower in Sweden than in the Czech Republic and Italy (Domański & Przybysz, 2007; Katrňák & Manea, 2020). However, only few studies investigated trends in educational assortative mating in Sweden, the Czech Republic, and Italy. The available evidence suggests that, in these countries, assortative mating declined among the tertiary educated and increased for less educated husbands and wives (Katrňák & Manea, 2020). Ultimately, structural opportunities and assortative mating vary over time and across countries. Thus, they can both affect trends and cross-country differences in educational sorting outcomes.

4.3 Method

4.3.1 Data

Our data contains information on all marriages that were contracted in Sweden, the Czech Republic, and Italy in even years from 2000 to 2020 (2000, 2002, …, 2020).[24] This includes first and higher-order marriages. Table A4.1 in the Appendix shows the absolute numbers of contracted marriages by year and country. In total, we analyzed 3,285,848 marriages.

The data provide precise measures of the incidence of marriage. In contrast to prevalence measures (stock of marriages) featured by much of previous research, incidence measures (newly established marriages) are unaffected by changes after marriage, such as educational upgrades or assortative divorce. Incidence measures are therefore advantageous to study change in marital sorting. Furthermore, the data do not suffer from sampling bias as they include information on all contracted marriages.

[24] We thank the Statistical Offices of Italy, Sweden, and the Czech Republic for providing the data and making this research possible.

However, cross-country differences and changes in the prevalence of unmarried cohabitation may question the appropriateness of focusing only on married couples (Kiernan, 2001b; Prioux, 2006). For example, in Sweden cohabitation is more common than in other European countries (Kiernan, 2001b). Furthermore, less educated individuals tend to live in cohabiting unions more often than more educated women and men (Bumpass & Lu, 2000; C. R. Schwartz, 2010). Trends and cross-country differences in the education-specific selectivity into cohabiting unions could affect our results by shaping the educational compositions of married women and men. For instance, if less educated women increasingly chose cohabitation over marriage, this shift could lead to a decrease in hypergamy rates among those who eventually marry. Research also suggests that assortative mating patterns differ between cohabitors and married couples (Blackwell & Lichter, 2000; Esteve et al., 2013; Schoen & Weinick, 1993). If these differences shift over time or vary across countries, they could also affect our findings. However, empirically, it remains an open question to what extent trends and cross-country differences in educational sorting outcomes in marriages have been influenced by these mechanisms. Despite this potential limitation, our study focuses on marriages because reliable incidence measures for cohabiting unions are not readily available, while the incidence of marriages is clearly defined and recorded by national statistical offices.

In all analyzed countries, the number of contracted marriages dropped considerably in 2020, which is most likely linked to restrictions that were imposed on weddings during the early phases of the COVID-19 pandemic, such as limiting the number of guests. From 2018 to 2020, the number of contracted marriages halved in Italy and declined by more than 20% in the Czech Republic and Sweden. Moreover, in 2008, the Czech Republic introduced the option not to identify husbands' and wives' education. Because this has been increasingly applied in subsequent years, the number of contracted marriages has declined in our sample. When interpreting the results, this needs to be considered as educational attainment could influence whether individuals report their educational level.

4.3.2 Measurement

Educational sorting outcomes. To measure the joint distribution of husbands' and wives' education, we distinguished four levels of education: low, lower intermediate, upper intermediate, and high. While these levels are not strictly comparable across countries in terms of years of education, they do reflect meaningful country-specific differences in the educational systems coded by the countries' statistical offices. In the Appendix, we provide detailed information on the comparability of the measure. To achieve a measure of educational sorting outcomes that allows for an intuitive interpretation, we collapsed these outcomes into three categories that distinguish between homogamy (wife and husband equally educated), hypogamy (wife more educated than husband), and hypergamy (wife less educated than husband).

Structural opportunities. We used the educational composition of husbands and wives who married in a given year and country to measure structural opportunities. Thus, in a marriage table the marginal distributions reflect structural opportunities. This approximation of structural opportunities has two limitations. First, individuals who do not marry may have been available on the partner market. Therefore, variation in the educational gradient in marriage across time and space (Bertrand et al., 2020; Kalmijn, 2013) can affect the measure of structural opportunities. For example, Leesch and Skopek (2023) showed that, in Ireland, a small but non-negligible part of trends in educational sorting outcomes is linked to changes in the educational gradient in union formation. Second, we observe marriages of different cohorts within one period. Thus, the age at which women and men marry – which has been increasing over time (OECD, 2019) – influences who marries in a given year. That means our measure of structural opportunities in one period includes individuals of different birth cohorts who possibly belonged to different partner markets. However, by measuring structural opportunities with the marginal distributions, we achieve comparability with the bulk of studies that control for the marginal distributions to study assortative mating (e.g., Mare, 1991; C. R. Schwartz & Mare, 2005).

Assortative mating. In line with previous literature, we employed the odds ratio structure in a marriage table to measure assortative mating. The odds ratios in a marriage table reflect the association between husbands' and wives' education net of structural opportunities.

4.3.3 Analytical approach

Our analysis involved four steps. First, we examined trends in absolute homogamy, hypogamy, and hypergamy rates in Sweden, the Czech Republic and Italy. Second, we investigated changes in structural opportunities by analyzing trends in wives' and husbands' educational attainment. In the third step, we modeled assortative mating using log-linear models. Lastly, we analyzed the extent to which within-country trends and between-country differences in educational sorting outcomes can be attributed to trends and differences in assortative mating and structural opportunities. For this purpose, we applied a decomposition approach introduced by Leesch and Skopek (2023). The assortative mating models were estimated using the LEM software (Vermunt, 1997), while Stata 16 was employed for the remaining analyses.

The decomposition includes two steps. First, we swapped either the odds ratios or the marginal distributions between two marriage tables and determined the cell frequencies that match this counterfactual combination of odds ratios and marginal distributions. Table 4.1 shows that there are two observed or factual marriage tables and two hypothetical or counterfactual marriage tables. In each table we calculated the required educational sorting outcome, such as the fraction of homogamous unions. Y denotes observed or factual sorting outcomes and $\dot{Y}$ stands for hypothetical or counterfactual sorting outcomes. Of course, the sorting outcome derived from the observed table 1 (e.g., observed in county 1 or at time 1) has the odds ratios and marginal distributions of table 1 (Y_{11}). The outcomes in Table 2 were obtained through the odds ratios and marginal distributions of table 2 (Y_{22}). The counterfactual marital sorting outcomes reflect the odds ratios of table 1 and the marginal distributions of table 2 ($\dot{Y}_{21}$) or the odds ratios of table 2 and the marginal distributions of table 1 ($\dot{Y}_{12}$).

Table 4.1. Observed and counterfactual educational marital sorting outcomes

	Assortative mating	
Structural opportunities	Table 1	Table 2
Table 1	Y_{11}	$\dot{Y}_{12}$
Table 2	$\dot{Y}_{21}$	Y_{22}

Upon swapping the odds ratios or marginal distributions, we obtained the counterfactual marriage tables by using iterative proportional fitting (IPF) (Deming & Stephan, 1940; Lomax & Norman, 2016). IPF adjusts the cells in a table alternately to the row and column totals of another table without changing the odds ratio structure of the initial table. The process of rescaling cells to row and column totals continues iteratively until all cells match the predefined odds ratio structure and marginal distributions which results in the required counterfactual table.

In the second step, we used the counterfactual and observed marriage tables to analyze the extent to which differences in educational sorting are attributable to differences in assortative mating and structural opportunities. To investigate the role of structural opportunities for trends and country differences in educational sorting, we compared educational sorting outcomes (e.g., homogamy rate) between both tables after the odds ratios had been fixed at table 1 ($\dot{Y}_{21} - Y_{11}$) and at table 2 ($Y_{22} - \dot{Y}_{12}$). In both comparisons, educational sorting outcomes differ only in marginal distributions. We calculated the average marginal distribution component from both marginal distribution components. Correspondingly, the average odds ratio component was obtained from differences in educational sorting after marginal distributions had been fixed at table 1 ($\dot{Y}_{12} - Y_{11}$) and table 2 ($Y_{22} - \dot{Y}_{21}$).

The method allows pairwise comparisons only. Thus, to analyze trends in educational sorting in marriages within countries, we compared marriage tables of each year with the marriage table of the reference year 2000 (10 comparisons within each country). To decompose of cross-country differences, we compared marriage tables of two countries within the same year (3 comparisons for each of the 11 time points).

4.4 Results

4.4.1 Educational sorting outcomes in marriages

Figure 4.1 shows educational sorting outcomes in marriages in Sweden, the Czech Republic, and Italy. The solid lines depict observed educational sorting outcomes. The dashed lines will be discussed at the end of the next section because they reflect structural opportunities. In each year, in all three countries, most marriages were contracted between equally educated men and women, and hypogamy rates (wives are more educated than husbands) have been higher than hypergamy rates (wives are less educated than husbands). However, educational sorting outcomes differ substantially between countries. Up to 2018, homogamy rates were the lowest in Sweden and the highest in Italy. Hypogamy and hypergamy rates were the highest in Sweden and the lowest in Italy, with the Czech Republic in between.

From 2000 to 2020, educational sorting outcomes changed substantially. In Sweden, the homogamy rate increased, hypergamy declined, and the hypogamy rate remained at a constant level of about 32%. In the Czech Republic, homogamy rates fluctuated between 54.5% and 59.7%. Hypogamy increased, and the hypergamy rate declined from 19.6% in 2000 to about 14% in 2014 and has hardly changed since then. In Italy, homogamy increased up to 2018 and dropped considerably in the last year. No clear trends in hypogamy are visible, and the hypergamy rate declined up to 2018, followed by a substantial increase in 2020.

The striking change in educational sorting outcomes in Italy in 2020 could be linked to the outbreak of the COVID-19 pandemic. Italy was the first European country to be heavily affected by the pandemic, and it implemented some of the strictest lockdown measures in the European Union (Plümper & Neumayer, 2022). Social distancing measures banned wedding ceremonies in spring 2020 and later transitioned to severely limiting the number of guests. Further research is necessary to understand the profound changes in educational sorting outcomes in Italy in 2020. First evidence suggests that uncertainty about the duration of the COVID-19 pandemic affected marriage intentions (Guetto et al., 2021). This uncertainty might influence couples differently, depending on both partners' education, for example, if uncertainty about the duration of the pandemic is linked to employment uncertainty.

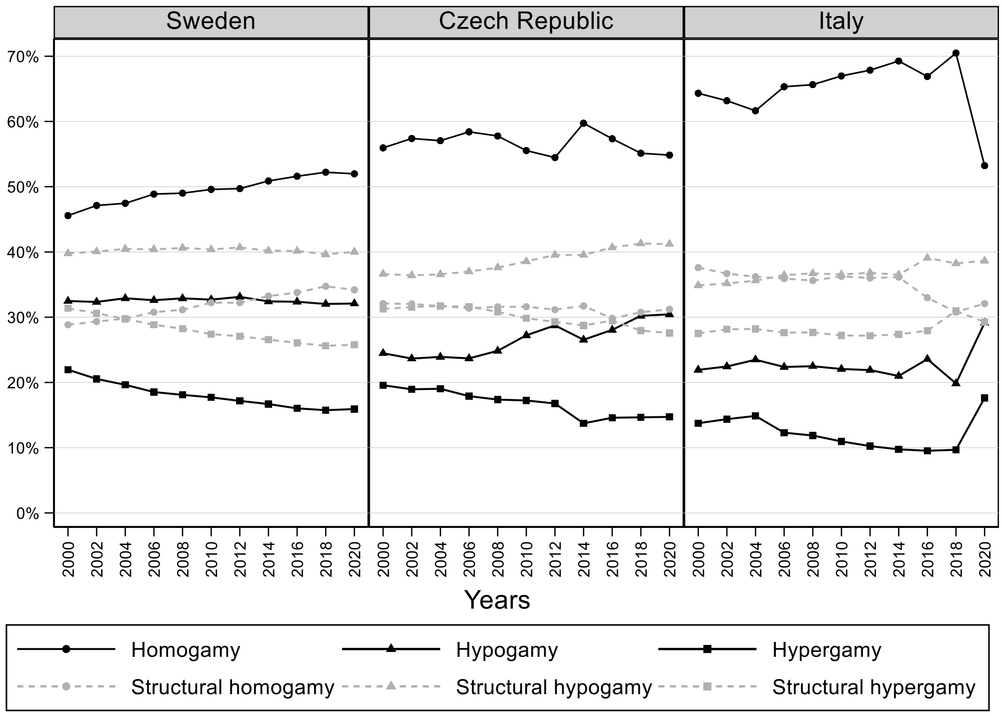

Fig. 4.1 Observed (solid lines) and structural (dashed lines) educational sorting outcomes

Note: Structural sorting outcomes refer to hypothetical educational sorting outcomes if there were no association between spouses' education

4.4.2 Structural opportunities

Figure 4.2 shows trends in the educational attainment of husbands and wives. In all countries, higher education has expanded considerably. The Czech Republic recorded a rapid increase in higher education, especially for wives – from approximately 10% in 2000 to 40.4% in 2020. In Sweden and Italy, the growth in higher education has been somewhat slower. In Sweden, higher education was already widespread in 2000 (40.4% for wives and 35.7% for husbands), while in Italy, only a minority (around 10%) was highly educated. Upper intermediate education has risen in all countries among husbands, but remained stable or declined for wives. Lower intermediate education has decreased markedly among husbands and wives in all countries, and those with a low level of education formed the smallest groups in all years and countries.

Despite the main trends in educational attainment being similar in all three countries, they do not necessarily shape trends in structural opportunities in the same way. In a low-educated context, educational expansion typically leads to more variation in educational levels. In highly educated contexts, educational expansion is linked to a growing concentration of individuals to few educational levels. To demonstrate this, the dissimilarity index in Figure 4.2 displays the fraction of cases that would need to be redistributed to achieve a distribution in which each educational category is represented by an equal share.[25] In Sweden, husbands' and wives' dissimilarity index has risen. That means the variation in educational levels declined. For Italian husbands and wives, the index declined from 2000 to 2018, while in the Czech Republic, it declined up to 2008 and increased afterwards. Therefore, trends in educational variation differ considerably across countries.

Also, gender differences in education have been changing over time. In Sweden, the ratio of higher educated wives to husbands had already reversed by 2000. In Italy, it reversed in 2002 and in the Czech Republic in 2008. In recent years, the ratio of higher educated wives to husbands reached approximately 1.3 in all countries. To illustrate that Figure A4.1 in the Appendix plots trends in education-specific sex ratios.

[25] The dissimilarity index is defined as D = $\frac{1}{2}\sum_{i=1}^{N} | \frac{a_i}{A} - \frac{b_i}{A} |$, with a_i being the number of individuals with educational level *i*, A the number of all individuals and b_i the hypothetical number of individuals with educational level *i* if educational attainment were distributed equally across all educational levels *i*.

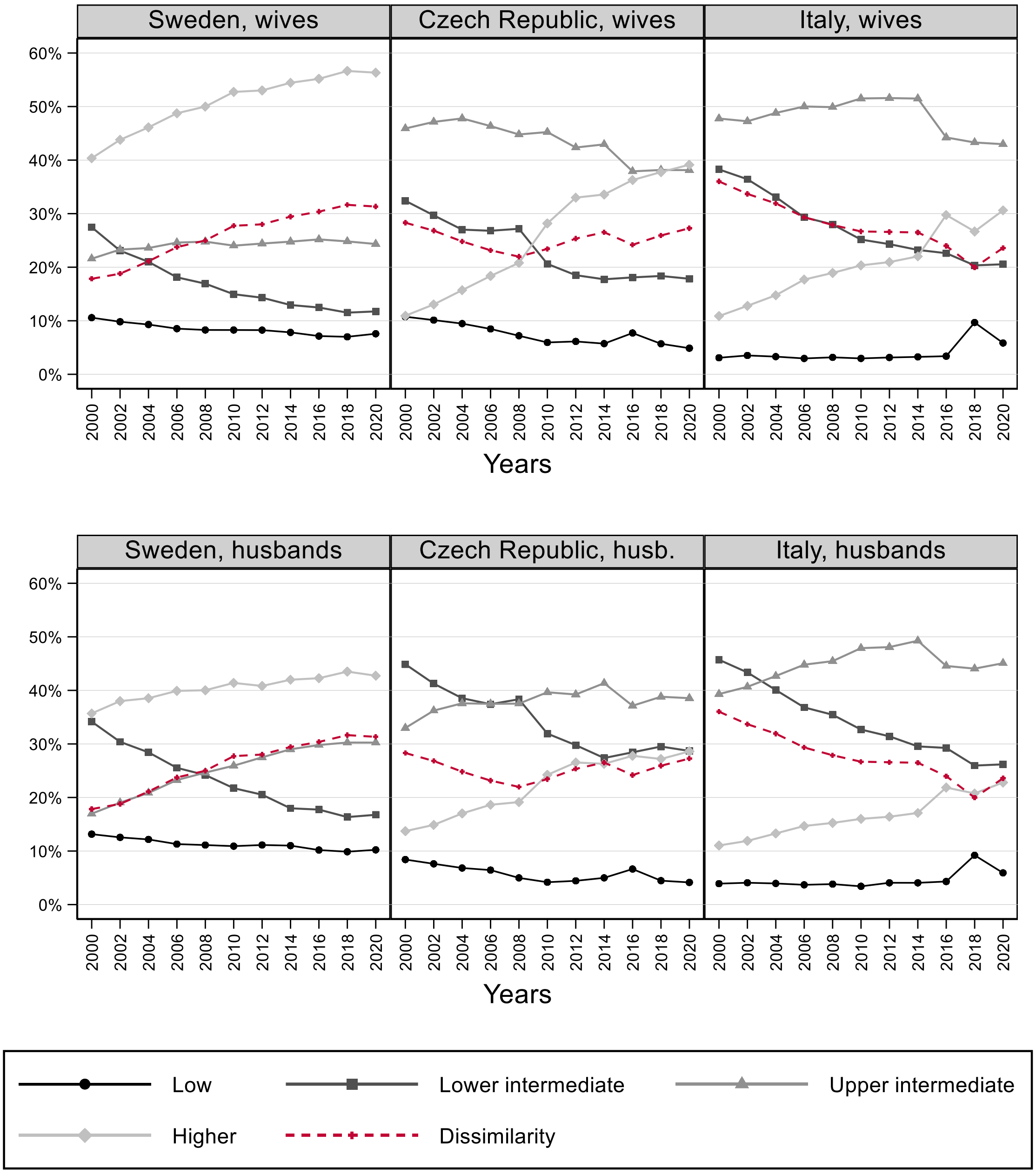

Fig. 4.2 Trends in husbands' and wives' educational attainment and trends in the dissimilarity index

For a more intuitive analysis of trends in structural opportunities, the dashed lines in Figure 4.1 show educational sorting outcomes if husbands and wives would match randomly, and educational sorting outcomes were determined only by structural opportunities.[26] Observed and structural educational sorting outcomes differ substantially. If there were no assortative mating, homogamy rates would be lower, and heterogamy rates would be higher. Moreover, country differences in educational sorting outcomes would be smaller if matching were entirely random. This suggests that assortative mating contributes to between-country variation in sorting outcomes. In addition, sorting outcomes would have changed if there had been no assortative mating. For example, in Sweden, homogamy would have increased, and hypergamy would have declined. That suggests that trends in structural opportunities are, to some extent, linked to trends in educational sorting outcomes.

4.4.3 Assortative mating

To investigate trends and country differences in assortative mating, we estimated log-linear models. In these models, the interaction parameters are odds ratios. The models control for structural opportunities because odds ratios are invariant to changes in total sample size and row and column marginal distributions (Agresti, 2002; Powers & Xie, 2008; Von Eye & Mun, 2013).[27]

We present the goodness-of-fit statistics of all models in Table 4.2. Model 1 is the null association model, assuming that there is no association between husbands' and wives' education (MW). The model fits the data very poorly – it has a positive BIC (Raftery, 1995), misclassified more than 25% of all marriages, and has an L^2 of 65483 with 297 degrees of freedom. Model 2, a constant association model, assumes that the association between husbands' and wives' education (MW) is constant across time and countries. The

[26] Katrňák & Manea (2020) label this as 'zero' homogamy, because it would occur if there were no association between spouses' education levels.

[27] Log-linear models have been used to identify assortative mating and social fluidity in social stratification research since the late 1980s (cf. Ganzeboom et al., 1991). We standardized the *n* in each two-way sub-table to 5,000 marriages. For each country, we thus obtained a sample of marriages amounting to 55,000 (5,000 x 11 tables/years). The total number of marriages (N) is 165,000.

model fits the data significantly better than the null association model, but still poorly, which indicates that assortative mating differs over time and across countries (the BIC criterion is still positive).

Model 3 is based on Model 2 but includes 32 additional parameters to identify trends in the association between husbands' and wives' education (MW) in each country. It is a model of uniform difference (Erikson & Goldthorpe, 1992) or a log-multiplicative model (Xie, 1992) assuming that the association pattern (MW) changes in the same way over countries and periods. In this model, there is a significant decrease in the L^2 (by 77% compared to Model 2; by 97% compared to Model 1), the dissimilarity index declines and the BIC turns negative. However, the L^2/d.f. ratio indicates that this is not the most satisfactory model to interpret our data (L^2/d.f. = 6.62). Model 4 is identical to Model 3, but we 'blocked' the main diagonals in the tables because it is known from social stratification research (Breen, 2004; Erikson & Goldthorpe, 1992; Hauser, 1978) that the association is mostly concentrated on the diagonals. This 'hereditary effect' usually overrides any other pattern in the data. Therefore, we included 128 parameters for diagonal cells in all tables (33 analyzed tables times 4 cells on a diagonal, minus 4 cells that are part of the basic association). Model 4 fits the data better than previous ones (L^2/d.f. = 2.61, Δ = 0.82%), but the BIC criterion is higher than in Model 3, indicating model overestimation (more parameters than necessary are identified).

To relax the assumption of uniform difference, we calculated regression-type layer effect models (cf. Goodman & Hout, 1998, 2001). Model 5 assumes a linear, but non-uniform, change in the pattern of association (MW) among countries and periods (for the extension of this model to four-way data see Katrňák & Manea, 2020). According to the BIC, Model 5 is more parsimonious and fits the data much better than Models 3 and 4. However, it still does not reproduce the data sufficiently (L^2/d.f. = 4.07; Δ = 2.38%). In

Model 6, the change in MW association is therefore modeled as categorical over time but linear across countries. Model 7 assumes the opposite: changes in the MW association are linear over time but categorical across countries. Finally, Model 8 supposes that the change in MW association is categorical across time and countries. Model 7 fits the data the best (BIC = -2338; L^2/d.f. = 2.73; Δ = 1.95%). Change in the MW pattern is modeled as linear, represented by one parameter, but as categorical across countries, represented by one parameter for each country. Based on Model 7, we conclude that assortative mating exists in all countries, but the strength of assortative mating differs between counties. Trends in assortative mating have been comparatively linear over time.

Table 4.2. Statistics of model fit for the analysis of assortative mating by period and country

	Model	Model description	L^2	Δ	d.f.	L^2/d.f.	BIC
1	CPM CPW	Conditional independence, no MW association	65482.58	25.52%	297	220.48	61914.51
2	model 1 + MW	Constant association, MW associations are the same by CP	7216.13	6.89%	288	25.06	3756.19
3	model 1 + MW*φ^{CP}	Log-multiplicative uniform layer effect, MW associations change in uniform way by CP (Xie model)	1693.47	3.24%	256	6.62	-1382.04
4	model 1 + MW*φ^{CP}+ D	Log-multiplicative uniform layer effect, MW associations change in uniform way by CP (Xie model), blocked table diagonals	334.32	0.82%	128	2.61	-1203.44
5	model 1 + MW+ MW*r^P+ MW*r^C	Regression-type layer effect, MW associations change in different ways by C and P (Goodman-Hout model)	1059.09	2.38%	260	4.07	-2064.47
6	model 1 + MW+ MW^P+ MW*r^C	Regression-type layer effect, MW associations change in different ways by C and P (Goodman-Hout model), P is dummy (categorical)	977.39	2.36%	188	5.20	-1281.18
7	**model 1 + MW+ MW*r^P+ MW^C**	**Regression-type layer effect, MW associations change in different ways by C and P (Goodman-Hout model), C is dummy (categorical)**	***689.34***	***1.95%***	***252***	***2.74***	***-2338.11***
8	model 1 + MW+ MW^P+ MW^C	Regression-type layer effect, MW associations change in different ways by C and P (Goodman-Hout model), P and C are dummy (categorical)	608.59	1.87%	180	3.38	-1553.88

Note: C-country, P-year, M-man, W-woman, φ – multiplicative uniform layer effect among tables; D – blocked main diagonals; L^2 – the log-likelihood ratio chi-square statistic; df – degrees of freedom; BIC – Bayesian information criterion (BIC= L2 – (d.f.) log (N)); N – total number of cases (165 000); Δ – index of dissimilarity (indicates the proportion of cases misclassified by the model).

Figure 4.3 presents trends and cross-country differences in assortative mating for each marriage table cell. The rows of Figure 4.3 show the educational levels of men (L – low, LI – lower intermediate, UI – upper intermediate, and H – high). In the columns, we see women's educational levels. Inside each square, we depict the parameters of Model 7 for each period and country. The x-axis displays the order of years in the model and the distances between them. Years are arranged non-chronologically to facilitate modeling a linear change and distances in the MW association. Parameters above 0 (dashed line) indicate higher chances for this educational combination than if assortative mating were averaged across all countries and periods. If they are below 0, the chances for the educational combination are lower compared to average assortative mating.

In all countries, homogamous assortative mating (diagonal of Figure 3) is higher at the margins of the educational distribution (low and high education). Furthermore, larger differences between spouses' educational levels are associated with lower chances for the educational combination to occur. Homogamous assortative mating is the lowest in Sweden in all educational categories. Moreover, the model suggests that the trends are similar in all countries and that changes are relatively small throughout the analyzed period. In all educational categories except higher education, there is a change in homogamous assortative mating. However, the years are not ordered strictly chronologically from left to right on the x-axis. From the first-year cluster (2000-2004), over the second-year cluster (2006-2012) up to the third-year cluster (2014-2018), homogamous assortative mating increased for the first three education categories. The year 2020 marks a change in this trend, indicating a decline in assortative mating. Heterogamous assortative mating changes in all educational categories except for higher education as well. Thus, we observe cross-country and cross-temporal variation in the opportunity structure and in assortative mating. In the next section, we analyze to what extent observed differences in educational sorting in marriages can be explained by structural opportunities and assortative mating.

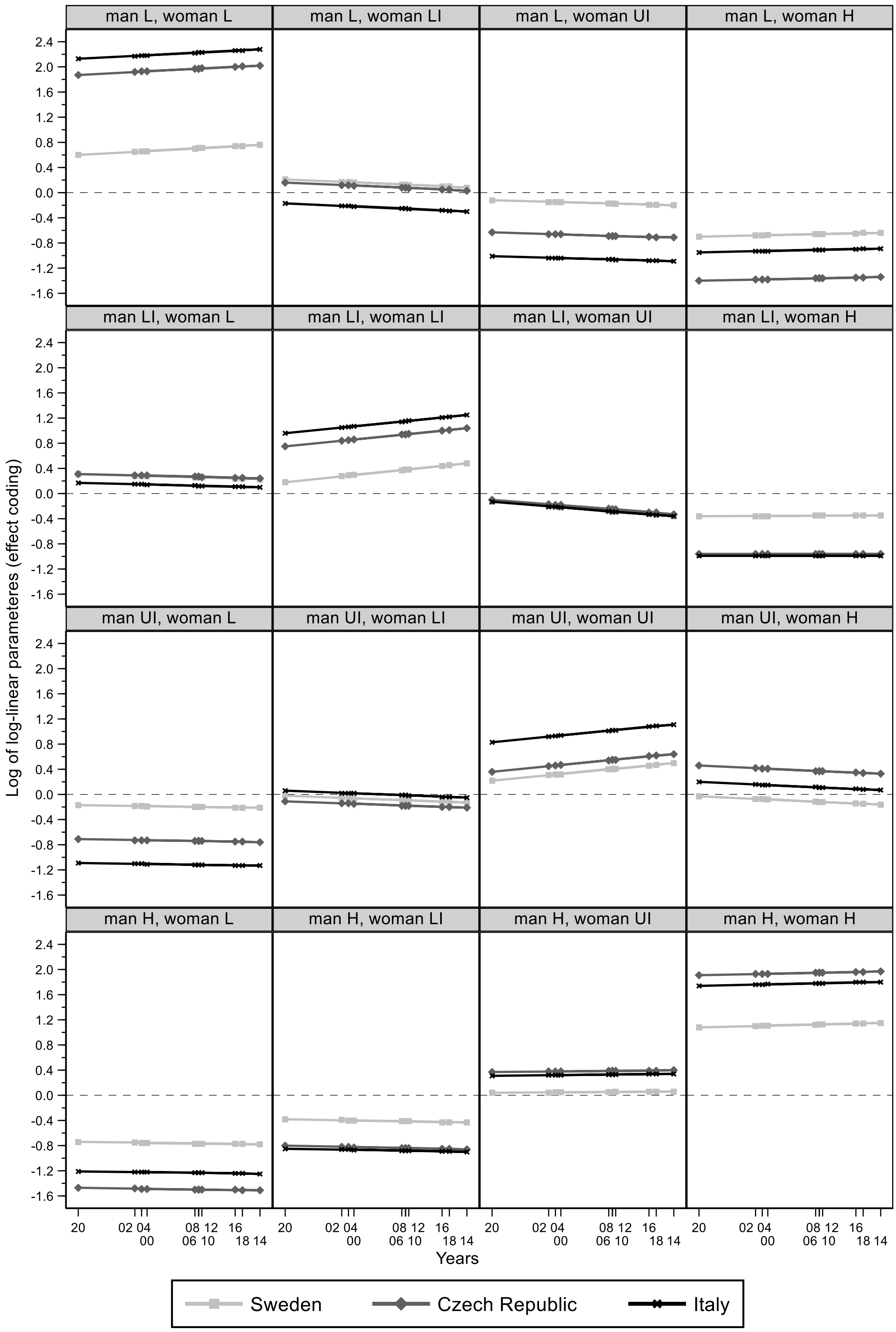

Fig. 4.3 Trends in assortative mating patterns (model 7) by period and country

Note: L – low, LI – lower intermediate, UI – upper intermediate, H – high

4.4.4 Decomposition of educational sorting outcomes in marriages

Figure 4.4 presents the decomposition results of trends in educational sorting outcomes in marriages. The sum of the light grey and dark grey bars equals observed differences in homogamy, hypogamy, and hypergamy rates compared to the reference year 2000. The light grey bars show to what extent changes in educational sorting outcomes are attributable to trends in assortative mating. The dark grey bars indicate the importance of changing opportunity structures for trends in educational sorting outcomes. The exact decomposition results and standard errors are shown in Tables A4.2 to A4.4 in the Appendix. The standard errors were estimated via bootstrapping by resampling 500 samples with replacement. In addition, Figure A4.2 in the Appendix depicts trends in educational sorting if only assortative mating (green line) or structural opportunities (red line) had changed.

Trends in homogamy. The extent to which the rise in homogamy rates is attributable to trends in assortative mating and structural opportunities differs across countries. In Sweden, changing opportunity structures and assortative mating patterns both contribute to the rising homogamy rate. For instance, from 2000 to 2020, the homogamy rate increased by 6.4 percentage points. The change in assortative mating accounts for 3.2, and the change in structural opportunities for 3.2 percentage points of this trend. In the Czech Republic, homogamy rates fluctuate without a clear trend. This pattern is almost exclusively ascribable to trends in assortative mating. In Italy, the growth in homogamy from 2004 to 2018 was entirely driven by changes in assortative mating. The fraction of homogamous marriages would have declined if only structural opportunities had changed. Thus, the rise in the percentage of homogamous marriages would have been even more pronounced if structural opportunities had not changed. Also, the substantial decline in homogamy in 2020 is predominantly due to changes in assortative mating.

Trends in hypogamy. In Sweden, the percentage of hypogamous marriages has hardly changed since the turn of the millennium. Our decomposition analysis reveals that this apparent stability results from the balance of two opposite forces. If only assortative mating differed between 2000 and 2020, we would have observed a decline in hypogamy by 1.6 percentage points. However, if 2000 and 2020 only differed in structural opportunities, the hypogamy rate would have increased by 1.3 percentage points. In the Czech Republic, changes in structural opportunities are the main driver of the growth in hypogamy. In Italy, trends in structural opportunities are linked to rising hypogamy, while trends in assortative mating were associated with declining hypogamy. Like in Sweden, both trends have been mainly offsetting each other.

Trends in hypergamy. Overall, hypergamy has been declining in all three countries. Despite the similarity in trends in hypergamy, the drivers of these trends differ between countries. In Sweden and the Czech Republic, the decline in hypergamy can predominantly be ascribed to changes in structural opportunities. For example, in Sweden, hypergamy declined by 6.0 percentage points from 2000 to 2020; 4.5 percentage points of this decline are attributable to changes in the opportunity structure. In contrast, in Italy, up to 2018, mainly trends in assortative mating were responsible for the decline in hypergamy. However, in general, we find an association between trends in structural opportunities and rising hypogamy and declining hypergamy rates.

In conclusion, despite the similarities in trends in educational sorting outcomes, the extent to which these trends are attributable to trends in structural opportunities and assortative mating varies across countries. However, we find that trends in structural opportunities are associated with rising hypogamy and declining hypergamy rates, while trends in assortative mating tend to be linked to rising homogamy rates.

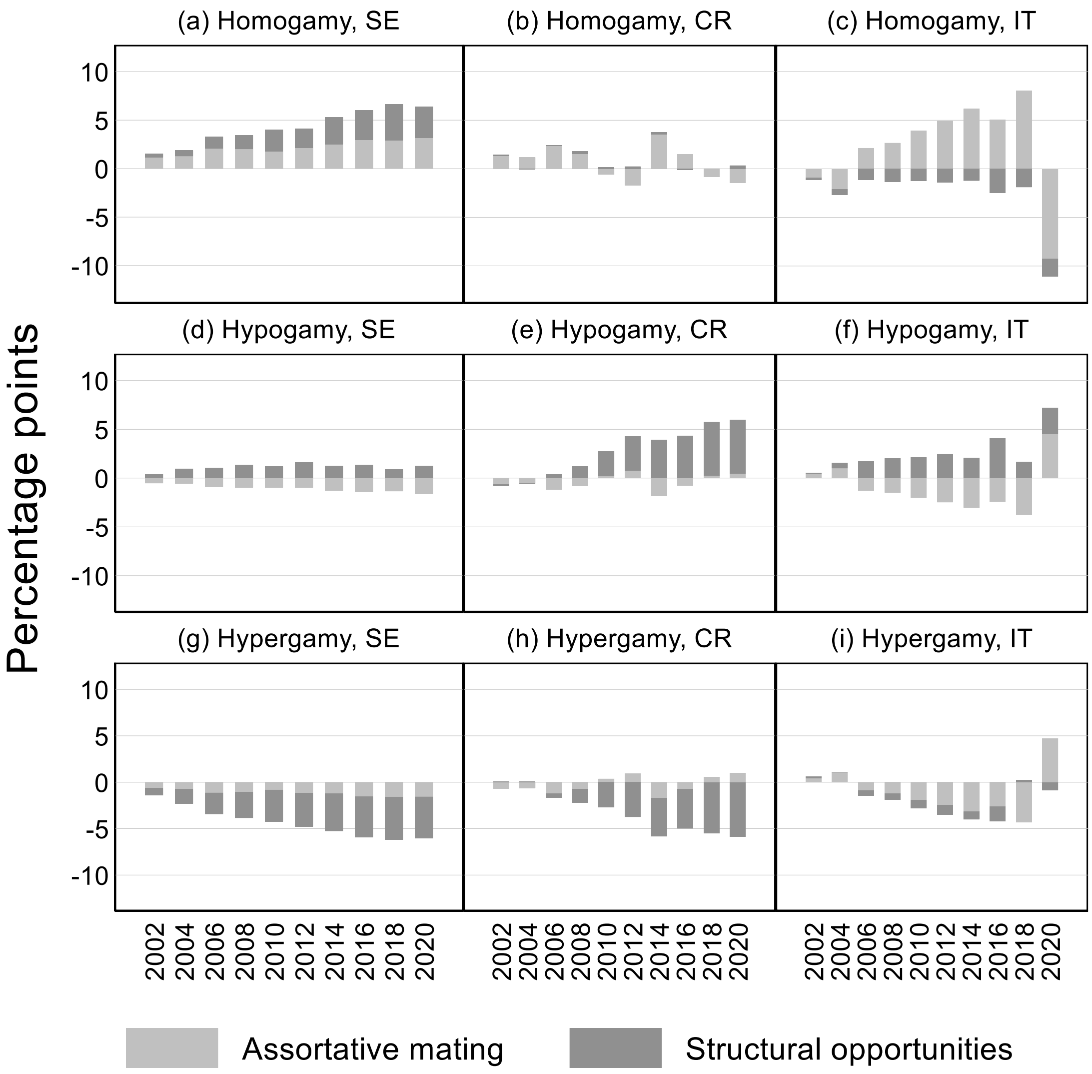

Fig. 4.4 Decomposition of trends in educational sorting outcomes in marriages

Note: SE – Sweden, CR – Czech Republic, IT – Italy

Figure 4.5 shows the decomposition of country differences in educational sorting outcomes. Exact values and standard errors are provided in Tables A4.5 to A4.7 in the Appendix. The sum of the light grey and dark grey bars equals observed differences in homogamy, hypogamy, or hypergamy rates in the indicated year. For example, the first bar in panel (a) shows that in 2000 the Italian homogamy rate was 18.8 percentage points higher than in Sweden. The light grey bar indicates that this gap can be attributed to differences in assortative mating. The dark grey bar shows that if structural opportunities would not differ between Italy and Sweden, the gaps in homogamy rates would be even slightly higher. Overall, observed differences between countries' educational sorting outcomes are primarily attributable to between-country variation in assortative mating.

Country differences in homogamy. From 2000 to 2018, homogamy rates were the highest in Italy and the lowest in Sweden. These differences are almost entirely linked to differences in assortative mating. The gaps in homogamy rates between the Czech Republic and Sweden can be primarily ascribed to differences in assortative mating. The negative dark grey bars indicate that the observed differences in homogamy would even be more pronounced if there were no differences in structural opportunities. Moreover, the assortative mating component drops substantially throughout the observation period suggesting that convergence in assortative mating patterns contributed to converging homogamy rates. Differences in homogamy rates between the Czech Republic and Italy are driven by assortative mating and structural opportunities. The structural opportunity component is, however, substantially smaller.

Country differences in hypogamy. Hypogamy rates are the highest in Sweden and the lowest in Italy. Country differences in hypogamy rates are mainly associated with different assortative mating patterns. For example, in 2018, the hypogamy rate in Italy was 12.2 percentage points lower than in Sweden. 9.5 percentage points of this difference can be attributed to assortative mating and 2.7 percentage points to structural opportunities. However, for differences between the Czech Republic and Sweden, the assortative mating component declined over time.

Country differences in hypergamy. Hypergamy rates are generally the highest in Sweden, followed by the Czech Republic and Italy. These patterns are mainly attributable to differences in assortative mating. In most years, differences in structural opportunities had a counteracting ‘effect’. That means if structural opportunities were the same, gaps in hypergamy would be more pronounced. The only exception from this pattern is the difference in hypergamy rates between Italy and the Czech Republic, which partly stems from differences in structural opportunities.

In conclusion, the findings suggest that cross-country differences in educational sorting outcomes are primarily attributable to differences in assortative mating. In contrast, within-country trends in structural opportunities have been more important for trends in educational sorting outcomes, especially for trends in hypogamy and hypergamy rates.

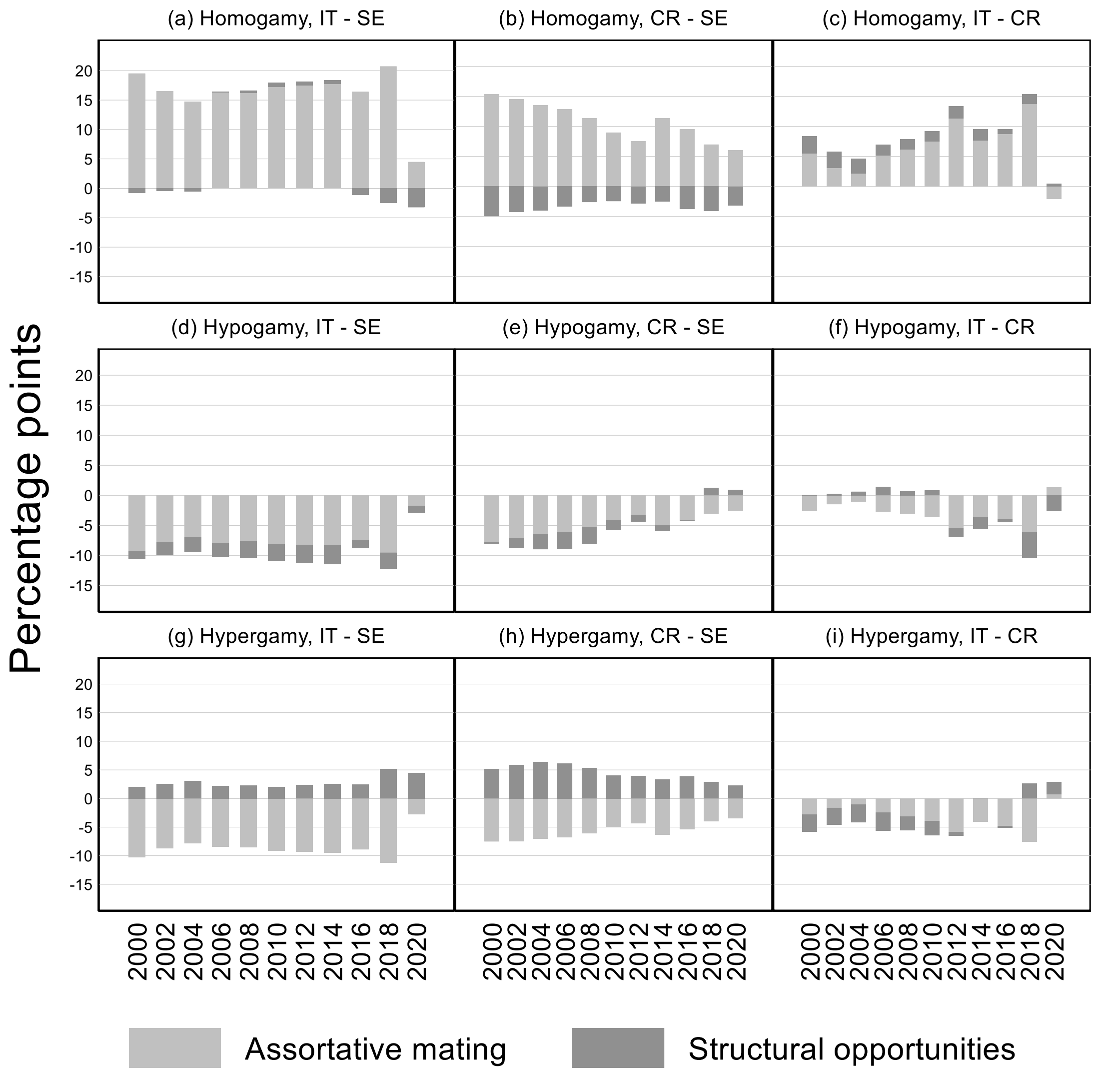

Fig. 4.5 Decomposition of cross-country differences in educational sorting outcomes in marriages

Note: SE – Sweden, CR – Czech Republic, IT – Italy

4.5 Discussion

Using population-level incidence data on marriages from Sweden, the Czech Republic, and Italy between 2000 and 2020, our study sought to explain within-country trends and cross-country differences in educational sorting outcomes. First, we examined how structural opportunities, assortative mating, and educational sorting outcomes vary over time and across countries. Subsequently, we analyzed the extent to which variations in assortative mating and structural opportunities have shaped observed trends and differences in educational sorting outcomes.

With respect to within-country trends we found that the proportions of homogamous (wife and husband equally educated) and hypogamous marriages (wife more educated than husband) either increased or remained stable. In all three countries, the percentage of hypergamous marriages (wife less educated than husband) declined. Using log-linear models, we found a slight increase in homogamous assortative mating, while changes in heterogamous assortative mating were minimal. Decomposition results suggested that these trends in assortative mating favored homogamous and disfavored heterogamous marriages in Sweden and Italy, while no clear trend emerged in the Czech Republic. Furthermore, a substantial increase in husbands' and wives' educational attainment resulted in changes in structural opportunities. In all three countries, we identified these changes as a driving force of rising hypogamy and declining hypergamy. The influence of changing structural opportunities on trends in the share of homogamous marriages differed between countries. Moreover, the extent to which observed trends in educational sorting outcomes can be attributed to changes in assortative mating and structural opportunities differs across countries. For example, although changes in assortative mating and structural opportunities were consistently linked to a declining fraction of hypergamous marriages, in Sweden the 'structural opportunity effect' predominated, while in Italy the 'assortative mating effect' was stronger.

For cross-country differences we found the highest proportion of homogamous marriages in Italy, followed by the Czech Republic and Sweden at the lower end. Conversely, Sweden had the highest rates of hypogamy and hypergamy, while Italy recorded the lowest. Using log-linear analyses, we identified substantial cross-country differences in homogamous and heterogamous assortative mating. Decomposition results indicated that these differences in assortative mating were crucial in shaping variations in educational sorting outcomes across countries. Consequently, cross-country differences in structural opportunities – despite differences in actual educational distributions – were less relevant in accounting for disparities in homogamy and heterogamy outcomes across countries.

Our findings provide valuable insights into the structural causes of within-country trends in educational sorting outcomes. For example, researchers hypothesized that the rise in women's socioeconomic attainment relative to men's could have led to an increase in hypogamous and a decline in hypergamous assortative mating (Han, 2022; C. R. Schwartz, 2013). Another body of research argues that the reversal of the gender gap in higher education has altered structural opportunities, leading to more hypogamous and fewer hypergamous unions and marriages (De Hauw et al., 2017; Esteve et al., 2016; Van Bavel, 2012). Our study can contribute to this debate. In line with the structural explanation, we found that changes in structural opportunities alone would have led to a shift from hypergamous to hypogamous marriages. However, if only assortative mating had changed, the proportions of hypogamous and hypergamous marriages would have both declined. Therefore, our results suggest that changing assortative mating patterns due to the rise in women's socioeconomic attainment relative to men's are not the main driver of the surge in 'non-traditional' unions in which women 'marry down' in education.

The results of this study also improve our understanding of variations in educational sorting outcomes across countries. Scholars anticipated that factors such as economic inequalities or welfare regimes shape cross-country differences in assortative mating (Domański & Przybysz, 2007; Fernandez et al., 2005). While our study could not investigate why assortative mating varied across countries, our findings highlight the role of these variations in explaining differences in homogamy and heterogamy outcomes between countries. This underscores the importance of studying the reasons behind cross-country differences in assortative mating. Furthermore, even though countries differ in husbands' and wives' educational compositions, the impact of cross-country differences in structural opportunities on educational sorting outcomes was small. This indicates that the educational attainment within the groups of homogamous, hypogamous, and hypergamous marriages differ across countries. For example, even though Sweden and Italy would have a similar homogamy rate if they would differ only in structural opportunities, there might be more highly educated homogamous marriages in Sweden compared to Italy. For a more detailed understanding of cross-country differences in educational sorting outcomes, future research could investigate these outcomes disaggregated by husbands' and wives' education (i.e., each cell in a marriage table).[28]

Our study advances existing research that explored the roles of changing structural opportunities and assortative mating patterns in shaping trends in educational sorting outcomes. Results from this study support previous findings by linking changes in structural opportunities to a rise in hypogamy and a decline in hypergamy (Leesch & Skopek, 2023). However, in contrast to previous research (Leesch & Skopek, 2023; Permanyer et al., 2019), we found that changes in assortative mating were the primary driver of increasing homogamy. Several factors could explain these conflicting results. Compared to our study, Leesch & Skopek (2023) examined a different country context (Ireland) and timeframe (1991 to 2016), and worked with marriage stock data rather than incidence data. Moreover, the existing literature used different measures of educational attainment and focused on young, partnered women, whereas we included all marriages

[28] Such analyses can also improve our understanding of educational inequalities between couples, as the percentage of homogamous marriages alone is not sufficient to evaluate how educational resources are distributed between couples. For example, if homogamy occurs at the upper and lower ends of the educational spectrum, it indicates high levels of educational inequality between couples. However, if all marriages were between tertiary-educated partners, there would be no educational inequality between couples.

(Leesch & Skopek, 2023; Permanyer et al., 2019). Consequently, changes in the timing of union formation might contribute to these differences in findings.

Lastly, we note some limitations of our study. First, conceptually, we treat assortative mating and structural opportunities as two independent components, while there might be some endogeneity if structural opportunities have shaped assortative mating and vice versa. For instance, individuals aiming to find a highly educated partner might pursue higher education themselves. However, this is a general limitation our study shares with other decomposition analyses in this line of research (Leesch & Skopek, 2023; Permanyer et al., 2019) as well as the long tradition of log-linear modelling in research on assortative mating (e.g., Kalmijn, 1991b; Mare, 1991; C. R. Schwartz & Mare, 2005).

Second, changes and cross-country differences in the selection into marriages could affect our results. Leesch and Skopek (2023) found a small but non-negligible link between changes in the educational gradient in union formation and educational sorting outcomes in Ireland. In recent decades, the educational gradient in marriage has remained relatively stable in Sweden, the Czech Republic, and Italy, but it varies considerably between countries (Bertrand et al., 2020). Therefore, in our study, education-specific selection into unions might have a more pronounced effect on cross-country differences in educational sorting outcomes than within-country trends.

Third, research indicates that assortative mating differs between married couples and unmarried cohabitors (Blackwell & Lichter, 2000; Schoen & Weinick, 1993). If these differences vary over time or across countries, they might influence our findings on trends and cross-country differences in educational sorting outcomes. Additionally, since our data include first and higher-order marriages, differences in the selectivity into remarriages might also affect our results.

Fourth, patterns of assortative mating and educational sorting outcomes can be sensitive to the chosen educational categories (Gihleb & Lang, 2016), which is typically a limitation in research on assortative mating and educational sorting outcomes. In this study, the educational classification is not strictly comparable across countries but reflects the country-specific boundaries of the educational systems. Thus, particularly when comparing educational sorting outcomes across countries, the measurement of education can be a limitation in our study.

Despite these limitations, our study contributes to a better empirical understanding of trends and cross-country differences in homogamy and heterogamy outcomes. It is the first study to link cross-country differences in educational sorting outcomes primarily to differences in assortative mating. Additionally, we contribute to a small but growing body of research that analytically distinguishes the impact of assortative mating and structural opportunities on trends in educational sorting outcomes.

5 Five decades of marital sorting in France and the United States – the role of educational expansion and the changing gender imbalance in education

5.1 Introduction

In recent decades, the global expansion of higher education and the reversal of the gender gap in education have profoundly altered the educational compositions of partner markets. The proportion of highly educated individuals has been increasing worldwide, with women's educational levels rising faster than men's (Schofer & Meyer, 2005). During this process, the gender gap in higher education has reversed in most European and North American countries (De Hauw et al., 2017; Esteve et al., 2016).

Since both processes – the rise in educational attainment and the reversal of the gender gap in higher education – have transformed the pool of potential partners, they are most likely associated with shifts in *marital sorting outcomes*[29]. Marital sorting outcomes refer to the joint distribution of husbands' and wives' education levels. The increase in educational attainment can influence these outcomes by affecting the probability of encountering an equally educated candidate, which depends on the proportion of such candidates on the partner market (Blau et al., 1982; S. K. Lewis & Oppenheimer, 2000). Furthermore, scholars argue that the reversal of the gender gap in higher education has increased the likelihood of matches between more educated women and less educated men (hypogamy), compared to matches between less educated women and more educated men (hypergamy) (Van Bavel, 2012).

[29] Note that this study investigates all cohabiting couples, regardless of whether they are married or not. However, to improve the readability of the text, we use the terms 'marriage' and 'union' interchangeably.

Despite these straightforward expectations, our understanding of how changes in structural opportunities affect trends in marital sorting outcomes remains limited. Much of the existing research employs log-linear models that control for changes in the educational compositions of partner markets to analyze trends in assortative mating, i.e., the degree of non-randomness by which available men and women sort into unions (e.g., Kalmijn, 1991b; C. R. Schwartz & Mare, 2005; Smits, 2003). Therefore, the bulk of empirical research controls for the expansion of women's and men's education instead of studying their effects on trends in marital sorting outcomes.

While a few studies have examined the association between trends in structural opportunities and marital sorting outcomes, their ability to disentangle the distinct influences of higher education expansion and changes in the gender imbalance in education is limited (Corti & Scherer, 2021; De Hauw et al., 2017; Erát, 2021; Esteve et al., 2016; Katrňák & Manea, 2020; Leesch & Skopek, 2023).[30] Only Permanyer et al. (2019) found that the rise in college versus no-college homogamy is primarily associated with the expansion of college education, rather than changes in the gender gap in education. However, their methodology is limited to 2 x 2 marriage tables, making it unsuitable for analyzing more nuanced trends in marital sorting outcomes. Therefore, there is a need for detailed analyses that use more precise measures of education. Furthermore, there is a lack of research that adopts a long-term perspective, spanning several decades, and examines not only homogamy but also heterogamy outcomes.

In addition, most existing studies face several limitations. First, existing research uses measures, such as the gender gap in tertiary education, to capture gender imbalances

[30] We use the term 'gender imbalance in education' to describe gender differences in educational attainment, regardless of how they are measured. In line with previous literature, 'gender gap in education' refers to education-specific sex ratios, typically using the sex ratio in tertiary education. 'Education-gender association' refers to the odds ratios that reflect the association between gender and educational levels. For example, it involves the ratio of the odds that a low-educated person is a woman to the odds that a high-educated person is a woman.

in education (Corti & Scherer, 2021; De Hauw et al., 2017). However, these measures are intertwined with the expansion of higher education and depend not only on the association between gender and education but also on the overall educational attainment of the population. Second, research usually aggregates marital sorting outcomes, such as the percentage of more and less educated homogamous couples, to obtain an overall homogamy rate (Esteve et al., 2016; Permanyer et al., 2019). This aggregation of differently educated homogamous or heterogamous unions could obscure differences in trends between those groups. Therefore, studying trends in disaggregated marital sorting outcomes is crucial for understanding the relationship between changing structural opportunities and patterns of 'who marries whom'. Third, most existing studies restrict their samples to partnered individuals, operationalizing structural opportunities through the educational distributions of *partnered* women and men (Permanyer et al., 2019; C. R. Schwartz & Mare, 2005). This approach could yield biased estimates of structural opportunities because the educational gradient in union formation, i.e., union formation rates by education, has changed over time (Bertrand et al., 2016; Kalmijn, 2013; Leesch & Skopek, 2023).

This study investigates how educational expansion and changes in the education-gender association are linked to marital sorting outcomes. We exploit microdata census samples from France and the United States, provided by IPUMS International (Minnesota Population Center, 2020), to apply counterfactual decompositions. Census data have been available since the 1960s for both countries (1962–2011 for France and 1960–2015 for the United States). This makes the United States and France one of the few countries in which data on marital sorting outcomes are available over the entire process of the expansion of higher education. By choosing these data, we present the first study examining the relationship between changing partner market compositions and marital sorting outcomes over five decades. This is a sufficient period to capture the shift from predominantly low to predominantly high educational attainment in the population of young adults. While much previous research on marital sorting has focused on trends in educational assortative mating in the United States, this paper contextualizes this line of research by (a) examining the degree to which trends in assortative mating and structural opportunities contribute to marital sorting outcomes and (b) providing a comparative analysis between the United States and France, one of Europe's most populous countries. This comparison provides our study with demographic contexts of North America and Europe, which display considerable differences in trends in women's and men's education. For example, in France, the expansion of tertiary education began later and occurred more rapidly than in the United States. Furthermore, scholars consistently found increases in educational assortative mating in the United States, while in Europe, trends in assortative mating patterns were more diverse (Blossfeld, 2009; C. R. Schwartz, 2013). Thus, the comparison between the United States and Europe is vital for advancing assortative mating research.

Our study also addresses several limitations of previous research. First, unlike earlier research, we use a measure for the gender imbalance in education, namely the odds ratios describing the association between gender and education, that is independent of the overall educational attainment of all individuals on the partner market. Second, our study deepens the understanding of trends in marital sorting by analyzing not only aggregated marital sorting outcomes, such as homogamy, hypogamy, and hypergamy rates, but also disaggregated outcomes. That means we examine the joint distribution of husbands' and wives' education, which includes outcomes such as the percentage of tertiary-educated wives married to a tertiary-educated husband. Third, we investigate how trends in assortative mating and education-specific changes in union formation rates contribute to trends in marital sorting outcomes, which allows us to isolate the influence of changing opportunity structures.

5.2 Background

5.2.1 Educational expansion

Since the 1960s, higher education has expanded globally (Schofer & Meyer, 2005). This development has influenced the educational attainment of women and men on the partner market, altering the structural opportunities to encounter more or less educated candidates. Educational expansion, therefore, can shape marital sorting outcomes because the relative size of a group (e.g., tertiary educated women) affects the likelihood of encountering a member of that group (Blau, 1977; Blau et al., 1982; S. K. Lewis & Oppenheimer, 2000). For example, a higher proportion of tertiary educated women increases the probability that a man will encounter and potentially marry a tertiary educated woman. Thus, it is straightforward to expect that educational expansion is associated with an increasing proportion of unions involving highly educated individuals and a declining share of unions involving less educated individuals.

Educational expansion may have also influenced the overall *homogamy* rate by altering the opportunities to meet equally educated candidates. Prior to the expansion of higher education, most individuals on the partner market were low-educated. As higher education began to increase, the variation in educational attainment also increased. If the expansion of higher education continues, we anticipate a decline in this variation, with the majority of young men and women in the partner market becoming highly educated. We can already observe this outcome in countries like Canada, Ireland, and the United Kingdom (OECD, 2022a). That means the structural opportunities for homogamy peak at the beginning and end of higher education expansion, when the variation in educational levels is low. Thus, we expect that higher education expansion is associated with a U-shaped pattern in homogamy rates (Katrňák & Manea, 2020; Michielutte, 1972). Consequently, educational expansion also has the potential to influence trends in *heterogamy* outcomes. If educational expansion is associated with a U-shaped pattern in homogamy trends, we would expect heterogamy trends (i.e., the sum of hypogamy and hypergamy) to follow an inverted U-shaped pattern.[31]

Permanyer et al. (2019) found that educational expansion is associated with declining homogamy rates in less educated contexts and rising homogamy rates in more educated countries. On the flipside, this implies that educational expansion resulted in rising heterogamy rates in less educated countries and declining heterogamy rates in more educated contexts. However, their study covered relatively short periods of about ten years, which do not capture the shift from low to high educational attainment that we expected to lead to a U-shaped trend in homogamy. Thus, there is a lack of studies examining the relationship between educational expansion and trends in homogamy and heterogamy over a period covering the entire higher education expansion process. Moreover, to get a more detailed empirical picture of the relationship between educational expansion and trends in marital sorting outcomes, research would need to investigate these outcomes disaggregated by husbands' and wives' education (i.e., the joint distribution of husbands' and wives' education). For example, one may hypothesize that the early stages of higher education expansion led to a decline in homogamy rates because rising variation in education reduced the structural opportunities for less educated homogamous unions. However, prior literature primarily analyzed overall fractions of homogamous, hypogamous, or

[31] For example, imagine a population of 100 women and 100 men, where half of them are low-educated and the other half are highly educated. If partnerships were formed randomly, we would observe a 50% rate of homogamy and 25% each for hypogamy and hypergamy. Now, consider a shift in this distribution, where higher education expands to the point that only one woman and one man remain low-educated. In that case, the potential maximum of hypogamous and hypergamous unions would shrink to 1% (1/100 = 0.01). In this scenario we would observe one union between a low-educated woman and a highly educated man, one union between a low-educated man and a highly educated woman, and 98 unions between highly educated women and men.

hypergamous unions (Katrňák & Manea, 2020; Permanyer et al., 2019). That means, there is a lack of research adopting a long-term perspective and analyzing more detailed measures of sorting outcomes.

5.2.2 Gender imbalances in education

During the process of educational expansion, women's educational attainment has risen more rapidly than men's, leading to a reversal in the gender imbalance in education. This shift could contribute to changes in *homogamy* rates because gender differences in educational attainment limit opportunities for encounters between equally educated men and women. For example, homogamous matches would be impossible if all women were tertiary educated and all men were secondary educated. Therefore, we anticipate a negative relationship between the gender imbalance in education and homogamy rates, irrespective of whether women or men are more educated.

Although previous research has not investigated the relationship between the gender imbalance in education and homogamy, an increasing number of studies examine the link between these gender imbalances and *heterogamy*. These studies have investigated whether women's educational advantage is associated with increased hypogamy and decreased hypergamy (De Hauw et al., 2017; Esteve et al., 2016; Han, 2022). The relationship between the gender imbalance in education and hypogamy and hypergamy appears evident: if the availability of men who are more educated than the average woman decreases, the probability of hypergamy is expected to decrease too. Consequently, an increase in the availability of men who are less educated than the average of women should be linked to an increase in hypogamy.[32]

[32] In addition, building on partner search theory (England & Farkas, 1986; Oppenheimer, 1988) it has been argued that the reversal of the gender gap in education led to an education-specific mating squeeze – a shortage of highly educated men and low-educated women (De Hauw et al., 2017; Van Bavel, 2012). If we assume that individuals have preferences for equally or more educated candidates, then the reversal of the

Several studies have demonstrated a striking country-level correlation between the gender gap in education and the proportion of heterogamous couples where women are more educated than men (Erát, 2021; Esteve et al., 2012, 2016). Furthermore, research using micro-level data on marital sorting outcomes has identified an association between the gender gap in education and hypogamy and hypergamy outcomes. Exploiting cross-country variations in the gender gap in education, DeHauw et al. (2017) found that the likelihood of highly educated women partnering down in education increases with the share of women among the highly educated. Corti and Scherer (2021) demonstrate that for low-educated men and highly educated women, the reversal of local gender gaps in education increases the likelihood of being in a hypogamous union or without a partner. Using country-level fixed effects, Han (2022) indicates that the reversal of the gender gap in college education is linked to the degree of educational hypogamy. However, none of these studies have quantified the degree to which trends in hypogamy and hypergamy rates can be attributed to the reversal of the gender gap in education.

Although the expansion of higher education and changes in the gender imbalance in education coincided (Esteve et al., 2016), only one previous study has examined to what extent these factors contribute to changes in homogamy rates (Permanyer et al., 2019). The study suggests that educational expansion primarily drives trends in college versus no college homogamy, with changes in the gender balance in education having minimal impact. However, there is a lack of similar approaches that (a) use a more detailed measure for education, (b) investigate trends in hypogamy and hypergamy rates, and (c) study trends over an extended period.

gender gap in education can push individuals in hypogamous unions. However, since assumptions about partner preferences (and search costs) are required to derive hypotheses about the reversal of the gender gap in education from partner search theory, the theory will not be further discussed.

5.2.3 Other sources of change in marital sorting outcomes

If structural opportunities had not changed, what else might explain trends in homogamy and heterogamy rates? Numerous studies show that the degree of *assortative mating* (i.e., non-random matching into unions) has changed over time (e.g., Mare, 1991; C. R. Schwartz & Mare, 2005). Therefore, to understand the relationship between educational expansion, the changing association between gender and education, and marital sorting outcomes, it is necessary to control for the influence of assortative mating. For example, even if structural opportunities for homogamy have declined, mechanisms of assortative mating favoring homogamy (e.g., a preference for equally educated partners) may have become stronger. In such a case, we might observe no substantial differences in homogamy rates, even though structural opportunities for homogamy have been increasing.

Furthermore, changes in education-specific *union formation* rates could explain why homogamy and heterogamy rates have shifted. Since our study investigates marital sorting in the population of *partnered* women, education-specific union formation patterns could determine trends in marital sorting outcomes.[33] Shifts in the educational gradient in union formation could counterbalance or strengthen the effect of changing structural opportunities because they shape the educational composition of husbands and wives. For example, the impact of the reversal of the gender gap in tertiary education on marital sorting outcomes could be mitigated if tertiary educated women were more likely to remain without a partner. However, empirically, in many Western countries, the marriage rates of more educated women increasingly surpass those of less educated women (Bertrand et al., 2020; Goldstein & Kenney, 2001). These changes in the educational gradient in union

[33] In contrast, when analyzing marital sorting outcomes among all (partnered and unpartnered) women or men, the size and educational composition of the population that does not marry can be understood as a possible outcome of the partner search process. For example, someone may want to marry, but if the available candidates on the partner market do not meet their aspirations, they may choose to remain without a partner. Thus, in line with partner search theories, not being married is one possible outcome of the partner search process.

formation have been associated with rising homogamy and declining hypergamy rates (Leesch & Skopek, 2023).

5.2.4 The contexts of France and the United States

The educational system of the United States stands in stark contrast to that of most European countries. The demand-driven and decentralized nature of the US American system (Garnier et al., 1989; Turner, 1960) is linked to diversity in school types, limited state control over curricula, and competition among educational institutions. Moreover, the economic costs associated with education can impose significant limitations on the accessibility of higher education (OECD, 2020a). In contrast, the majority of European educational systems tend to be more supply-driven and centralized (Garnier et al., 1989; Turner, 1960). France is an example of such a system, as its government takes a significant role in curriculum planning and regulating access to education.

These differences in the educational systems of France and the United States go hand in hand with their expansion of higher education. While the United States experienced an early expansion in higher education, France displays a later but more rapid expansion in tertiary education. Therefore, we expect a more pronounced impact of educational expansion on trends in marital sorting outcomes in France.

Moreover, the diversity in educational institutions in the United States may obscure assortative mating patterns. For example, individuals from less prestigious educational institutions might be more likely to marry down in education (cf. Uchikoshi, 2022). In contrast, we would not expect such a pattern in France, where educational degrees and curricula are more standardized. Despite such differences between the United States and Europe the generalizability of assortative mating trends in the United States (Kalmijn, 1991b; Mare, 1991; C. R. Schwartz & Mare, 2005) to European country contexts is still an open debate.

5.3 Data and Methods

5.3.1 Data

Our analysis is based on microdata census samples from France (1962–2011) and the United States (1960–2015) provided by IPUMS International (Minnesota Population Center, 2020). First, we restricted the data to women aged 25 to 34 (France: N = 2,650,637; United States: N = 2,481,040). We chose a lower age bound of 25 to minimize right censoring issues related to completing tertiary education, while the upper age bound of 34 minimizes the influence of changes that occur after union formation, such as union dissolution, repartnering, and educational upgrades (Permanyer et al., 2019; C. R. Schwartz & Mare, 2012).

Second, we approximated the educational distribution of the male population who could have been potential partners for the 25-to-34-year-old women identified in the previous step. We argue that this male population consists of men who are in a married or unmarried cohabiting union with women from our female sample, as well as unpartnered men who could have been potential partners for 25-to-34-year-old women. To estimate the educational composition of the unpartnered men, we used a sample of men aged 27 to 36.[34] Within this sample, we calculated the ratios of unpartnered to partnered men by education, year, and country. We approximated the educational distributions of unpartnered men by multiplying these ratios with the number of men who are married to the women in our initial sample per educational level, year, and country.

Third, we applied person weights to obtain representative samples of the population. Initially, we took the total weighted frequency w_{ijkl} for all cells. Here i (i = 1,

[34] We chose a 10-year age range that covers the age differences within couples as accurately as possible. Based on samples that pool all years by country, no other 10-year interval covers more unions than the interval that includes 27- to 36-year-old men.

2, 3) represents men's education, j (j = 1, 2, 3) women's education, k (k = 1, 2) the country and l the census year (l = 1, …, 8). Because this step inflates the sample size, we deflated the samples back to their original size using a factor obtained by dividing the number of cases per year, sex, and country by the sum of all weights in the respective group (C. R. Schwartz & Mare, 2005).

5.3.2 Measures

Education. We derived our measure for education from the International Standard Classification of Education 2011 (ISCED 2011) (UNESCO, 2012). ISCED 2011 was designed to achieve a cross-nationally comparable coding of education (Schneider, 2013). We collapsed the ISCED measure into three categories: "lower secondary education or less" (ISCED 0–2), "complete secondary education" (ISCED 3–4) and "complete university education" (ISCED 5 and higher) (cf. UNESCO, 2012). We grouped individuals with lower secondary education together with those who attained primary education or less because lower secondary education is relatively uncommon in both countries. On average, across all observed census samples, 8.9% of individuals in the United States, and 4.2% in France, attained lower secondary education. Moreover, in the United States, "lower secondary education" is not completed with a degree. The classification of education into three groups (ISCED 0–2, ISCED 3–4 and ISCED 5 and higher) has been widely used to measure education in the United States and compare it to European countries (e.g., Berghammer & Adserà, 2022; Karlson, 2021; Monaghan, 2015). We provide additional information on the educational systems of the United States and France in the Appendix.

Marital sorting outcomes. We investigated the joint distribution of husbands' and wives' education to measure marital sorting outcomes. For instance, we analyzed the percentage of unions between tertiary educated women and secondary educated men or between low-educated women and men. We considered all cohabiting unions irrespective of their marital status.

Structural opportunities. Structural opportunities for each year and country were measured by the educational composition in the sample of women aged 25 to 34, and the corresponding sample of men, as described above.

Educational expansion. To distinguish between educational expansion and the gender imbalance in education, we depicted the structural opportunities in an 'education table'. This table is a contingency table that shows women's and men's educational compositions. The table can be denoted by $\boldsymbol{E_{ct}}$, which is a *2 x K* matrix showing the percentage of women (first row) and men (second row) within each of the *K* educational levels. Thereby, *c* (*c* = 1, 2) refers to the country and *t* (*t* = 1, …, 8) to the census year.

$$\boldsymbol{E_{ct}} = \begin{bmatrix} e_{f1} & \cdots & e_{fK} \\ e_{m1} & \cdots & e_{mK} \end{bmatrix} \quad (5.1)$$

To measure changes in educational attainment, we calculated the percentage of individuals (i.e., the combined total of women and men) within each educational level. This means that the marginal distributions in an education table indicate the level of educational expansion.[35]

Gender imbalance in education. Our measure for the gender imbalance in education is based on the categorical association between gender and education. This association is reflected by the odds ratio structure $\boldsymbol{OR_{ct}}$, contained in matrix $\boldsymbol{E_{ct}}$. The odds

[35] The marginal distributions also show the share of women and men in a sample. Since the marriage tables were constructed in a way that they include 50% women and 50% men at each year in both countries, this does not affect our educational expansion measure.

ratios represent the odds that a *i*-educated person is male $\left(\frac{e_{mi}}{e_{fi}}\right)$ divided by the odds that a *j*-educated person is male $\left(\frac{e_{mj}}{e_{fj}}\right)$. For example, taking the lowest educational level as reference category, the odds ratio structure underlying matrix $\boldsymbol{E_{ct}}$ can be expressed in the following vector.

$$\boldsymbol{OR_{ct}} = \begin{bmatrix} 1 & \frac{e_{m2}}{e_{f2}} / \frac{e_{m1}}{e_{f1}} & \cdots & \frac{e_{mK}}{e_{fK}} / \frac{e_{m1}}{e_{f1}} \end{bmatrix} \tag{5.2}$$

We used this odds ratio structure to measure the association between gender and education. Importantly, the odds ratios in Equation 5.2 are independent of the marginal distribution in the education table (Equation 5.1), which we used to measure educational expansion. Our study utilizes this feature to analytically distinguish between educational expansion and the association between gender and education.

Our approach stands in contrast to previous research that employed margin-dependent metrics to measure the gender imbalance in education. Some studies relied on sex ratios in tertiary education (Corti & Scherer, 2021; De Hauw et al., 2017; Han, 2022), while others used the index of female educational advantage (F-index) (Erát, 2021; Esteve et al., 2012, 2016). The F-index measures the probability that a randomly selected woman is more educated than a randomly selected man, given that they are differently educated (Esteve et al., 2016).[36]

[36] The index of female educational advantage is defined as $F = \frac{p_f^3(p_m^1+p_m^2)+p_f^2+p_m^1}{1-(p_f^1p_m^1+p_f^2p_m^2+p_f^3p_m^3)}$. The proportions of women and men in an educational category *e* (*e*=1,2,3) are denoted by p_f^e and p_m^e.

These absolute measures of gender gaps in education reflect gender differences in educational attainment. However, variation in absolute gender gaps may arise from differences in the education-gender association or from differences in overall educational attainment. Therefore, absolute measures, such as the sex ratio in higher education or the F-index are not suitable for our study, as we aim to disentangle the roles of the education-gender association and educational expansion in shaping trends in marital sorting outcomes. In the Appendix, we provide a numerical example to illustrate this point.

Assortative mating. In a marriage table, the odds ratios show the association between husbands' and wives' education net of their overall educational attainment. Thus, we employed the odds ratio structure of a marriage table to measure assortative mating.

Educational gradient in marriage. The educational gradient in marriage was measured by the ratios of unpartnered to partnered women and men by educational level, year, and country.

5.3.3 Methods

Our analysis involves three steps. First, we analyzed how structural opportunities have changed in the United States and France. To illustrate these trends, we present changes in the following: (a) the percentage of individuals per educational level, (b) the education-specific sex ratios, and (c) the odds ratios reflecting the education-gender association. In the second step, we investigated trends in marital sorting outcomes, i.e., the joint distribution of husbands' and wives' education. Finally, we applied a counterfactual decomposition technique to contextualize the first two steps. The decomposition analysis aims to empirically determine the extent to which trends in marital sorting outcomes can be attributed to educational expansion and changes in the association between gender and education.

The aim of the decomposition analysis is to isolate the statistical contributions of educational expansion and the changing gender-education association to the observed differences in marital sorting outcomes. Additionally, we examined the impact of trends in assortative mating and the educational gradient in marriage. Drawing upon an approach proposed by Leesch and Skopek (2023), our analysis systematically compares observed marital sorting outcomes with hypothetical 'counterfactual' ones. This allows us to break down the differences between the marital sorting outcomes of two marriage tables into four distinct components: educational expansion, the education-gender association, assortative mating, and the educational gradient in union formation. To analyze changes in marital sorting outcomes throughout the observation period, we compare the sorting outcomes from Time 1 (1962 in France and 1960 in the United States) with sorting outcomes observed in subsequent years.

Counterfactual marital sorting outcomes. The decomposition analysis builds on counterfactual marriage tables. In these tables, at least one of the four components is exchanged with that from another marriage table. Table 5.1 provides an overview of both factual (indicated in bold) and counterfactual marital sorting outcomes. The letter *h* stands for the marital sorting outcome derived from a marriage table, such as the fraction of homogamous unions. The first index stands for the educational distribution of all individuals, indicating educational expansion. The second index reflects the education-gender association, the third represents the educational gradient in marriage, and the fourth index stands for assortative mating. For example, the counterfactual table h_{2122} reflects, what marital sorting outcomes would have occurred if Time 2 had the same education-gender association as Time 1. Similarly, h_{1122} answers the question "What marital sorting outcomes would have occurred if Time 2 had the same educational distribution and the same education-gender association as Time 1?". Including the two factual marriage tables from Time 1 and Time 2, we work with a total of 4^2 =16 tables.

Table 5.1. Factual and counterfactual marital sorting outcomes

Marginal distributions				
Education			Assortative mating	
Educational distribution	Education-gender association	Educational gradient in marriage	T1	T2
T1	T1	T1	**h_{1111}**	h_{1112}
T1	T1	T2	h_{1121}	h_{1122}
T1	T2	T1	h_{1211}	h_{1212}
T1	T2	T2	h_{1221}	h_{1222}
T2	T1	T1	h_{2111}	h_{2112}
T2	T1	T2	h_{2121}	h_{2122}
T2	T2	T1	h_{2211}	h_{2212}
T2	T2	T2	h_{2221}	**h_{2222}**

The counterfactual marriage tables are obtained through iterative proportional fitting (IPF) (Deming & Stephan, 1940). IPF alternately rescales the row and column totals to the cells of a contingency table while preserving the table's odds ratio structure. We use IPF to adjust the cell frequencies in a marriage table to a different set of marginal distributions while keeping the odds ratio structure of the initial table constant. This method enables us to examine how marital sorting outcomes would have developed if only the odds ratios or the marginal distributions of the marriage table had changed (h_{2221} and h_{1112}). For example, to create the counterfactual h_{2221}, we match the marginal distributions of Time 2 with the odds ratio structure of Time 1 and calculate the corresponding cell frequencies using IPF. Numerical examples for constructing counterfactuals are provided in the Appendix.

Figure 5.1 graphically represents the hierarchical logic of the decomposition approach. This illustration shows that differences in marital sorting outcomes can *only* originate from differences in odds ratios (assortative mating) or marginal distributions. However, various reasons can explain changes in the marginal distributions. These trends might result from differences in women's and men's education or shifts in the educational gradient in marriage. Additionally, trends in women's and men's education could emerge from educational expansion or changes in the education-gender association.

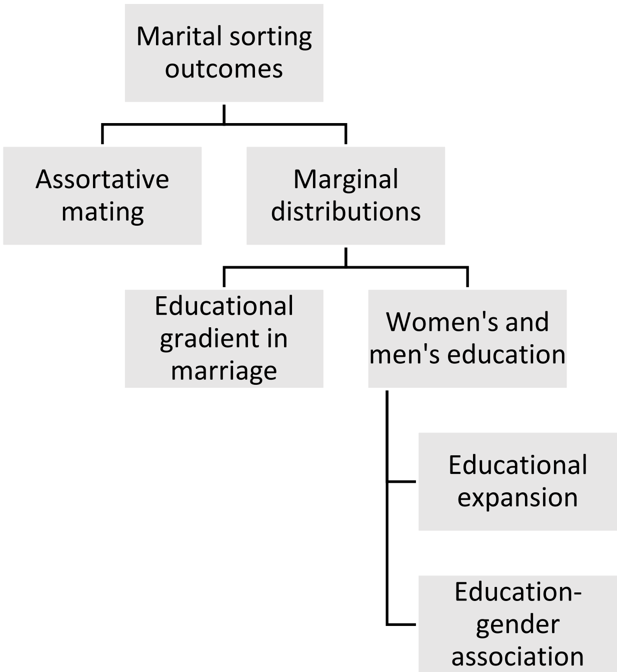

Fig. 5.1 Drivers of trends in marital sorting outcomes

Decomposition. We compare factual and counterfactual marital sorting outcomes to learn about the importance of the four components (educational expansion, the education-gender association, the educational gradient in marriage and assortative mating) for trends in marital sorting outcomes. For example, if Time 1 had the assortative mating patterns of Time 2 (h_{1112} - $\mathbf{h_{1111}}$) and none of the other components had changed, trends in marital sorting outcomes can be attributed to changes in assortative mating. On the other hand, we could also ask what difference in marital sorting outcomes would have been observed if Time 2 had the same assortative mating patterns as Time 1($\mathbf{h_{2222}}$ - h_{2221}). As there are two possible assortative mating components, we take the average to assess the average contribution of assortative mating to differences in marital sorting outcomes:

$$\Delta^{A} = \frac{1}{2}\,(h_{1112} - \mathbf{h_{1111}} + \mathbf{h_{2222}} - h_{2221}). \tag{5.3}$$

To analyze the association between trends in marginal distributions and marital sorting outcomes, we calculate the differences between Time 1 and Time 2 in two scenarios. First, we consider the scenario where Time 1 had the marginal distributions of Time 2, and second, we assume Time 2 had the marginal distributions of Time 1:

$$\Delta^{MD} = \frac{1}{2}\,(\mathbf{h_{2222}} - h_{1112} + h_{2221} - \mathbf{h_{1111}}). \tag{5.4}$$

Next, we investigate to what extent trends in marital sorting can be attributed to changes in the educational gradient in marriage (Δ^{MD_g}) and to changes in women's and men's educational distribution (Δ^{MD_e}). In this case, it is necessary to calculate both 'effects' (Δ^{MD_g} and Δ^{MD_e}) for the assortative mating structure of Time 1 and Time 2 because trends in assortative mating also contribute to trends in marital sorting outcomes (compare Figure 5.1). Thus, we take the average of the four possible components:

$$\Delta^{MD_g} = \frac{1}{4}\left(h_{1121} - \mathbf{h_{1111}} + h_{2221} - h_{2211} + h_{1122} - h_{1112} + \mathbf{h_{2222}} - h_{2212}\right) \quad (5.5)$$

$$\Delta^{MD_e} = \frac{1}{4}\left(h_{2211} - \mathbf{h_{1111}} + h_{2221} - h_{1121} + h_{2212} - h_{1112} + \mathbf{h_{2222}} - h_{1122}\right) \quad (5.6)$$

Accordingly, our approach requires taking the average of eight components to calculate the average 'educational expansion component'$(\Delta^{MD_e^E})$ and the 'education-gender association component' ($\Delta^{MD_e^G}$). This is necessary because all possible differences must be calculated for the educational gradient and the assortative mating patterns of Time 1 and Time 2:

$$\Delta^{MD_e^G} = \frac{1}{8}\left(h_{1211} - \mathbf{h_{1111}} + h_{1221} - h_{1121} + h_{2211} - h_{2111} + h_{2221} - h_{2121} + h_{1212} - h_{1112} + h_{1222} - h_{1122} + h_{2212} - h_{2112} + \mathbf{h_{2222}} - h_{2122}\right) \quad (5.7)$$

$$\Delta^{MD_e^E} = \frac{1}{8}\left(h_{2111} - \mathbf{h_{1111}} + h_{2121} - h_{1121} + h_{2211} - h_{1211} + h_{2221} - h_{1221} + h_{2112} - h_{1112} + h_{2122} - h_{1122} + h_{2212} - h_{1212} + \mathbf{h_{2222}} - h_{1222}\right) \quad (5.8)$$

All four components (assortative mating, the educational gradient in marriage, educational expansion, and the education-gender association) add up to the total changes in marital sorting outcomes (Equation 5.9). In addition, the sum of the educational expansion and the education-gender association components equals the component that represents the 'effect' of women's and men's education (Δ^{MD_e}). The educational gradient in marriage, educational expansion, and the education-gender association sum up to the average marginal distribution 'effect' (Δ^{MD}).

$$\Delta^{T} = \underbrace{\underbrace{\Delta^{MD_e^E} + \Delta^{MD_e^G}}_{=\Delta^{MD_e}} + \Delta^{MD_g}}_{=\Delta^{MD}} + \Delta^{A} \tag{5.9}$$

5.4 Results

We present the results in three steps. First, we show trends in structural opportunities, education-specific sex ratios, and the odds ratios that reflect the association between gender and education. Next, we illustrate changes in marital sorting outcomes over time. In the last step, we present the extent to which the observed trends in marital sorting outcomes are linked to educational expansion and changes in the education-gender association.

5.4.1 Trends in structural opportunities

Figure 5.2 shows trends in women's and men's educational attainment. Although France and the United States display similar trends in educational attainment, the magnitude of change differs between the two countries. In both countries, the percentage of women and men who have attained lower secondary education or less has been declining considerably, while tertiary education has been increasing. The proportion of women and men who completed secondary education increased in the second half of the last century and began to decrease slightly after the turn of the millennium. The drop in individuals who attained lower secondary education and the surge in those with tertiary education have been more pronounced in France. The rise in secondary education in the second half of the last century was more substantial in France, yet the overall levels of secondary education remain higher in the United States than in France.

The sharp decline in the lowest educational category suggests a decrease in the percentage of unions involving low-educated wives and husbands. Meanwhile, the rise in the highest educational category indicates an increase in marriages that involve highly educated women and men. Moreover, the variability in educational levels appears to have increased in France during the second half of the last century. However, despite the significant rise in tertiary education in both countries, which could have reduced disparities in educational levels after the turn of the millennium, a substantial variation in educational levels persisted at the end of the observation period, as upper secondary education remains a common outcome. This suggests that the expansion of higher education might not have been strong enough yet to result in a U-shaped trend in overall homogamy rates.

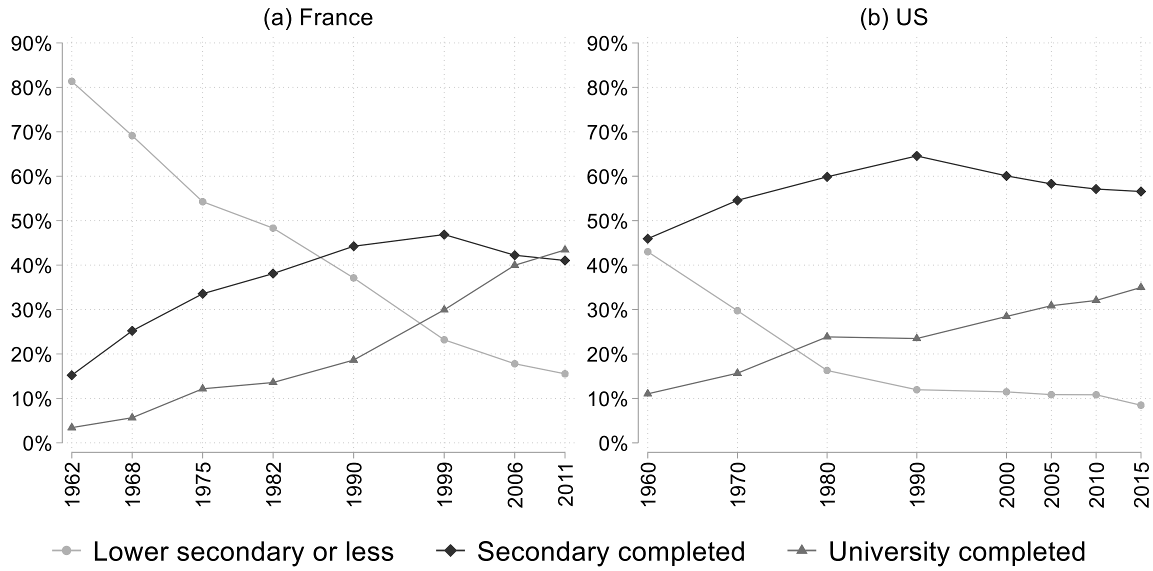

Fig. 5.2 Trends in women's and men's education

Notes: Data are weighted.

Figure 5.3 illustrates trends in education-specific sex ratios, which reflect absolute gender gaps in education. A sex ratio above 1 implies that there are more women than men at a certain educational level. A ratio below 1 indicates a surplus of men in a specific educational group. The most pronounced shift in sex ratios was observed among tertiary educated individuals, where the proportion of women has been expanding rapidly. As a result, the sex ratio in tertiary education reversed in both countries.

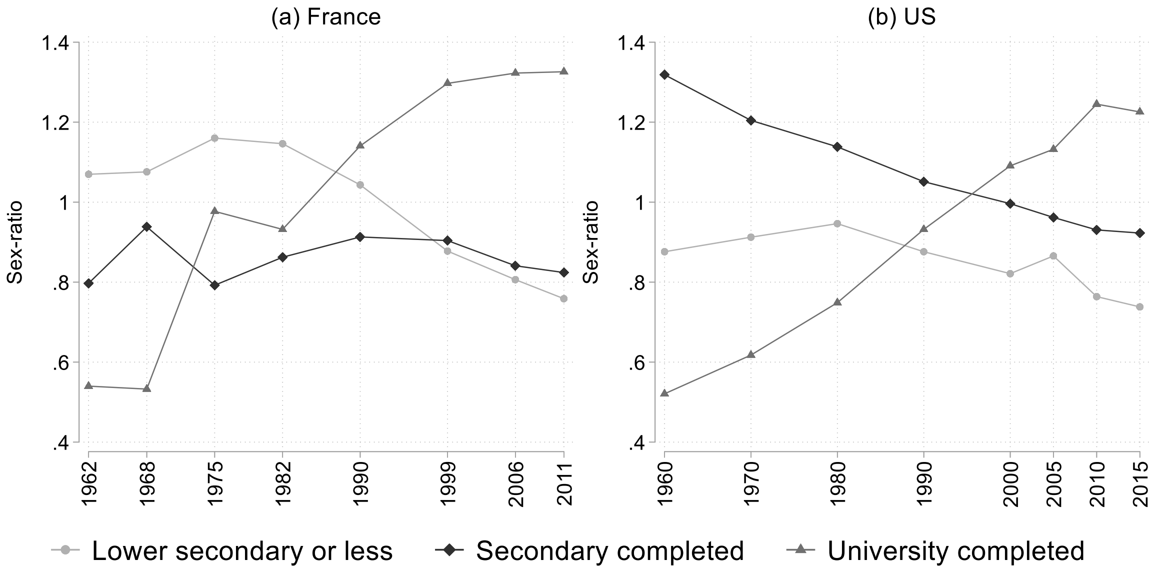

Fig. 5.3 Trends in absolute gender gaps in education (education-specific sex-ratios (women/men))

Notes: Data are weighted.

Trends in education-specific sex ratios could be a result of a gender-neutral expansion in higher education or changes in the education-gender association. Figure 5.4 visualizes these changes in the association between education and gender. The dark gray line illustrates the logarithm of the ratio of the odds that a medium-educated person is a woman to the odds that a low-educated person is a woman. The light gray line represents the logarithm of the ratio of the odds that a highly educated person is a woman to the odds that a low-educated person is a woman. The latter has been rising steeply and shifted from negative to positive. This change may have contributed to an increase in hypogamy and a decrease in hypergamy rates.

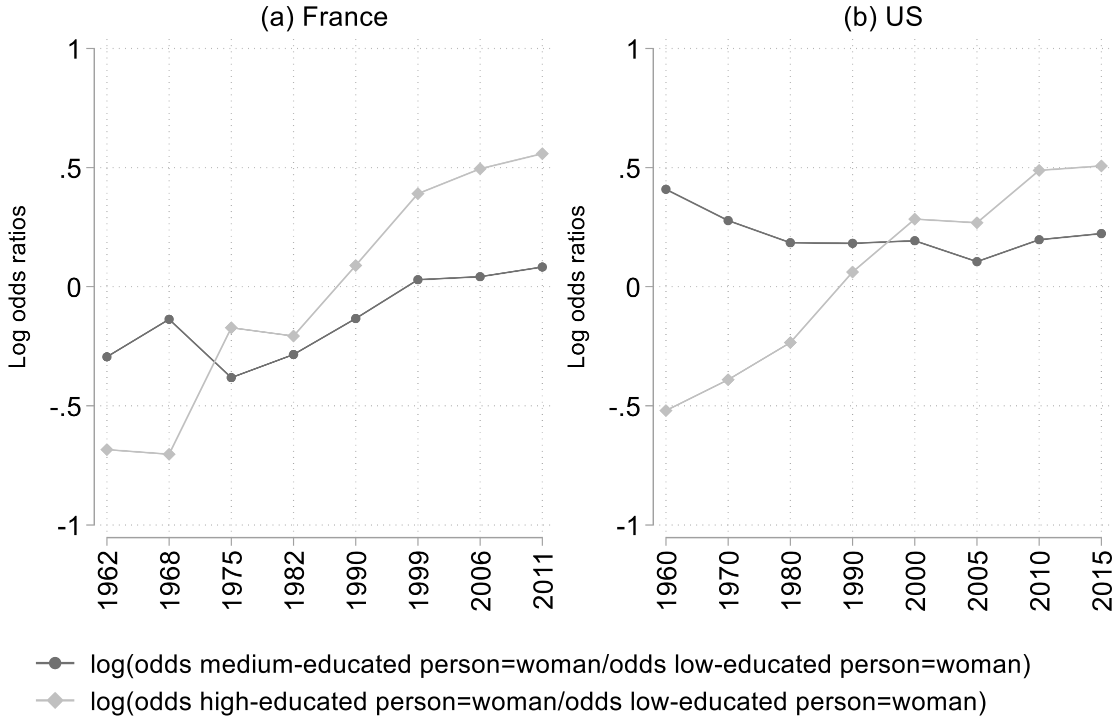

Fig. 5.4 Trends in the association between gender and education

Notes: Data are weighted.

This paper aims to enhance our understanding of the role that educational expansion and changes in the education-gender association play in trends in marital sorting outcomes. However, as discussed earlier, trends in assortative mating and the educational gradient in marriage may also explain changes in marital sorting outcomes. Therefore, Figure A5.1 in the Appendix displays trends in assortative mating. We used log odds ratios to measure 'over-selection' and 'under-selection' in marital sorting outcomes. Overall, assortative mating has changed only moderately. Figures A5.2 and A5.3 depict trends in the educational gradient in marriage by showing the percentage of married women and men by educational level. In France, in the 1960s, marriage rates for highly educated women were substantially lower than for medium and low-educated women. Throughout the observation period, marriage rates among women of different educational levels have been converging. For women in the United States and men in France and the United States, marriage rates have declined across all educational groups. In the United States this decline has been more pronounced among the less educated groups.

5.4.2 Trends in marital sorting outcomes

Figure 5.5 shows marital sorting outcomes by year and country. The sum of the stacked bars represents the percentage of homogamy, hypogamy, and hypergamy in unions of women aged 25 to 34 years. The different gray tones reflect the percentage of marital sorting outcomes by the educational level of women and their partners. For example, in panel (a), the light gray bars demonstrate that in France, the proportion of wives who attained lower secondary education or less and are married to an equally educated man, has declined profoundly from more than 70% in 1962 to less than 10% in the 2000s.

Aggregated trends in women's homogamy, hypogamy and hypergamy rates differ substantially between France and the United States. In France, homogamy declined from 78.1% in 1962 to 57.5% in 1990. Subsequently, homogamy rates experienced a slight increase, reaching 60.3% in 2011. In the United States, homogamy grew from 62.5% in 1960 to 70.7% in 2000 and has stabilized since then. In France, hypogamy has been steadily rising over the last 50 years. In the United States, hypogamy rates declined until the 1980s, followed by growth until 2015. Hypergamy increased in France and the United States until the 1970s, followed by considerable declines.

Despite substantial differences in aggregated trends in marital sorting outcomes, there are notable similarities in disaggregated marital sorting outcomes. For example, both countries have witnessed a decline in the percentage of women in low-educated homogamous unions, while the proportion of secondary and tertiary-educated homogamous unions has increased. However, the decrease in homogamy between low-educated men and women has been considerably more pronounced in France. As a result, aggregate homogamy rates declined in France and rose in the United States until the 1990s.

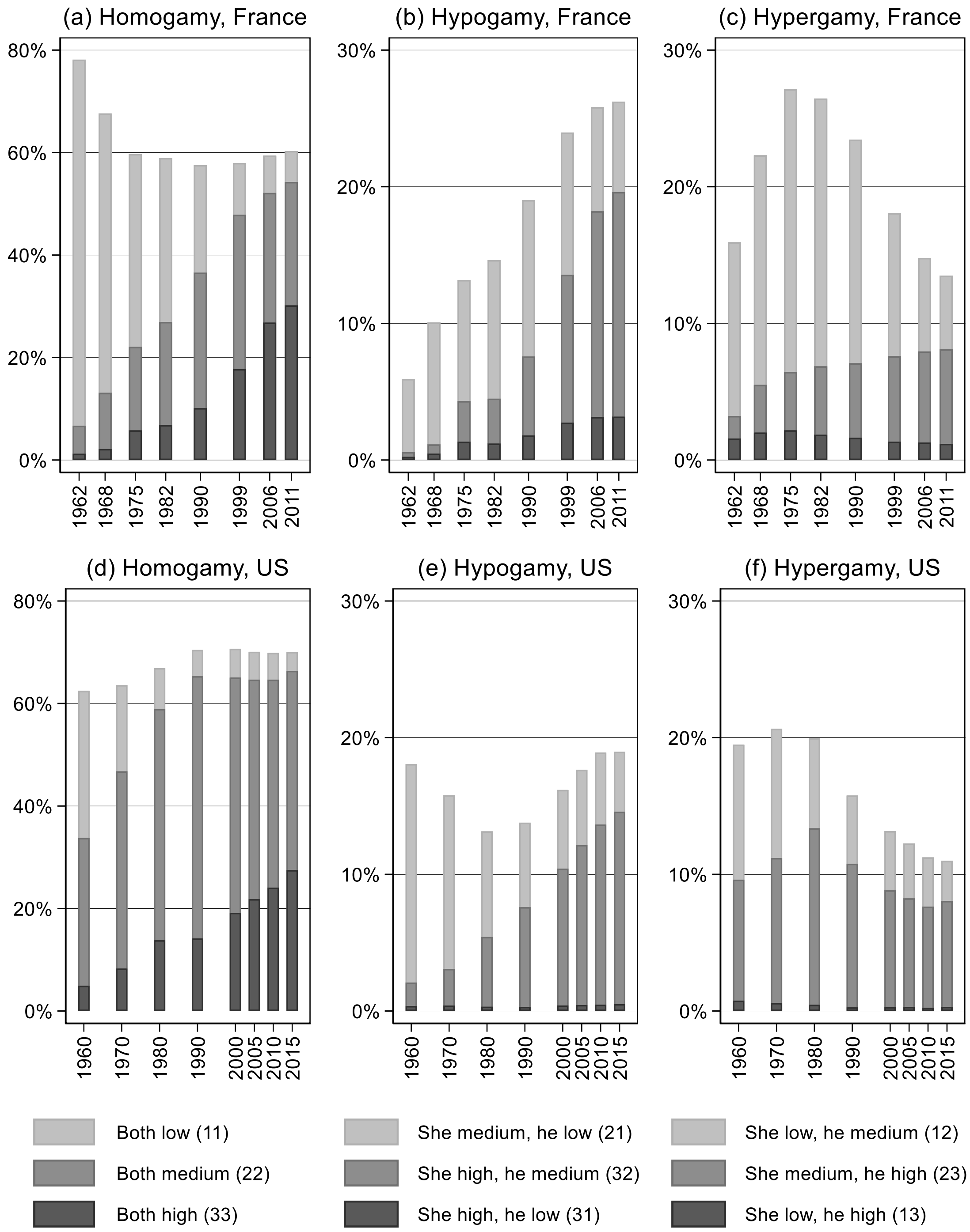

Fig. 5.5 Trends in marital sorting outcomes

Notes: The numbers in brackets stand for the following educational levels: 1 – lower secondary education or less, 2 – complete secondary education, 3 – complete university education. The first number stands for women's educational attainment. The second number indicates men's educational attainment. Data are weighted.

5.4.3 Decomposition

Figures 5.6 to 5.8 show the decomposition results. The exact results and standard errors can be found in Tables A5.1 to A5.6 in the Appendix. The standard errors were estimated using bootstrapping. Most of the 'educational expansion' and 'education-gender association' parameters are significant at a .001 level.[37] The white bars represent the extent to which marital sorting outcomes can be attributed to educational expansion. The light gray bars illustrate the role of the education-gender association in trends in marital sorting outcomes. The dark gray bars indicate the assortative mating component, while the black bars reflect the relationship between changes in the educational gradient in marriage and trends in marital sorting outcomes. Assortative mating and the educational gradient in marriage both contributed to trends in marital sorting outcomes. However, the role of educational expansion and the education-gender association is more considerable. Since our primary focus is to understand the influence of educational expansion and the gender gap in education on marital sorting, we will not provide a detailed interpretation of the assortative mating and marriage gradient components.

Homogamy. Figure 5.6 shows that educational expansion in France and the United States is associated with a decrease in the proportion of low-educated wives married to low-educated husbands and an increase in the percentages of secondary and tertiary-educated wives married to men with the same educational level. However, in both countries, the educational expansion component began to gradually decline for secondary educated wives in homogamous unions around the turn of the millennium.

[37] The following 'educational expansion' and 'education-gender association' parameter have p-values above 0.05: Educational expansion parameter: United States - difference between 1960 and 1970 in the "13" outcome. Education-gender association: France - difference between 1962 and 1968 in the "13" outcome. France - difference between 1962 and 1975 in the "21" outcome. France - difference between 1962 and 1968 in the "31" outcome. France - difference between 1962 and 2010 in the "21" outcome. France - difference between 1962 and 2015 in the "21" outcome.

In France, the part of the overall homogamy change, attributable to educational expansion, markedly declined between 1962 and 1990, followed by a moderate increase afterwards. This evidence supports the U-shape hypothesis in France. However, in the United States, the decline in the percentage of wives in low-educated homogamous unions due to educational expansion outweighs the effect of educational expansion on the rise in homogamy among highly educated wives entirely.

In both countries, the reversal of the association between education and gender slightly contributed to increasing homogamy across all educational levels. However, after the turn of the millennium, the ‘education-gender association effect’ stalled in the United States and declined slightly in France. Although the effect is small, it aligns with the expected consequences of the reversal of the gender gap in education. As the education levels of women and men became more alike, homogamy became more prevalent, and the development of women’s educational advantage has been linked to a stalling or reversing trend in homogamy.

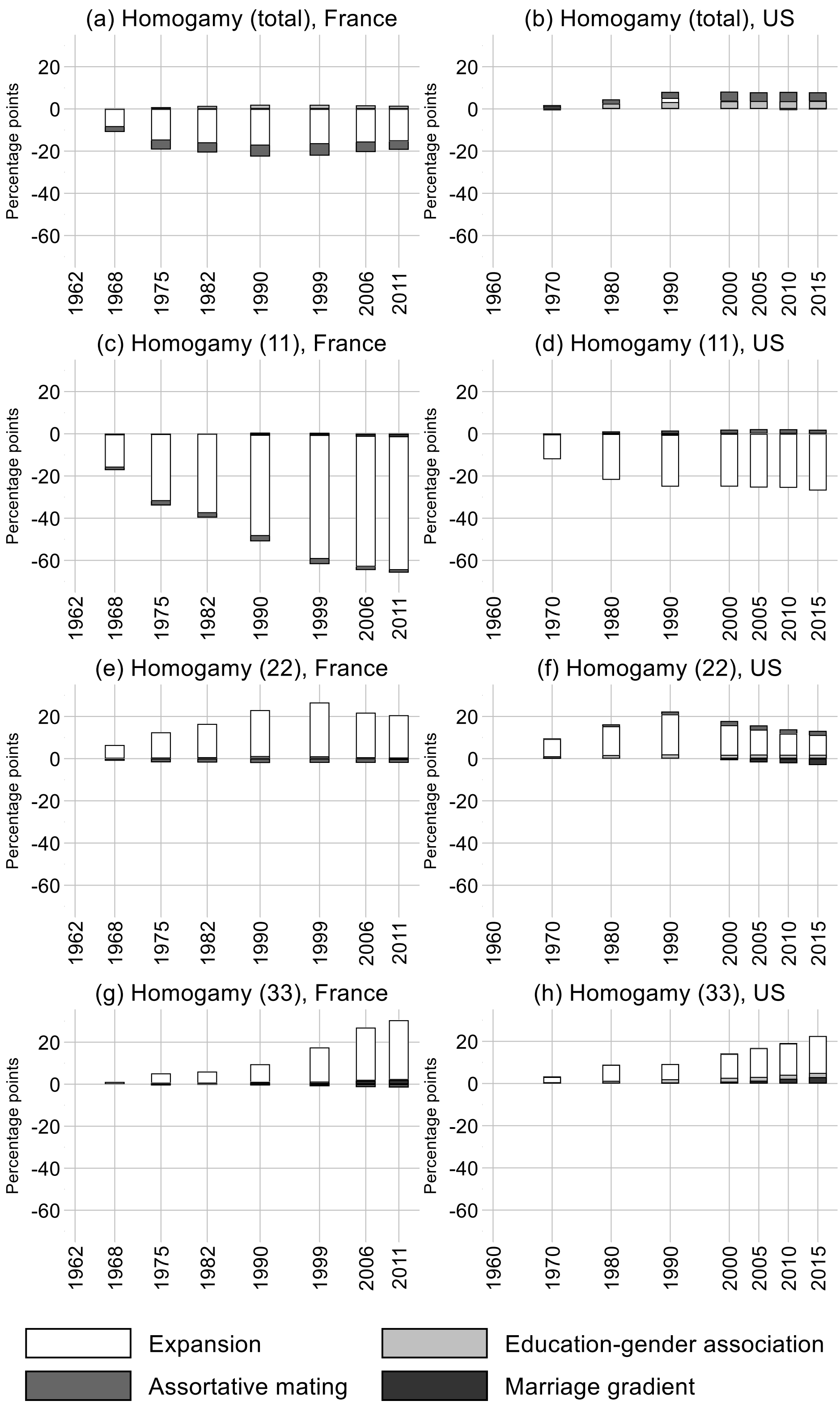

Fig. 5.6 Decomposition of trends in homogamy outcomes

Notes: The numbers in brackets stand for the following educational levels: 1 – lower secondary education or less, 2 – complete secondary education, 3 – complete university education. The first number stands for women's educational attainment. The second number indicates men's educational attainment. Data are weighted.

Hypogamy. Figure 5.7 displays the decomposition results for trends in hypogamy (she is more educated than he). In both countries, educational expansion and the changing gender imbalance in education accounted for a substantial increase in unions between tertiary-educated women and secondary-educated men (32). Changes in the share of unions between tertiary-educated women and lower secondary of less educated men (31) are negligible. However, the relationship between educational expansion and the proportion of unions between women with complete secondary education and lower secondary or less educated men (21) differs in France and the United States. In the United States, educational expansion contributed to a considerable decline in this type of union, while changes in France were small. These differences in the relationship between educational expansion and the percentage of secondary educated wives partnered with less educated men (21) explain why educational expansion is associated with rising hypogamy in France but declining hypogamy in the United States. This leads to the overall finding that, in France, educational expansion and changes in the gender imbalance in education contributed to the rise in hypogamy. In the United States, these two trends act as opposing forces. The proportion of hypogamous unions would have declined if only the overall educational attainment had changed, while we would have seen an increase in hypogamy if only the gender imbalance in education had changed.

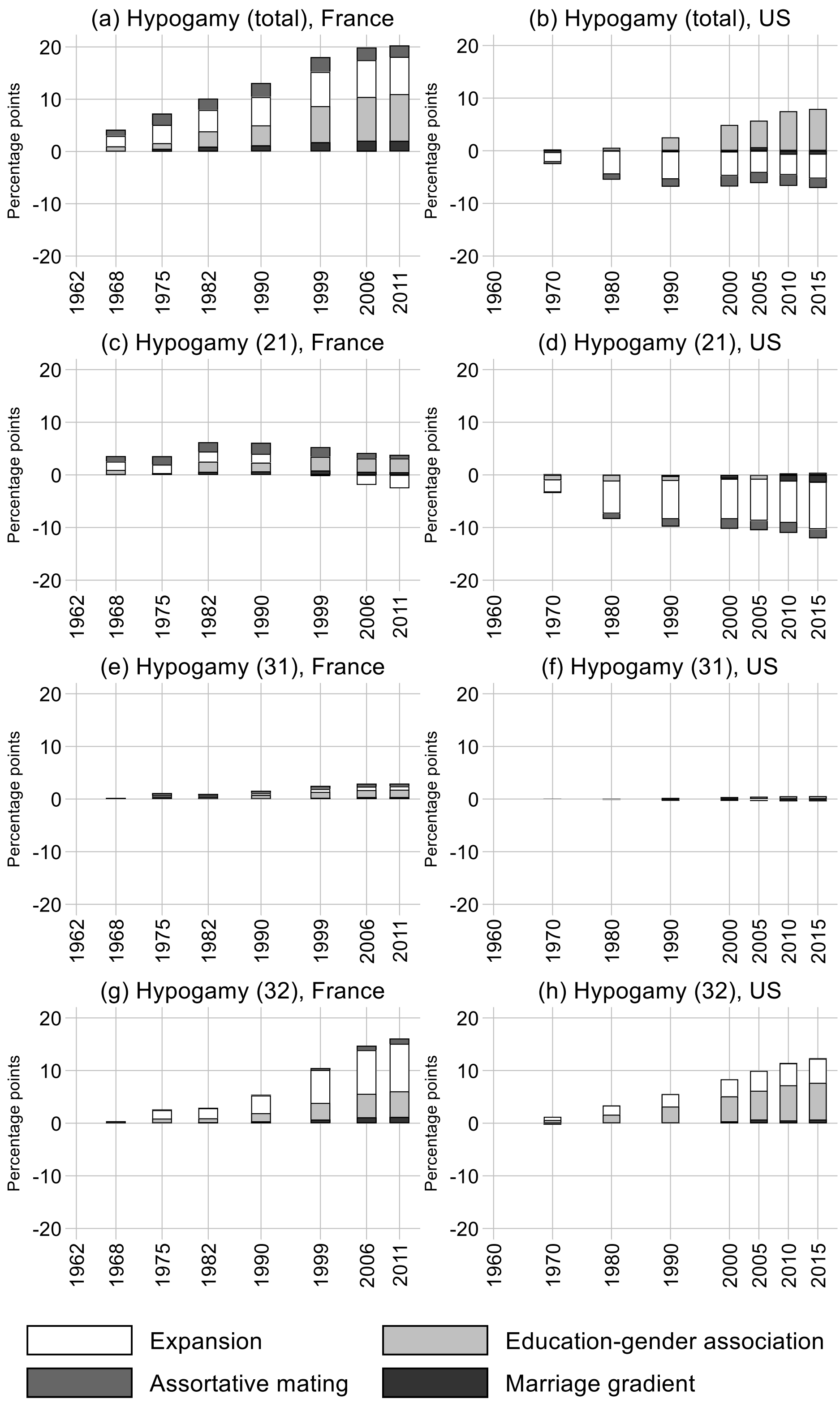

Fig. 5.7 Decomposition of trends in hypogamy outcomes (she is more educated than he)

Notes: The numbers in brackets stand for the following educational levels: 1 – lower secondary education or less, 2 – complete secondary education, 3 – complete university education. The first number stands for women's educational attainment. The second number indicates men's educational attainment. Data are weighted.

Hypergamy. Figure 5.8 presents the decomposition results for trends in hypergamy (she is less educated than he). France and the United States display similarities in the drivers of trends in the percentage of wives with secondary education who are in a union with a more educated man (23). In both countries, the proportion of these unions would have declined if only the education-gender association had changed, while it would have increased if only the overall educational attainment had varied over time. However, the roles of educational expansion and changing gender imbalances in hypergamy trends among less educated women and men (12) differ between the two countries. In France, trends in the percentage of these unions would have followed an inverted U-shape pattern if only the overall educational attainment had changed and would have decreased if only the gender imbalance in education had shifted. In the United States, unions between low-educated women and medium-educated men would have declined if only the overall educational attainment had changed, and these trends are scarcely affected by changes in the gender imbalance in education. The percentage of unions between low-educated women and tertiary-educated men (13) has remained virtually unchanged. Taken together, the influences of educational expansion and the education-gender association on trends in overall hypergamy rates partially counterbalance each other. Educational expansion is associated with rising hypergamy rates, while changes in the gender gap in education are linked to declining hypergamy rates.

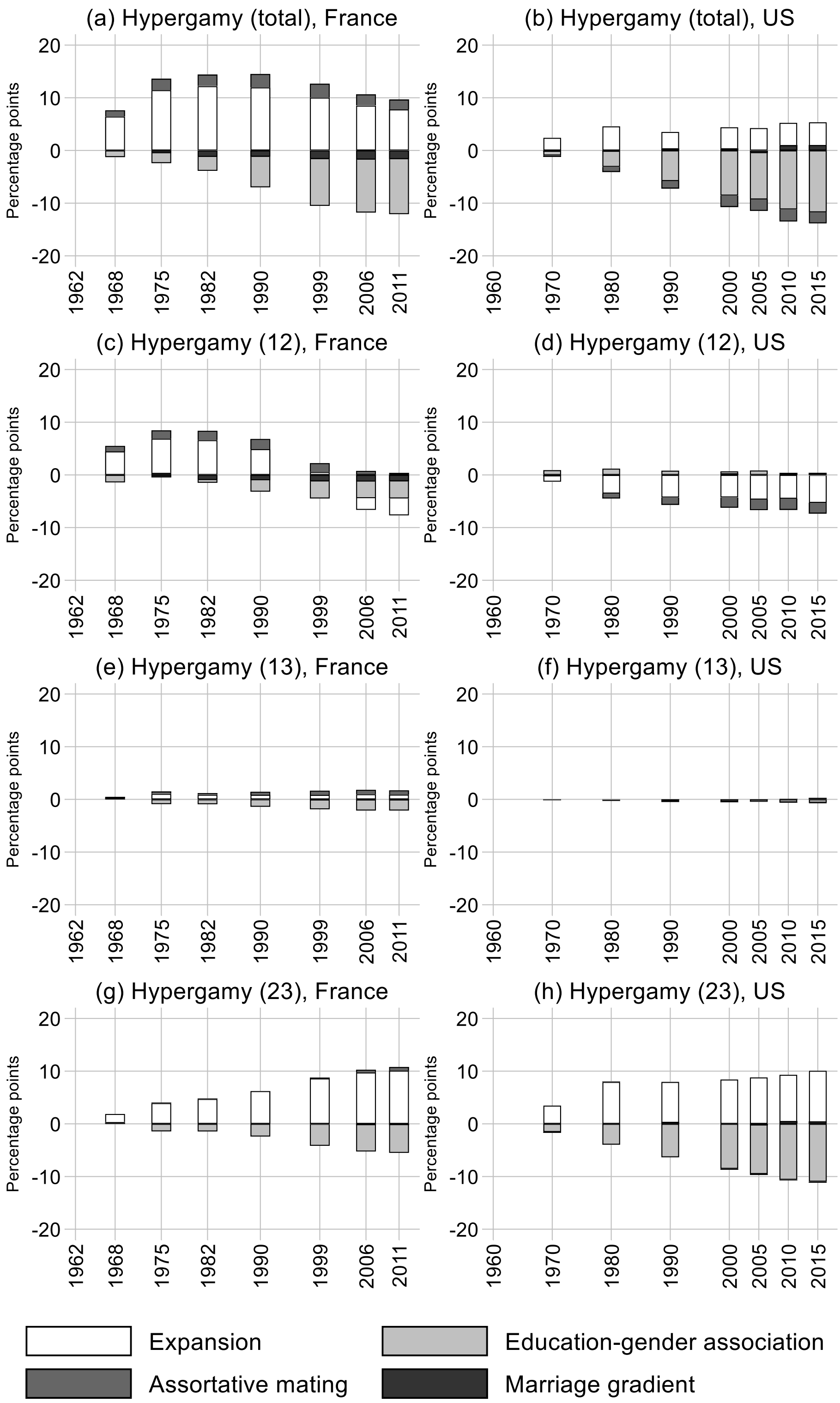

Fig. 5.8 Decomposition of trends in hypergamy outcomes (she is less educated than he)

Notes: The numbers in brackets stand for the following educational levels: 1 – lower secondary education or less, 2 – complete secondary education, 3 – complete university education. The first number stands for women's educational attainment. The second number indicates men's educational attainment. Data are weighted.

Assortative mating and the educational gradient in marriage. In the previous figures, the dark gray and black bars indicate the association between assortative mating, the educational gradient in marriage and trends in marital sorting outcomes. This demonstrates that trends in marital sorting are not solely the consequence of changes in women's and men's educational attainment. For example, trends in assortative mating tend to be linked to declining homogamy in France but rising homogamy in the United States. Furthermore, in France, we observe trends in the educational gradient in marriage to be associated with rising hypogamy and declining hypergamy. Although trends in assortative mating and the educational gradient in marriage contribute less to trends in marital sorting outcomes than changing structural opportunities, their role should not be underestimated. For example, in France, trends in assortative mating account for 5.5 percentage points of the decline in the overall homogamy rate from 1962 to 1999.

In summary, the decomposition of *disaggregated* trends in marital sorting outcomes shows that the relationships between educational expansion, changes in the education-gender association and marital sorting outcomes generally align with the theoretical expectations. Educational expansion contributed to a decline in low-educated and an increase in more educated homogamous unions. Furthermore, changes in the association between education and gender have been associated with rising hypogamy and declining hypergamy rates. However, we find that the extent to which disaggregated trends in marital sorting outcomes can be attributed to educational expansion and the education-gender association differs considerably between France and the United States, leading to differences in the relationship between changing structural opportunities and aggregated trends in homogamy, hypogamy, and hypergamy. Moreover, our results suggest that educational expansion, and the resulting shift in structural opportunities on the partner market, can affect hypogamy and hypergamy rates, even if the association between gender and education had remained unchanged.

5.4.4 Sensitivity analyses

Changes in the timing of union formation may have influenced the educational composition of 25 to 34-year-old women and their partners. For instance, if highly educated women increasingly postpone union formation beyond the age of 34, they might be underrepresented in the more recent samples of our analysis. This trend could impact the findings of this study, as an underrepresentation of highly educated women implies an underrepresentation of women who cannot marry up in education.

As numerous studies have shown that union formation and marriage increasingly occur later in life (Billari & Liefbroer, 2010; Buchmann & Kriesi, 2011) we tested the sensitivity of our results by replicating the analyses with a sample of 35 to 44-year-old women. The results, presented in Tables 5.7 to 5.12 in the Appendix, demonstrate that the conclusions drawn from analyzing a sample of 25 to 34-year-old women remain consistent when analyzing a sample of women aged 34 to 44.

5.5 Discussion

Over the last 50 years, the educational attainment of women and men on the partner market has been changing profoundly – not only has the educational attainment of available candidates increased, but the association between gender and education has also changed. However, previous research contributed little to disentangling the influences of these two forces on trends in marital sorting outcomes. In this article, we applied counterfactual decompositions to investigate the roles of educational expansion and changes in the education-gender association in shaping trends in aggregated and disaggregated marital sorting outcomes in France and the United States over a period spanning from the 1960s to the 2010s.

In line with the theoretical expectations, we find that educational expansion has contributed to a decline in the fraction of less educated women in homogamous unions and increased homogamy among more educated women. However, the association between educational expansion and the overall trends in homogamy rates differs between France and the United States. This divergence occurs because, in the second half of the last century in France, declining rates of less educated wives married to less educated husbands outweighed the rise in the number of women in more educated homogamous unions. In contrast, in the United States, these two trends balance each other out. Furthermore, as anticipated, changes in the education-gender association have been linked with rising hypogamy and declining hypergamy rates. We also found that educational expansion has contributed to these trends in hypogamy and hypergamy. If only the overall educational attainment had changed, we would observe declining rates of hypergamy and an increase in hypogamy in France. In the United States, we would see shrinking rates of hypogamy.

Nonetheless, the drivers of trends in marital sorting outcomes differ considerably between France and the United States. Notably, the expansion of education resulted in a U-shaped pattern in homogamy trends in France, while no association between educational expansion and homogamy trends was observed in the United States. Also, the impact of educational expansion on overall hypogamy trends differs in the United States and France. In France, educational expansion contributed to the rise in hypogamy, whereas in the United States, the expansion of higher education, without changes in other components, would have led to a decline in hypogamy.

Detailed analyses that dissect these trends based on women's and men's education levels suggest that the influence of educational expansion on marital sorting depends considerably on (a) the country-specific patterns of educational expansion and (b) the marital sorting outcomes in the given reference year. For instance, the pronounced decline in low-educated young men and women in France, compared to the United States, has resulted in more substantial decreases in low-educated homogamous couples in France. Consequently, the overall impact of educational expansion on homogamy differs considerably between the two contexts. Furthermore, the prevalence of hypogamy in France and the United States varies considerably in the reference category. In the early 1960s in France, less than 10% of young women were more educated than their partners. Conversely, in the United States, unions between medium-educated women and low-educated men were much more common than in France. As higher education expanded, the percentage of these low-educated hypogamous couples decreased, resulting in an overall negative effect of educational expansion on hypogamy in the United States.

We draw two main conclusions from our results. First, previous research suggests that the reversal of the gender gap in education is a driving force behind trends in hypogamy and hypergamy outcomes (Corti & Scherer, 2021; De Hauw et al., 2017; Esteve et al., 2016). However, our findings imply that hypogamy and hypergamy rates would also have changed even if the expansion in higher education had been gender-neutral. Second, our results underscore the importance of investigating disaggregated trends in marital sorting outcomes. We hypothesized that educational expansion would lead to a U-shaped trend in homogamy rates. However, we did not observe this pattern in the United States, as the decline in low-educated homogamous unions and the increase in highly educated homogamous unions counterbalanced each other entirely. In conclusion, our research challenges the notion that the gender gap in education is the sole driver of hypogamy and hypergamy trends and emphasizes the need for analyzing disaggregated marital sorting outcomes to comprehend the impact of changing structural opportunities on educational sorting outcomes.

Several approaches could be adopted in future research to deepen our understanding of how changing structural opportunities influence trends in marital sorting outcomes. Researchers should aim to investigate and compare the influences of changes in the education-gender association and absolute gender gaps in education on marital sorting outcomes. Even though trends in absolute gender gaps in education might arise from educational expansion, it is important to understand how they affect marital sorting outcomes, as they reflect structural opportunities on the partner market.

Moreover, future research may explore different counterfactual scenarios when studying trends in educational sorting outcomes, for instance, by choosing different baseline categories. This would be important in advancing our understanding of trends in marital sorting outcomes, as the effects of changes in structural opportunities depend on the baseline category. For example, the impact of educational expansion may vary between low-educated and highly educated contexts. Therefore, researchers might pose questions such as, ‘What trends in educational outcomes would have occurred if France had experienced the educational expansion of the United States?’.

Moreover, we believe it is crucial to enhance our understanding of how marital sorting outcomes impact social inequalities because the rise in university enrollment rates implies a likely continuation of observed trends in marital sorting (Roser & Ortiz-Ospina, 2013). Therefore, research may advance existing efforts to understand the relationship between women’s and men’s socioeconomic resources and social inequalities, such as socioeconomic (Boertien & Permanyer, 2019a; Corti & Scherer, 2022) or health inequalities (Potarca & Rossier, 2021; Rauscher, 2020).

Some limitations of this research need to be acknowledged. First, the decomposition assumes that the analyzed components have changed independently, although they might influence one another. For instance, changes in the educational gradient in marriage could be shaped by variations in the availability of preferred candidates and by changing partner preferences. Moreover, education-specific changes in the timing of union formation may have affected trends in educational sorting outcomes in our sample of 25-34-year-old partnered women. For example, if highly educated women increasingly postpone union formation beyond age 34, unions involving highly educated women would be increasingly underrepresented in our sample. Furthermore, union dissolution and repartnering may have affected the findings. To limit the influence of these mechanisms, we chose a sample of young women. However, with the available data, it was not possible to distinguish, for example, between first and higher order unions. Future research should build upon prior work (C. R. Schwartz, 2010) by investigating how selection into and out of unions affected assortative mating and marital sorting outcomes in the overall stock of unions. Additionally, due to the relatively broad categorization of educational attainment levels, some trends in marital sorting may remain obscured. For instance, marital sorting patterns may differ among different levels of tertiary education. However, despite these limitations, this study contributes to understanding trends in marital sorting outcomes by analytically distinguishing the structural drivers that have shaped half a century of trends in marital sorting outcomes.

6 Discussion

6.1 Summary

'Why do marital sorting outcomes differ over time and across countries?'. This thesis addressed this question by studying the roles of assortative mating (non-random matching) and structural opportunities (educational composition of partner markets) in shaping variations in marital sorting outcomes (the joint distribution of wives' and husbands' education). In addition, it examined how shifts in education-specific selection into marriages have influenced trends in marital sorting outcomes.

Chapter 2 introduced a methodological innovation that allows decomposing differences in cell frequencies between two contingency tables into differences in their odds ratios and marginal distributions. This approach allows attributing differences in marital sorting outcomes to differences in assortative mating and the educational distributions of husbands and wives, which researchers used to measure structural opportunities (e.g., Katrňák & Manea, 2020; Permanyer et al., 2019).

Chapter 3 utilized this decomposition approach to study the impact of changing structural opportunities and assortative mating patterns on trends in marital sorting outcomes in Ireland from 1991 to 2016. Additionally, I refined the method from Chapter 2 to assess the influence of changes in the educational gradient in union formation on marital sorting outcomes. The findings showed that changes in the educational attainment of potential partners on the market were the primary driver behind the rise in homogamy and hypogamy, and the decline in hypergamy. Assortative mating played a minor role, while changes in the educational gradient in union formation slightly influenced the increase in homogamy and the decrease in hypergamy.

Chapter 4 studied within-country trends and between-country differences in marital sorting outcomes. In this chapter, I analyzed the influence of trends and cross-country differences in assortative mating and structural opportunities on marital sorting outcomes in Sweden, the Czech Republic, and Italy from 2000 to 2020. The findings revealed stable or rising rates of homogamy and hypogamy, along with declining rates of hypergamy. The extent to which these trends were attributable to assortative mating and structural opportunities varied across these countries. Furthermore, I found variations in assortative mating to be the primary driver of cross-country differences in marital sorting outcomes, which suggests considerable cross-country differences in partner choice and matching mechanisms.

Chapter 5 investigated the underlying mechanisms that may explain the relationship between changing structural opportunities and trends in marital sorting outcomes. Therefore, I refined the method introduced in Chapter 2 to separate the influence of changes in the gender-education association and educational expansion on marital sorting outcomes. I employed this approach to study trends in marital sorting outcomes in the United States and France from the 1960s to the 2010s. The results indicated that trends in homogamy are primarily linked to educational expansion, while educational expansion and changes in the gender-education association both affected hypogamy and hypergamy trends.

In conclusion, this thesis introduced a novel methodology to study trends and differences in marital sorting outcomes. I applied this methodology to investigate the contributions of trends and differences in assortative mating, structural opportunities, and the educational gradient in union formation to variations in marital sorting outcomes.

6.2 Contribution

6.2.1 Methodological contribution

This thesis introduced a novel technique to decompose differences between contingency tables. Before this development, researchers analyzing marital sorting outcomes were restricted to describing the joint distribution of husbands' and wives' education. In practice, log-linear models predominated marital sorting research. However, these models are unsuitable for examining marital sorting outcomes, as they were designed to study association patterns in contingency tables independent of their marginal distributions. The empirical literature also reflects this methodological gap. Empirical research focused on the non-randomness of marital sorting outcomes and lost sight of the actual outcomes of the marital sorting process (Kalmijn, 1991b; C. R. Schwartz, 2013; C. R. Schwartz & Mare, 2005). This thesis addressed this methodological gap with the methodology introduced in Chapter 2 and its subsequent advancements in Chapters 3 and 5.

6.2.2 Empirical contribution

Structural opportunities. This thesis made several contributions to understanding the relationship between structural opportunities and marital sorting outcomes. First, all empirical chapters in this thesis contributed to a recent body of research that examined the influence of changing structural opportunities on trends in marital sorting outcomes (Katrňák & Manea, 2020; Permanyer et al., 2019). My findings resonate with this research, underscoring the impact of changing structural opportunities on trends in marital sorting outcomes. Furthermore, this thesis advanced prior studies by quantifying the influence of structural opportunities on marital sorting trends, covering longer periods, and employing more detailed educational levels than earlier studies.

Second, Chapter 5 contributed to the debate about the distinct impact of educational expansion and the shifting gender imbalance in education on trends in marital sorting outcomes (Permanyer et al., 2019; Van Bavel, 2012). While previous research suggested that the rise in college versus no-college homogamy primarily resulted from educational expansion, rather than shifts in the gender gap in higher education or assortative mating (Permanyer et al., 2019), this thesis offered more nuanced findings. My findings illustrated that educational expansion contributed to a decline in less educated homogamous unions and an increase in more educated homogamous unions. However, which of these trends predominated depends on the specific educational attainment levels during the analyzed periods. For example, it is likely that in an already highly educated context the rise in highly educated homogamous couples predominates. Moreover, in line with Permanyer et al. (2019), this thesis indicated that changes in the gender imbalance in education had only a minimal influence on homogamy trends. Chapter 5 also presented the first study examining the distinct impact of changes in the gender imbalance in education on trends in hypogamy and hypergamy. The results are consistent with previous literature, which expected the reversal of the gender imbalance in education to favor hypogamy and disfavor hypergamy (De Hauw et al., 2017; Esteve et al., 2016; Van Bavel, 2012). However, my findings also showed that educational expansion has influenced changes in hypogamy and hypergamy. Therefore, the relationship between the gender imbalance in education and marital sorting outcomes, as depicted in earlier research, could have been misleading because these studies typically did not account for educational expansion (Corti & Scherer, 2021; De Hauw et al., 2017; Esteve et al., 2016).

Third, Chapter 4 provided novel insights into the role of cross-country differences in structural opportunities in shaping marital sorting outcomes. The findings suggested that cross-country differences in partner market compositions had only a moderate impact on marital sorting outcomes. This indicates that the countries under investigation (Sweden, the Czech Republic, and Italy) offer similar structural opportunities for homogamous, hypogamous, and hypergamous matches despite differences in educational compositions on the partner market.

Taken together, this thesis reaffirmed previous research in finding a considerable impact of changing structural opportunities on trends in marital sorting outcomes. Moreover, it presented novel findings about the structural causes of this relationship as well as the role of structural opportunities in explaining variations in marital sorting outcomes across countries.

Assortative mating. This thesis helped to contextualize previous assortative mating research. First, prior research found that assortative mating has changed over time (Halpin & Chan, 2003; Mare, 1991; C. R. Schwartz & Mare, 2005). This thesis indicated that, in most investigated countries, changes in assortative mating had only a moderate influence on trends in marital sorting outcomes.[38] Thus, scholars might have overestimated the implications of changes in assortative mating. For example, researchers hypothesized that social changes (e.g., modernization or changes in gender inequalities and economic inequalities) may have altered partner choice and matching mechanisms (Blossfeld, 2009; C. R. Schwartz, 2013). However, Chapter 5 showed that over half a century, trends in assortative mating had only moderately influenced marital sorting outcomes. Thus, changes in partner choice and matching mechanisms might have not been strong enough to substantially alter 'who marries whom'. Furthermore, scholars discussed the consequences of assortative mating for social stratification outcomes, such as earnings inequality or intergenerational mobility (Blossfeld & Timm, 2003; Breen & Salazar, 2011;

[38] Nonetheless, changes in assortative mating contributed considerably to a rise in homogamy in Sweden and Italy. The findings are more consistent for trends in hypogamy and hypergamy.

C. R. Schwartz, 2013; C. R. Schwartz & Mare, 2005). This thesis suggested that in most countries, trends in assortative mating might not have been strong enough to change social stratification outcomes because their impact on marital sorting outcomes was limited.

Second, this thesis has implications for research on cross-country differences in assortative mating. Chapter 4 led to the novel finding that differences in marital sorting outcomes across countries were primarily driven by differences in assortative mating rather than structural opportunities. This result suggests that countries differ considerably in partner choice and matching mechanisms, underscoring the importance of studying cross-country differences in assortative mating (Domański & Przybysz, 2007; Smits, 2003; Smits et al., 1998b).

In summary, prior research showed that assortative mating varied within and between countries. This thesis added to this literature by finding that these between-country variations significantly shaped marital sorting outcomes, while trends in assortative mating had a lesser impact on trends in marital sorting outcomes.

Selection into unions. Chapters 3 and 5 have implications for marital sorting research, as they indicate that a small yet notable part of trends in marital sorting outcomes was driven by changes in the educational gradient in union formation. Previous studies typically omitted unpartnered women and men when analyzing trends in assortative mating and marital sorting outcomes (Mare, 1991; Permanyer et al., 2019; C. R. Schwartz & Mare, 2005). This thesis indicated that the results of these studies can be biased because the educational gradient in union formation had been changing over time.

In conclusion, this thesis provided methodological and empirical contributions to the literature on marital sorting. It introduced a decomposition technique for analyzing variations in marital sorting outcomes, shed light on the relative impact of assortative mating and structural opportunities on these outcomes, and enhanced our understanding of the relationship between women's and men's educational expansion, selection into unions, and marital sorting outcomes.

6.3 Limitations

This section outlines the limitations of the thesis. First, the empirical analyses are based on the assumption that the potential drivers of trends and differences in marital sorting outcomes are independent of each other. However, there can be endogeneity in these components. For instance, individuals might pursue higher education to increase their chances of having a highly educated partner, potentially altering assortative mating and structural opportunities.[39] This limitation is shared by other decomposition approaches in this field and log-linear models (e.g., Mare, 1991; Permanyer et al., 2019; C. R. Schwartz & Mare, 2005). Despite this limitation, this thesis improved our understanding of trends and differences in marital sorting outcomes by disentangling their drivers analytically.

Second, this thesis had to balance the measurement precision of structural opportunities and marital sorting outcomes. Chapter 4 studied all marriages that were contracted in a given period. This provides the analysis with precise incidence measures of marital sorting outcomes that are independent of processes that may happen during the marriage, such as assortative union dissolution. However, this chapter employed less precise measures of structural opportunities that did not include unmarried individuals, although they might have been available on the partner market. In contrast, Chapters 3 and 5 used more precise measures of structural opportunities, including unpartnered women and men. However, these chapters utilized less precise prevalence measures of marital sorting outcomes. These prevalence measures could also reflect, for example, the timing of union formation or assortative union dissolution. Ultimately, in this thesis, but

[39] Particularly, the educational gradient in union formation can be influenced by structural opportunities. Raymo and Iwasawa (2005) found that, in Japan, the decline in marriage rates among highly educated women is associated with the shortage of highly educated men on the partner market.

also in assortative mating research employing log-linear models, there is a trade-off between using more precise measures of marital sorting outcomes or structural opportunities.

Third, like most assortative mating research (e.g., Halpin & Chan, 2003; Mare, 1991; C. R. Schwartz & Mare, 2005), this thesis was limited to studying marital sorting by only one trait. However, education may correlate with other observed and unobserved traits. Therefore, trends and differences in educational homogamy and heterogamy might partially reflect variations in sorting based on other characteristics. For instance, if individuals increasingly search for a partner with traits that correlate with education, it could result in a rising share of educationally homogamous couples. Nonetheless, this thesis provides a precise analytical distinction between the impacts of assortative mating and structural opportunities on sorting outcomes, even though assortative mating could also reflect sorting by other characteristics than education.

Fourth, the results can be sensitive to the selected educational categories, which is a common challenge in research on marital sorting and assortative mating (Gihleb & Lang, 2016). This needs to be considered, especially when comparing the results across the chapters of this thesis, since each chapter differs slightly in the educational categorization. Even though educational attainment can be easily measured, it is difficult to define the degree of detail required to capture educational homogamy and heterogamy. Moreover, institutional changes, such as growing differentiation among higher education institutions, are a challenge when studying changes in educational homogamy and heterogamy (Uchikoshi, 2022). Future research is needed to explore the implications of different educational measures for marital sorting outcomes.

Fifth, while this thesis disentangles the impact of trends and differences in assortative mating and structural opportunities on marital sorting outcomes, the results of this thesis cannot be used to learn about why assortative mating and structural opportunities vary over time and across countries. One reason that could explain variation in assortative mating and structural opportunities is variation in the size and educational composition of the migrant population. For example, if migrants have different assortative mating patterns and the size of the migrant population increases the assortative mating patterns and marital sorting outcomes of the full population can change. Moreover, migration can affect structural opportunities. For example, immigration of highly educated young adults can change structural opportunities by increasing the availability of highly educated individuals on the partner market. Furthermore, it is important to consider that migration might stratify the partner market to the extent that migrants marry among each other rather than with the native population. However, this is a common limitation that this thesis shares with the body of research investigating assortative mating using log-linear models. Taken together, even though this thesis has limitations, it offers new insights into the drivers of marital sorting outcomes.

6.4 Future research

First, future research could benefit from further developments of the decomposition method presented in this thesis. For example, research has demonstrated that couples match non-randomly based on various traits such as age, education, race, or health (Luo, 2017). However, the availability of potential partners with these traits may also vary over time and across groups. An extension of the decomposition approach presented in this thesis to multi-dimensional tables could help to advance our understanding of marital sorting outcomes by multiple characteristics.

Future developments along this line may produce knowledge about the impact of social exchange patterns on marital sorting outcomes. According to social exchange theory, individuals search for a partner to exchange mutually rewarding resources. One way to assess whether social exchange processes affect marital sorting outcomes is to compare assortative mating patterns by trait A (e.g., education) between couples that are either homogamous or heterogamous in terms of trait B (e.g., earnings categories) (Gullickson, 2006). Thus, to evaluate the impact of patterns of social exchange on marital sorting outcomes researchers may use IPF to predict marital sorting outcomes if heterogamous couples (in terms of trait B) had the same assortative mating patterns as homogamous couples. Following the method introduced in this thesis, these counterfactuals could be used to examine the impact of variations in social exchange patterns on marital sorting outcomes.

Moreover, scholars could extend the proposed methodology to selection processes within unions, such as assortative parenthood (who has how many children with whom), which is critical for understanding the reproduction of social inequalities between generations. For example, to examine variations in parents' educational composition in populations of children, researchers could study marriage tables that are 'weighted' by fertility (Mare & Schwartz, 2006). Such tables can be used to investigate how variations in structural opportunities, assortative mating, and assortative parenthood, affect the educational composition of parents.

Second, aside from these potential methodological developments, future research may address empirical questions to improve the understanding of trends and differences in marital sorting outcomes. First, this thesis investigated the extent to which *observed changes* in marital sorting outcomes arise from shifts in structural opportunities and assortative mating. Consequently, the results depend on the chosen baseline categories (e.g., in Chapter 3, all census samples are compared with the one from 1991). To investigate the effect of changes in structural opportunities net of the baseline category, researchers could explore counterfactual scenarios such as ‘What if country A had experienced the changes in structural opportunities of country B?’.

Third, research should attempt to quantify the impact of trends in absolute gender gaps in education (i.e., education-specific sex ratios) on marital sorting outcomes. This is essential, as absolute gender gaps in education represent one aspect of the opportunity structures individuals encounter when searching for a partner. In addition, scholars may investigate to what extent the impact of trends in absolute gender gaps in education originates from changes in the education-gender association and a gender-neutral educational expansion. Such results would improve our understanding of the drivers of changes in women’s and men’s education and their consequences on marital sorting outcomes.

Fourth, this thesis analyzed marital sorting outcomes from the perspective of partnered women (Chapters 3 and 5) and married couples (Chapter 4). Adopting other perspectives could enhance the understanding of marital sorting outcomes. For example, future research might examine marital sorting outcomes using a sample of unpartnered and partnered women or men. This approach involves considering being unpartnered as a possible outcome of the partner search process. While focusing on partnered individuals is crucial for understanding social inequalities within and between couples, it is also important to investigate marital sorting outcomes among partnered and unpartnered individuals, as these outcomes may affect inequalities between individuals.

Fifth, the popularity of online dating has increased profoundly over the past years (Potarca, 2020; Thomas, 2020). In addition, partner markets in the online dating context typically feature a higher number of men than women (Potarca, 2020). This suggests that women have greater bargaining power and may achieve ‘better’ matches online compared to offline dating. Furthermore, the educational composition of women and men in online dating partner markets may differ from those in offline contexts, which can influence marital sorting outcomes too. Future research should investigate how these structural differences in online and offline dating markets affect the variation in marital sorting outcomes over time and across countries.

Sixth, in line with the majority of assortative mating research, this thesis conceptualized structural opportunities at the country level. That means, the educational compositions in populations of young women and men reflect structural opportunities. Future research should advance this perspective by studying local partner markets, for example, at the county level.

Seventh, the complexity of partnership types has increased considerably over the past decades (Thomson, 2014). In modern societies, partnerships consist of opposite and same-sex unions, encompassing first and higher-order marriages as well as cohabiting unions. Since this thesis investigated only opposite-sex marriages and cohabiting unions, the results cannot be used to learn about the mechanisms shaping sorting outcomes among same-sex couples. While prior research indicates that, across various traits, husbands and wives are more similar in opposite-sex unions than in same-sex unions (Jepsen & Jepsen, 2002; C. Schwartz & Graff, 2009), the mechanisms contributing to these differences are not yet fully understood. Future research could focus on the role that structural opportunities on the partner market play for these differences.

Eighth, in this thesis, I employed a small-N approach, focusing on a small number of countries chosen for theoretical reasons. To further study trends and differences in marital sorting outcomes, future research should broaden its perspective by adopting a large-N approach. The methodology presented in this thesis is well-suited to examine the structural drivers influencing within-country trends in multiple country contexts. However, it is important to acknowledge that the decomposition approach utilized here relies on pairwise comparisons, posing a challenge when extending the analysis to explore cross-country differences in marital sorting outcomes within a large-N framework. One potential strategy to approach such a cross-country comparison could be to compare the marital sorting outcomes of all countries to one marriage table that displays the average of all countries.

In conclusion, there is potential for future research to enhance the decomposition method presented in this thesis, for example, by extending its application to multi-dimensional tables. Additionally, empirical research should be expanded in the future to contribute to a more comprehensive understanding of variations in marital sorting outcomes. This may involve examining diverse groups, such as partnered and unpartnered women and men, as well as exploring differences between same-sex and opposite-sex couples.

6.5 Social policy

The observed trends in marital sorting outcomes may have diverse consequences for social inequalities. Scholars have argued that an increase in educational homogamy could contribute to growing economic inequalities between couples. This assumption stems from the notion that high proportions of low- and high-educated homogamous couples indicate elevated levels of educational inequality between couples (Blossfeld & Timm, 2003; Breen & Andersen, 2012; C. R. Schwartz, 2013). However, the empirical relationship between changes in educational homogamy and economic inequalities remains unclear. While several studies find that observed changes in assortative mating have not impacted earnings and income inequalities between couples (Boertien & Permanyer, 2019a; Breen & Andersen, 2012; Breen & Salazar, 2011), Breen and Andersen (2012) find that trends in marital sorting outcomes, driven by changing structural opportunities, slightly contributed to rising income inequality in Denmark. Consequently, the increase in the proportion of unions between equally educated women and men in many Western countries in recent decades may have affected the rise in economic inequalities between couples.

Moreover, the decline in unions in which women 'marry up' in education (hypergamy) and the concurrent rise in the percentage of unions in which women 'marry down' (hypogamy) can have implications for gender inequalities. Disparities in the educational attainment of wives and husbands can reflect earnings potential and the bargaining power of women and men within these unions (Lundberg & Pollak, 1996; Manser & Brown, 1980). Thus, the shift in marital sorting outcomes can empower women in decision-making processes and enhance their autonomy, particularly in choices related to employment (Caldwell, 1980). On the other hand, these trends may challenge traditional gender roles. For instance, attempts by men or women to reinstate traditional gender norms could restrict women's autonomy and decision-making power (Urbina, 2022).

Because of these anticipated relationships between marital sorting outcomes and social inequalities, the methodological developments and empirical findings of this thesis may be of interest to social policy researchers and policymakers. Due to the correlation between education and earnings, marital sorting outcomes could influence inequalities in earnings between households and between women and men. Income tax policies could offset or reinforce these inequalities in net earnings. For instance, income-splitting tax systems, where the spouse with a higher income transfers part of their income to the lower-earning spouse to reduce the household's income tax, have been criticized for exacerbating gender inequalities by encouraging a gendered division of labor (Bach et al., 2011). Moreover, such a policy may shape inequalities in households' net earnings because heterogamous couples benefit from them. In addition, in such a tax system, an increase in homogamous matching may lead to rising tax revenues, which should be of vital interest to policymakers. Given these expected links between marital sorting, earnings, and tax revenues, policymakers should take particular interest in forecasting the development of marital sorting outcomes. Social policy researchers could use current enrolment rates to predict future marital sorting outcomes via iterative proportional fitting.

Furthermore, policymakers have recommended mass schooling in low-income countries to empower young women (Murphy-Graham & Lloyd, 2016). Women's schooling could increase their autonomy because an increase in wives' earnings potential relative to their husbands' may diminish their husbands' power over them (Lundberg & Pollak, 1996; Manser & Brown, 1980). For this mechanism to occur, two assumptions must be fulfilled. First, an increase in women's education, relative to men's, has to lead to an increase in wives' education compared to their husbands'. Second, wives' educational advantage must enhance women's autonomy. While this thesis provides support for the first assumption, it remains uncertain under what conditions an increase in wives' education enhances women's autonomy. Recent evidence indicates that, in contexts with traditional gender norms, a rise in hypogamy could constitute a gender-norm violation that hinders progress toward gender equality (Behrman, 2019; Urbina, 2022).[40] Thus, in order to design social policies that have the intended consequences, research should study the relationship between marital sorting outcomes and gender equality.

6.6 Conclusion

This thesis examined the drivers of trends and cross-country variations in marital sorting outcomes. In the methodological section, I introduced an innovative approach for decomposing differences in contingency tables into variations in odds ratio structures and marginal distributions. The empirical application of this methodology led to several key

[40] Some theories suggest that couples who violate traditional gender norms use gender-traditional behaviors, such as a traditional division of unpaid work, to affirm gender identities (West & Zimmerman, 1987) or that men might use violence when they perceive their power as being threatened (Atkinson et al., 2005; Goode, 1971).

findings. In most investigated contexts, structural opportunities were the main driver of trends in marital sorting outcomes. Furthermore, assortative mating appeared more relevant than structural opportunities in explaining between-country differences in these outcomes. More detailed analyses showed that the reversal of the educational gradient in marriage moderately contributed to the observed trends. In addition, the expansion in higher education was associated with trends in homogamy and heterogamy, and changes in the education-gender association were linked to increased hypogamy and decreased hypergamy rates. In summary, the findings suggest that the rise in educational attainment among women and men has transformed the outcomes of the partner search process. Future research should investigate the implications of these trends on demographic and socioeconomic outcomes, such as fertility or the social reproduction of inequalities between generations.

7 References

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8 Appendices

8.1 Appendix Chapter 3

8.1.1 Figures

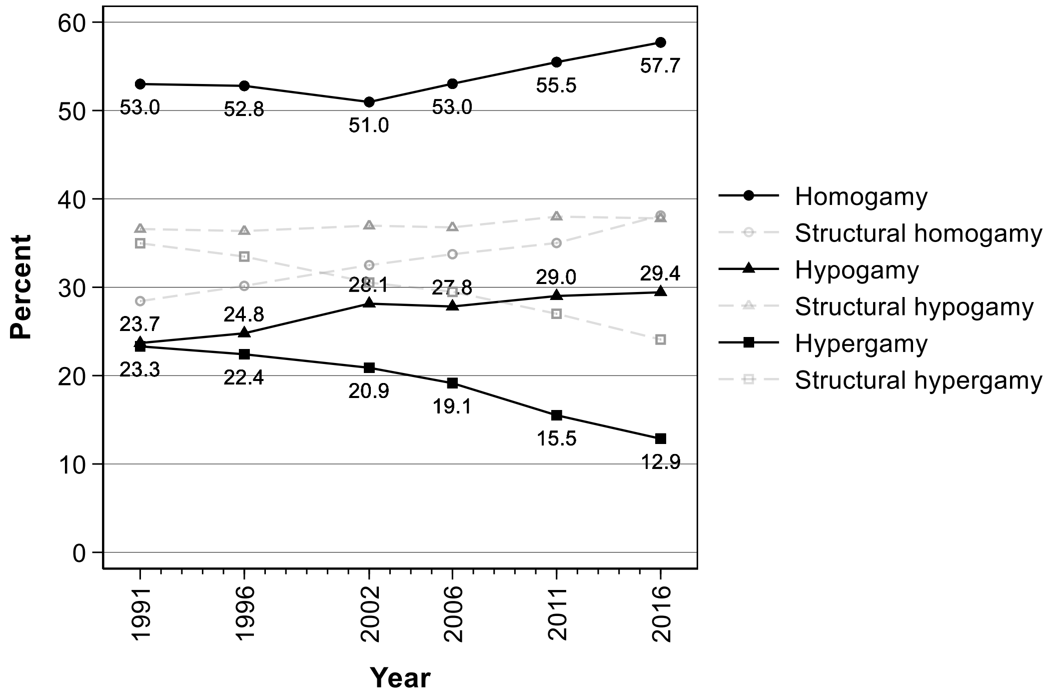

Figure A3.1. Partnered women's (age 35–44) observed marital sorting outcomes (solid lines) and hypothetical marital sorting outcomes if there were no association between spouses' education (dashed lines)

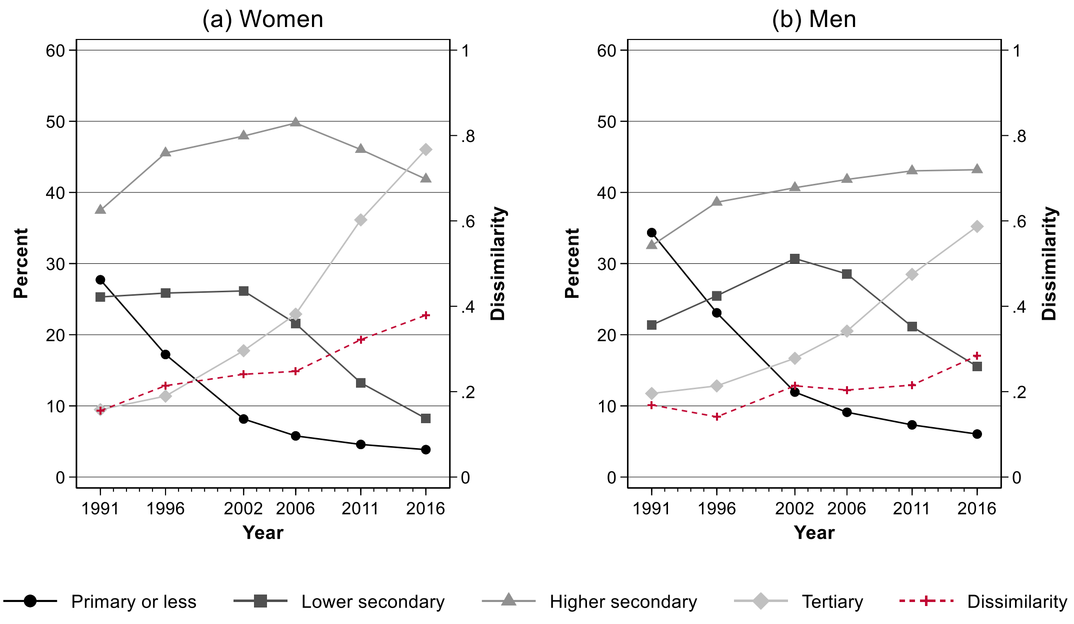

Figure A3.2. Educational attainment and dissimilarity index, women (age 35–44) and men (age 37–46)

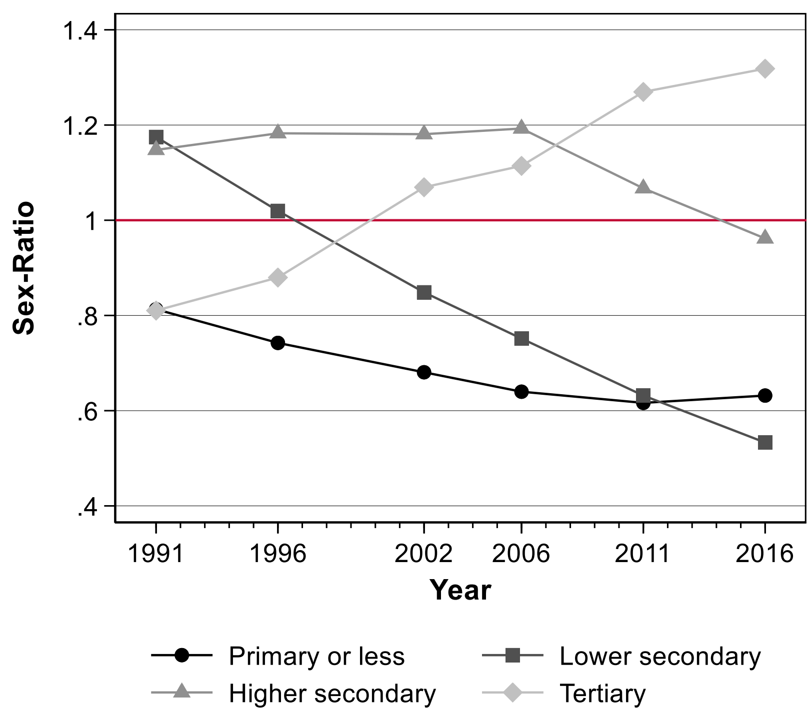

Figure A3.3. Sex-ratios (women/men) in educational attainment, women (age 35–44) and men (age 37–46)

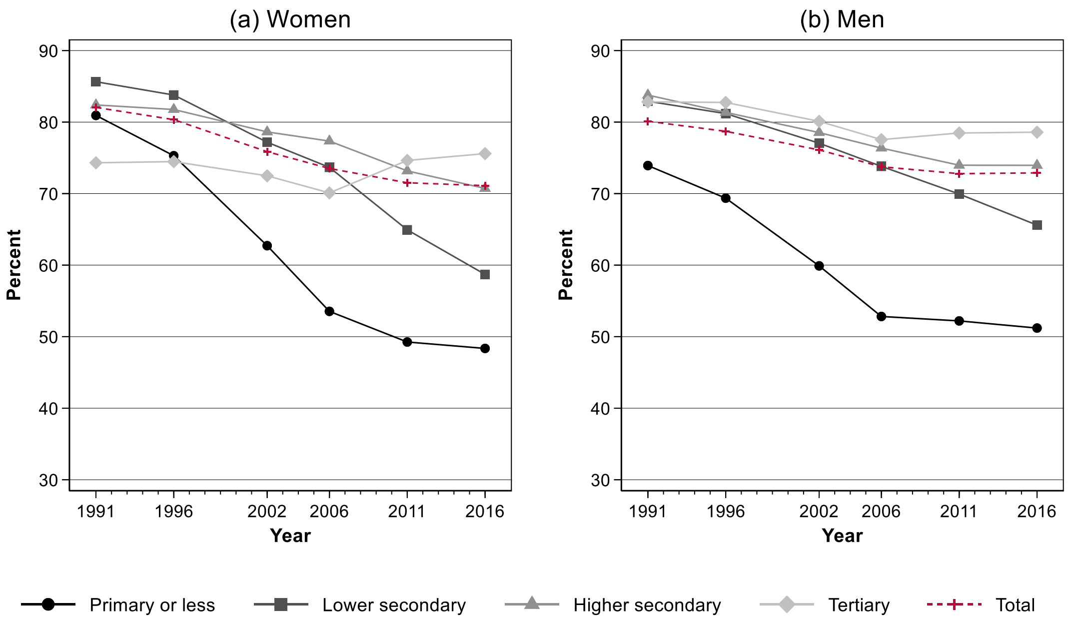

Figure A3.4. Share of married women (age 35–44) and men (age 37–46) by education

8.1.2 Tables

Table B3.1. Case numbers throughout the sample selection

	1991	1996	2002	2006	2011	2016
All cases	258,909	278,310	306,120	333,369	354,024	371,215
- men	132,019	141,649	154,959	167,530	180,205	189,525
- women aged < 25 and > 34	25,253	26,667	30,653	35,185	37,887	33,583
- partner in another household	24,675	26,232	30,097	34,546	37,422	33,093
- missing values	23,904	25,584	29,108	33,330	36,020	31,360
- unpartnered	15,767	14,961	15,068	17,598	19,650	16,231

Table B3.2. Factual and counterfactual marital sorting outcomes, two-fold decomposition

	Assortative mating ($\boldsymbol{OR}_t$)	
Opportunities ($\boldsymbol{E}_t^W, \boldsymbol{E}_t^H$)	T = 1	T = 2
T = 1	Y_{11}	$\dot{Y}_{12}$
T = 2	$\dot{Y}_{21}$	Y_{22}

Table B3.3. Factual and counterfactual marital sorting outcomes, three-fold decomposition

Opportunities ($E(\boldsymbol{G}_t^F, \boldsymbol{E}_t^F), E(\boldsymbol{G}_t^M, \boldsymbol{E}_t^M)$)		Assortative mating ($\boldsymbol{OR}_t$)	
Education distributions ($\boldsymbol{E}_t^F, \boldsymbol{E}_t^M$)	Marriage gradients ($\boldsymbol{G}_t^F$,$\boldsymbol{G}_t^M$)	T = 1	T = 2
T = 1	T = 1	Y_{111}	$\dot{Y}_{112}$
T = 1	T = 2	$\dot{Y}_{121}$	$\dot{Y}_{122}$
T = 2	T = 1	$\dot{Y}_{211}$	$\dot{Y}_{212}$
T = 2	T = 2	$\dot{Y}_{221}$	Y_{222}

Table B3.4. Decomposition of changes in marital sorting outcomes, women age (35–44)

Outcome	T1 1991	T2 1996	2002	2006	2011	2016
Homogamy						
Level	0.5299***	0.5279***	0.5097***	0.5303***	0.5548***	0.5770***
	(0.0037)	(0.0036)	(0.0035)	(0.0034)	(0.0033)	(0.0031)
Difference T2-T1	–	-0.0020	-0.0203***	0.0004	0.0248***	0.0471***
		(0.0050)	(0.0051)	(0.0052)	(0.0048)	(0.0048)
Decomposition						
Assort. mating	–	0.0073	-0.0118*	0.0050	0.0071	0.0063
		(0.0051)	(0.0054)	(0.0053)	(0.0051)	(0.0053)
Educ. expansion	–	-0.0077***	-0.0065**	-0.0014	0.0199***	0.0394***
		(0.0014)	(0.0020)	(0.0023)	(0.0029)	(0.0035)
Marriage gradient	–	-0.0017	-0.0020	-0.0032	-0.0021	0.0014
		(0.0016)	(0.0015)	(0.0017)	(0.0019)	(0.0022)
Marrying down						
Level	0.2369***	0.2479***	0.2814***	0.2782***	0.2901***	0.2943***
	(0.0032)	(0.0031)	(0.0032)	(0.0031)	(0.0030)	(0.0029)
Difference T2-T1	–	0.0110*	0.0445***	0.0413***	0.0532***	0.0574***
		(0.0043)	(0.0044)	(0.0044)	(0.0042)	(0.0043)
Decomposition						
Assort. mating	–	-0.0027	0.0095**	0.0030	0.0021	0.0053
		(0.0029)	(0.0030)	(0.0029)	(0.0029)	(0.0031)
Educ. expansion	–	0.0114*	0.0305***	0.0325***	0.0346***	0.0368***
		(0.0046)	(0.0049)	(0.0051)	(0.0060)	(0.0064)
Marriage gradient	–	0.0023	0.0046	0.0058	0.0165*	0.0153*
		(0.0055)	(0.0059)	(0.0060)	(0.0064)	(0.0069)
Marrying up						
Level	0.2331***	0.2242***	0.2089***	0.1915***	0.1552***	0.1286***
	(0.0032)	(0.0030)	(0.0029)	(0.0027)	(0.0024)	(0.0021)
Difference T2-T1	–	-0.0089*	-0.0242***	-0.0417***	-0.0780***	-0.1045***
		(0.0044)	(0.0043)	(0.0043)	(0.0039)	(0.0038)
Decomposition						
Assort. mating	–	-0.0046	0.0023	-0.0080**	-0.0092**	-0.0116***
		(0.0029)	(0.0030)	(0.0029)	(0.0028)	(0.0029)
Educ. expansion	–	-0.0037	-0.0240***	-0.0310***	-0.0545***	-0.0763***
		(0.0042)	(0.0044)	(0.0045)	(0.0047)	(0.0051)
Marriage gradient	–	-0.0006	-0.0025	-0.0026	-0.0143**	-0.0167**
		(0.0052)	(0.0054)	(0.0053)	(0.0052)	(0.0053)
N	17930	19261	20215	21178	23055	24745

Notes: Standard errors in parentheses. Standard errors for difference and decomposition terms were estimated via bootstrapping with 500 replications. Outcomes: *Homogamy* (equal education level for wife and husband), *marrying down* (wife more educated), *marrying up* (husband more educated). Significance: * p < .05, ** p < .01, *** p < .001.

Table B3.5. Decomposition of changes in marital sorting outcomes, excluding international migrants

Outcome	T1 1991	T2 1996	2002	2006	2011	2016
Homogamy						
Level	0.5471***	0.5683***	0.5415***	0.5430***	0.5582***	0.5683***
	(0.0044)	(0.0047)	(0.0050)	(0.0047)	(0.0045)	(0.0049)
Difference T2-T1	–	0.0212***	-0.0056	-0.0041	0.0111	0.0212**
		(0.0064)	(0.0070)	(0.0067)	(0.0066)	(0.0066)
Decomposition						
Assort. mating	–	0.0103	-0.0113	-0.0114	-0.0065	-0.0061
		(0.0062)	(0.0069)	(0.0068)	(0.0067)	(0.0071)
Educ. expansion	–	0.0091***	0.0039	0.0061*	0.0149***	0.0263***
		(0.0016)	(0.0023)	(0.0029)	(0.0040)	(0.0043)
Marriage gradient	–	0.0018	0.0019	0.0012	0.0028	0.0010
		(0.0023)	(0.0025)	(0.0029)	(0.0031)	(0.0029)
Marrying down						
Level	0.2681***	0.2557***	0.2976***	0.3151***	0.3325***	0.3245***
	(0.0039)	(0.0041)	(0.0046)	(0.0044)	(0.0043)	(0.0047)
Difference T2-T1	–	-0.0124*	0.0295***	0.0469***	0.0644***	0.0564***
		(0.0055)	(0.0062)	(0.0058)	(0.0059)	(0.0060)
Decomposition						
Assort. mating	–	-0.0054	0.0071	0.0091*	0.0061	0.0071
		(0.0034)	(0.0037)	(0.0037)	(0.0035)	(0.0037)
Educ. expansion	–	-0.0120*	0.0085	0.0181**	0.0371***	0.0281***
		(0.0050)	(0.0052)	(0.0059)	(0.0064)	(0.0068)
Marriage gradient	–	0.0049	0.0139*	0.0198**	0.0212**	0.0212**
		(0.0069)	(0.0070)	(0.0076)	(0.0076)	(0.0076)
Marrying up						
Level	0.1848***	0.1760***	0.1609***	0.1419***	0.1093***	0.1072***
	(0.0034)	(0.0036)	(0.0037)	(0.0033)	(0.0028)	(0.0031)
Difference T2-T1	–	-0.0088	-0.0239***	-0.0428***	-0.0755***	-0.0776***
		(0.0050)	(0.0051)	(0.0050)	(0.0046)	(0.0043)
Decomposition						
Assort. mating	–	-0.0049	0.0042	0.0023	0.0004	-0.0010
		(0.0032)	(0.0038)	(0.0036)	(0.0036)	(0.0038)
Educ. expansion	–	0.0029	-0.0124**	-0.0242***	-0.0520***	-0.0544***
		(0.0039)	(0.0039)	(0.0042)	(0.0040)	(0.0046)
Marriage gradient	–	-0.0067	-0.0158**	-0.0210***	-0.0239***	-0.0222***
		(0.0056)	(0.0053)	(0.0053)	(0.0050)	(0.0052)
N	12886	11158	9889	11096	12040	10037

Notes: Standard errors in parentheses. Standard errors for difference and decomposition terms were estimated via bootstrapping with 500 replications. Outcomes: *Homogamy* (equal education level for wife and husband), *marrying down* (wife more educated), *marrying up* (husband more educated). Significance: * p < .05, ** p < .01, *** p < .001.

8.2 Appendix Chapter 4

8.2.1 Tables

Table A4.1: Number of contracted marriages

	Sweden	Czech Republic	Italy
2000	36,424	55,321	284,410
2002	34,059	52,732	270,013
2004	38,139	51,447	248,969
2006	40,184	52,860	245,992
2008	44,439	51,648	246,613
2010	44,885	43,407	217,700
2012	45,587	41,434	207,138
2014	42,732	21,309	189,765
2016	43,883	23,129	203,258
2018	42,025	23,285	195,778
2020	31,960	18,482	96,841
Total	444,317	435,054	2,406,477

Table A4.2. Decomposition of changes in educational sorting outcomes in marriages in Sweden

	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020
Homogamy	0.4557***	0.4712***	0.4746***	0.4887***	0.4901***	0.4959***	0.4971***	0.5089***	0.5161***	0.5222***	0.5198***
Level	(0.0026)	(0.0027)	(0.0026)	(0.0025)	(0.0024)	(0.0024)	(0.0023)	(0.0024)	(0.0024)	(0.0024)	(0.0028)
Difference		0.0155***	0.0189***	0.0330***	0.0344***	0.0401***	0.0413***	0.0531***	0.0603***	0.0665***	0.0640***
T2 – T1		(0.0038)	(0.0036)	(0.0035)	(0.0033)	(0.0038)	(0.0035)	(0.0036)	(0.0038)	(0.0037)	(0.0036)
Assortative		0.0116***	0.0128***	0.0206***	0.0202***	0.0178***	0.0214***	0.0252***	0.0298***	0.0292***	0.0319***
mating		(0.0035)	(0.0032)	(0.0033)	(0.0030)	(0.0034)	(0.0032)	(0.0034)	(0.0034)	(0.0033)	(0.0035)
Opportunities		0.0039*	0.0060***	0.0124***	0.0142***	0.0223***	0.0199***	0.0279***	0.0305***	0.0372***	0.0322***
		(0.0016)	(0.0015)	(0.0016)	(0.0016)	(0.0017)	(0.0016)	(0.0018)	(0.0019)	(0.0020)	(0.0021)
Marrying down	0.3248***	0.3234***	0.3290***	0.3260***	0.3289***	0.3270***	0.3312***	0.3243***	0.3237***	0.3203***	0.3210***
Level	(0.0025)	(0.0025)	(0.0024)	(0.0023)	(0.0022)	(0.0022)	(0.0022)	(0.0023)	(0.0022)	(0.0023)	(0.0026)
Difference		-0.0013	0.0043	0.0012	0.0041	0.0022	0.0064*	-0.0005	-0.0011	-0.0045	-0.0038
T2 – T1		(0.0036)	(0.0033)	(0.0033)	(0.0033)	(0.0034)	(0.0033)	(0.0034)	(0.0033)	(0.0034)	(0.0034)
Assortative		-0.0053**	-0.0054**	-0.0092***	-0.0095***	-0.0096***	-0.0098***	-0.0129***	-0.0144***	-0.0135***	-0.0162***
mating		(0.0020)	(0.0019)	(0.0019)	(0.0018)	(0.0021)	(0.0019)	(0.0021)	(0.0020)	(0.0019)	(0.0021)
Opportunities		0.0040	0.0097***	0.0104***	0.0136***	0.0119***	0.0163***	0.0124***	0.0133***	0.0090**	0.0125***
		(0.0029)	(0.0029)	(0.0028)	(0.0028)	(0.0029)	(0.0026)	(0.0028)	(0.0028)	(0.0028)	(0.0030)
Marrying up	0.2195***	0.2053***	0.1964***	0.1853***	0.1810***	0.1771***	0.1717***	0.1669***	0.1603***	0.1575***	0.1592***
Level	(0.0022)	(0.0022)	(0.0020)	(0.0019)	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0020)
Difference		-0.0141***	-0.0231***	-0.0342***	-0.0385***	-0.0424***	-0.0478***	-0.0526***	-0.0592***	-0.0620***	-0.0603***
T2 – T1		(0.0030)	(0.0030)	(0.0029)	(0.0027)	(0.0031)	(0.0026)	(0.0027)	(0.0028)	(0.0026)	(0.0029)
Assortative		-0.0063**	-0.0074***	-0.0114***	-0.0107***	-0.0082***	-0.0116***	-0.0123***	-0.0154***	-0.0158***	-0.0156***
mating		(0.0021)	(0.0020)	(0.0019)	(0.0018)	(0.0019)	(0.0019)	(0.0019)	(0.0020)	(0.0019)	(0.0021)
Opportunities		-0.0079***	-0.0157***	-0.0228***	-0.0278***	-0.0342***	-0.0362***	-0.0403***	-0.0438***	-0.0463***	-0.0446***
		(0.0023)	(0.0024)	(0.0022)	(0.0021)	(0.0023)	(0.0020)	(0.0021)	(0.0021)	(0.0021)	(0.0022)
N	36424	34059	38139	40184	44439	44885	45587	42732	43883	42025	31960

Notes: Standard errors in parentheses. Standard errors for difference and decomposition terms were estimated via bootstrapping with 500 replications. Outcomes: *Homogamy* (equal education level for wife and husband), *marrying down* (wife more educated), *marrying up* (husband more educated). Significance: * $p < .05$, ** $p < .01$, *** $p < .001$.

Table A4.3. Decomposition of changes in educational sorting outcomes in marriages in the Czech Republic

	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020
Homogamy	0.5596***	0.5739***	0.5705***	0.5841***	0.5778***	0.5554***	0.5447***	0.5973***	0.5735***	0.5513***	0.5485***
Level	(0.0021)	(0.0022)	(0.0022)	(0.0021)	(0.0022)	(0.0024)	(0.0024)	(0.0034)	(0.0033)	(0.0033)	(0.0037)
Difference		0.0144***	0.0110***	0.0245***	0.0182***	-0.0042	-0.0148***	0.0377***	0.0140***	-0.0083*	-0.0111*
T2 – T1		(0.0031)	(0.0030)	(0.0031)	(0.0029)	(0.0033)	(0.0033)	(0.0039)	(0.0037)	(0.0039)	(0.0043)
Assortative		0.0133***	0.0118***	0.0236***	0.0153***	-0.0061	-0.0173***	0.0356***	0.0151***	-0.0083*	-0.0145***
mating		(0.0030)	(0.0029)	(0.0030)	(0.0029)	(0.0031)	(0.0033)	(0.0039)	(0.0036)	(0.0038)	(0.0042)
Opportunities		0.0011	-0.0008	0.0009	0.0029**	0.0019	0.0025	0.0021	-0.0011	0.0001	0.0035
		(0.0009)	(0.0009)	(0.0010)	(0.0011)	(0.0012)	(0.0013)	(0.0016)	(0.0016)	(0.0017)	(0.0019)
Marrying down	0.2447***	0.2366***	0.2392***	0.2369***	0.2485***	0.2722***	0.2875***	0.2654***	0.2806***	0.3022***	0.3044***
Level	(0.0018)	(0.0019)	(0.0019)	(0.0018)	(0.0019)	(0.0021)	(0.0022)	(0.0030)	(0.0030)	(0.0030)	(0.0034)
Difference		-0.0081**	-0.0056*	-0.0078**	0.0038	0.0275***	0.0428***	0.0207***	0.0358***	0.0575***	0.0596***
T2 – T1		(0.0025)	(0.0025)	(0.0027)	(0.0025)	(0.0028)	(0.0029)	(0.0033)	(0.0036)	(0.0035)	(0.0040)
Assortative		-0.0064***	-0.0055***	-0.0116***	-0.0081***	0.0024	0.0078***	-0.0184***	-0.0076***	0.0028	0.0046*
mating		(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0017)	(0.0018)	(0.0021)	(0.0020)	(0.0020)	(0.0023)
Opportunities		-0.0017	-0.0000	0.0038	0.0119***	0.0251***	0.0349***	0.0390***	0.0434***	0.0546***	0.0550***
		(0.0021)	(0.0020)	(0.0021)	(0.0021)	(0.0023)	(0.0023)	(0.0027)	(0.0029)	(0.0031)	(0.0034)
Marrying up	0.1957***	0.1895***	0.1903***	0.1790***	0.1737***	0.1724***	0.1678***	0.1373***	0.1459***	0.1465***	0.1472***
Level	(0.0017)	(0.0017)	(0.0017)	(0.0017)	(0.0017)	(0.0018)	(0.0018)	(0.0024)	(0.0023)	(0.0023)	(0.0026)
Difference		-0.0062*	-0.0054*	-0.0167***	-0.0220***	-0.0233***	-0.0279***	-0.0584***	-0.0498***	-0.0492***	-0.0485***
T2 – T1		(0.0025)	(0.0022)	(0.0025)	(0.0023)	(0.0025)	(0.0024)	(0.0028)	(0.0028)	(0.0030)	(0.0031)
Assortative		-0.0069***	-0.0063***	-0.0120***	-0.0072***	0.0037*	0.0095***	-0.0172***	-0.0075***	0.0055**	0.0099***
mating		(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0017)	(0.0017)	(0.0021)	(0.0019)	(0.0021)	(0.0022)
Opportunities		0.0007	0.0009	-0.0047*	-0.0148***	-0.0271***	-0.0374***	-0.0412***	-0.0423***	-0.0547***	-0.0585***
		(0.0018)	(0.0017)	(0.0019)	(0.0018)	(0.0019)	(0.0018)	(0.0019)	(0.0021)	(0.0022)	(0.0024)
N	55321	52732	51447	52860	51648	43407	41434	21309	23129	23285	18482

Notes: Standard errors in parentheses. Standard errors for difference and decomposition terms were estimated via bootstrapping with 500 replications. Outcomes: *Homogamy* (equal education level for wife and husband), *marrying down* (wife more educated), *marrying up* (husband more educated). Significance: * $p < .05$, ** $p < .01$, *** $p < .001$.

Table A4.4. Decomposition of changes in educational marital sorting outcomes in marriages in Italy

	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020
Homogamy	0.6432***	0.6318***	0.6165***	0.6533***	0.6565***	0.6698***	0.6786***	0.6927***	0.6690***	0.7048***	0.5324***
Level	(0.0009)	(0.0009)	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0011)	(0.0010)	(0.0010)	(0.0016)
Difference		-0.0114***	-0.0268***	0.0100***	0.0132***	0.0266***	0.0354***	0.0495***	0.0257***	0.0616***	-0.1109***
T2 – T1		(0.0012)	(0.0013)	(0.0013)	(0.0013)	(0.0013)	(0.0014)	(0.0014)	(0.0014)	(0.0013)	(0.0019)
Assortative		-0.0091***	-0.0209***	0.0214***	0.0266***	0.0391***	0.0494***	0.0618***	0.0505***	0.0805***	-0.0925***
mating		(0.0012)	(0.0013)	(0.0013)	(0.0013)	(0.0013)	(0.0013)	(0.0013)	(0.0013)	(0.0013)	(0.0018)
Opportunities		-0.0023***	-0.0059***	-0.0114***	-0.0134***	-0.0126***	-0.0140***	-0.0123***	-0.0248***	-0.0189***	-0.0183***
		(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0007)
Marrying down	0.2193***	0.2244***	0.2348***	0.2237***	0.2249***	0.2206***	0.2189***	0.2099***	0.2357***	0.1984***	0.2914***
Level	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0015)
Difference		0.0052***	0.0156***	0.0045***	0.0056***	0.0013	-0.0003	-0.0094***	0.0165***	-0.0208***	0.0721***
T2 – T1		(0.0010)	(0.0011)	(0.0011)	(0.0012)	(0.0012)	(0.0013)	(0.0012)	(0.0012)	(0.0012)	(0.0017)
Assortative		0.0045***	0.0100***	-0.0128***	-0.0146***	-0.0199***	-0.0249***	-0.0302***	-0.0241***	-0.0373***	0.0452***
mating		(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0010)
Opportunities		0.0007	0.0055***	0.0173***	0.0202***	0.0212***	0.0245***	0.0208***	0.0405***	0.0165***	0.0269***
		(0.0009)	(0.0009)	(0.0009)	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0015)
Marrying up	0.1375***	0.1437***	0.1487***	0.1230***	0.1187***	0.1096***	0.1024***	0.0974***	0.0953***	0.0967***	0.1762***
Level	(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0012)
Difference		0.0063***	0.0112***	-0.0145***	-0.0188***	-0.0279***	-0.0351***	-0.0401***	-0.0422***	-0.0408***	0.0387***
T2 – T1		(0.0009)	(0.0010)	(0.0009)	(0.0009)	(0.0009)	(0.0010)	(0.0010)	(0.0009)	(0.0009)	(0.0014)
Assortative		0.0046***	0.0108***	-0.0086***	-0.0120***	-0.0193***	-0.0245***	-0.0316***	-0.0264***	-0.0432***	0.0473***
mating		(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0010)
Opportunities		0.0016*	0.0004	-0.0060***	-0.0068***	-0.0086***	-0.0105***	-0.0084***	-0.0157***	0.0025***	-0.0086***
		(0.0006)	(0.0007)	(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0006)	(0.0006)	(0.0007)	(0.0010)
N	284410	270013	248969	245992	246613	217700	207138	189765	203258	195778	96841

Notes: Standard errors in parentheses. Standard errors for difference and decomposition terms were estimated via bootstrapping with 500 replications. Outcomes: *Homogamy* (equal education level for wife and husband), *marrying down* (wife more educated), *marrying up* (husband more educated). Significance: * p < .05, ** p < .01, *** p < .001.

Table A4.5. Decomposition of differences in educational sorting outcomes in marriages between Italy and Sweden

	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020
Homogamy											
Italy: Level	0.6432***	0.6318***	0.6165***	0.6533***	0.6565***	0.6698***	0.6786***	0.6927***	0.6690***	0.7048***	0.5324***
	(0.0009)	(0.0009)	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0011)	(0.0010)	(0.0010)	(0.0016)
Sweden: Level	0.4557***	0.4712***	0.4746***	0.4887***	0.4901***	0.4959***	0.4971***	0.5089***	0.5161***	0.5222***	0.5198***
	(0.0026)	(0.0027)	(0.0026)	(0.0025)	(0.0024)	(0.0024)	(0.0023)	(0.0024)	(0.0024)	(0.0024)	(0.0028)
Difference	0.1875***	0.1606***	0.1418***	0.1645***	0.1663***	0.1739***	0.1816***	0.1839***	0.1529***	0.1826***	0.0126***
Italy – Sweden	(0.0029)	(0.0029)	(0.0027)	(0.0027)	(0.0026)	(0.0027)	(0.0026)	(0.0027)	(0.0027)	(0.0027)	(0.0032)
Assortative	0.1954***	0.1650***	0.1474***	0.1634***	0.1622***	0.1705***	0.1751***	0.1778***	0.1641***	0.2073***	0.0449***
mating	(0.0031)	(0.0030)	(0.0028)	(0.0028)	(0.0026)	(0.0027)	(0.0027)	(0.0026)	(0.0027)	(0.0027)	(0.0031)
Opportunities	-0.0079***	-0.0045*	-0.0056***	0.0011	0.0041**	0.0034*	0.0064***	0.0061***	-0.0112***	-0.0247***	-0.0323***
	(0.0020)	(0.0018)	(0.0017)	(0.0015)	(0.0015)	(0.0015)	(0.0016)	(0.0015)	(0.0014)	(0.0015)	(0.0015)
Marrying down											
Italy: Level	0.2193***	0.2244***	0.2348***	0.2237***	0.2249***	0.2206***	0.2189***	0.2099***	0.2357***	0.1984***	0.2914***
	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0015)
Sweden: Level	0.3248***	0.3234***	0.3290***	0.3260***	0.3289***	0.3270***	0.3312***	0.3243***	0.3237***	0.3203***	0.3210***
	(0.0025)	(0.0025)	(0.0024)	(0.0023)	(0.0022)	(0.0022)	(0.0022)	(0.0023)	(0.0022)	(0.0023)	(0.0026)
Difference	-0.1055***	-0.0990***	-0.0942***	-0.1023***	-0.1040***	-0.1064***	-0.1123***	-0.1144***	-0.0880***	-0.1218***	-0.0296***
Italy – Sweden	(0.0025)	(0.0027)	(0.0026)	(0.0026)	(0.0025)	(0.0023)	(0.0024)	(0.0025)	(0.0025)	(0.0025)	(0.0031)
Assortative	-0.0930***	-0.0778***	-0.0694***	-0.0791***	-0.0771***	-0.0788***	-0.0823***	-0.0830***	-0.0751***	-0.0954***	-0.0173***
mating	(0.0017)	(0.0017)	(0.0016)	(0.0015)	(0.0015)	(0.0015)	(0.0015)	(0.0015)	(0.0016)	(0.0016)	(0.0018)
Opportunities	-0.0125***	-0.0211***	-0.0247***	-0.0232***	-0.0269***	-0.0276***	-0.0300***	-0.0314***	-0.0129***	-0.0265***	-0.0123***
	(0.0026)	(0.0027)	(0.0025)	(0.0023)	(0.0023)	(0.0022)	(0.0022)	(0.0022)	(0.0022)	(0.0022)	(0.0026)
Marrying up											
Italy: Level	0.1375***	0.1437***	0.1487***	0.1230***	0.1187***	0.1096***	0.1024***	0.0974***	0.0953***	0.0967***	0.1762***
	(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0012)
Sweden: Level	0.2195***	0.2053***	0.1964***	0.1853***	0.1810***	0.1771***	0.1717***	0.1669***	0.1603***	0.1575***	0.1592***
	(0.0022)	(0.0022)	(0.0020)	(0.0019)	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0020)
Difference	-0.0820***	-0.0616***	-0.0477***	-0.0623***	-0.0623***	-0.0675***	-0.0693***	-0.0695***	-0.0650***	-0.0608***	0.0170***

Italy – Sweden	(0.0022)	(0.0024)	(0.0022)	(0.0021)	(0.0019)	(0.0020)	(0.0018)	(0.0019)	(0.0019)	(0.0019)	(0.0024)
Assortative	-0.1024***	-0.0872***	-0.0780***	-0.0843***	-0.0851***	-0.0917***	-0.0928***	-0.0948***	-0.0890***	-0.1120***	-0.0276***
mating	(0.0017)	(0.0016)	(0.0015)	(0.0015)	(0.0014)	(0.0015)	(0.0014)	(0.0014)	(0.0015)	(0.0015)	(0.0017)
Opportunities	0.0204***	0.0256***	0.0303***	0.0221***	0.0228***	0.0241***	0.0235***	0.0253***	0.0241***	0.0512***	0.0446***
	(0.0017)	(0.0019)	(0.0018)	(0.0016)	(0.0014)	(0.0014)	(0.0013)	(0.0013)	(0.0012)	(0.0012)	(0.0019)
Italy: N	284410	270013	248969	245992	246613	217700	207138	189765	203258	195778	96841
Sweden: N	36424	34059	38139	40184	44439	44885	45587	42732	43883	42025	31960

Notes: Standard errors in parentheses. Standard errors for difference and decomposition terms were estimated via bootstrapping with 500 replications. Outcomes: *Homogamy* (equal education level for wife and husband), *marrying down* (wife more educated), *marrying up* (husband more educated). Significance: * p < .05, ** p < .01, *** p < .001.

Table A4.6. Decomposition of differences in educational sorting outcomes in marriages between the Czech Republic and Sweden

	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020
Homogamy											
Czech Republic:	0.5596***	0.5739***	0.5705***	0.5841***	0.5778***	0.5554***	0.5447***	0.5973***	0.5735***	0.5513***	0.5485***
Level	(0.0021)	(0.0022)	(0.0022)	(0.0021)	(0.0022)	(0.0024)	(0.0024)	(0.0034)	(0.0033)	(0.0033)	(0.0037)
Sweden: Level	0.4557***	0.4712***	0.4746***	0.4887***	0.4901***	0.4959***	0.4971***	0.5089***	0.5161***	0.5222***	0.5198***
	(0.0026)	(0.0027)	(0.0026)	(0.0025)	(0.0024)	(0.0024)	(0.0023)	(0.0024)	(0.0024)	(0.0024)	(0.0028)
Difference	0.1038***	0.1027***	0.0959***	0.0954***	0.0876***	0.0595***	0.0477***	0.0884***	0.0575***	0.0291***	0.0287***
CR – Sweden	(0.0033)	(0.0033)	(0.0034)	(0.0034)	(0.0032)	(0.0032)	(0.0032)	(0.0039)	(0.0038)	(0.0039)	(0.0045)
Assortative	0.1534***	0.1453***	0.1355***	0.1288***	0.1138***	0.0886***	0.0757***	0.1137***	0.0951***	0.0699***	0.0603***
mating	(0.0032)	(0.0034)	(0.0033)	(0.0032)	(0.0031)	(0.0032)	(0.0030)	(0.0036)	(0.0035)	(0.0036)	(0.0041)
Opportunities	-0.0496***	-0.0427***	-0.0396***	-0.0334***	-0.0262***	-0.0291***	-0.0280***	-0.0253***	-0.0376***	-0.0409***	-0.0316***
	(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0015)	(0.0015)	(0.0015)	(0.0018)	(0.0016)	(0.0018)	(0.0020)
Marrying down											
Czech Republic:	0.2447***	0.2366***	0.2392***	0.2369***	0.2485***	0.2722***	0.2875***	0.2654***	0.2806***	0.3022***	0.3044***
Level	(0.0018)	(0.0019)	(0.0019)	(0.0018)	(0.0019)	(0.0021)	(0.0022)	(0.0030)	(0.0030)	(0.0030)	(0.0034)
Sweden: Level	0.3248***	0.3234***	0.3290***	0.3260***	0.3289***	0.3270***	0.3312***	0.3243***	0.3237***	0.3203***	0.3210***
	(0.0025)	(0.0025)	(0.0024)	(0.0023)	(0.0022)	(0.0022)	(0.0022)	(0.0023)	(0.0022)	(0.0023)	(0.0026)
Difference	-0.0800***	-0.0868***	-0.0899***	-0.0891***	-0.0804***	-0.0548***	-0.0437***	-0.0589***	-0.0431***	-0.0181***	-0.0166***

CR – Sweden	(0.0031)	(0.0032)	(0.0031)	(0.0032)	(0.0031)	(0.0029)	(0.0030)	(0.0038)	(0.0036)	(0.0038)	(0.0045)
Assortative	-0.0782***	-0.0707***	-0.0655***	-0.0612***	-0.0532***	-0.0386***	-0.0325***	-0.0505***	-0.0417***	-0.0303***	-0.0256***
mating	(0.0019)	(0.0019)	(0.0019)	(0.0019)	(0.0017)	(0.0018)	(0.0017)	(0.0022)	(0.0020)	(0.0021)	(0.0024)
Opportunities	-0.0019	-0.0161***	-0.0243***	-0.0279***	-0.0272***	-0.0162***	-0.0112***	-0.0084**	-0.0015	0.0121***	0.0089*
	(0.0027)	(0.0028)	(0.0027)	(0.0027)	(0.0027)	(0.0027)	(0.0027)	(0.0031)	(0.0031)	(0.0031)	(0.0037)
Marrying up											
Czech Republic:	0.1957***	0.1895***	0.1903***	0.1790***	0.1737***	0.1724***	0.1678***	0.1373***	0.1459***	0.1465***	0.1472***
Level	(0.0017)	(0.0017)	(0.0017)	(0.0017)	(0.0017)	(0.0018)	(0.0018)	(0.0024)	(0.0023)	(0.0023)	(0.0026)
Sweden: Level	0.2195***	0.2053***	0.1964***	0.1853***	0.1810***	0.1771***	0.1717***	0.1669***	0.1603***	0.1575***	0.1592***
	(0.0022)	(0.0022)	(0.0020)	(0.0019)	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0020)
Difference	-0.0238***	-0.0158***	-0.0060*	-0.0063*	-0.0073**	-0.0048	-0.0039	-0.0296***	-0.0143***	-0.0109***	-0.0121***
CR – Sweden	(0.0028)	(0.0028)	(0.0026)	(0.0025)	(0.0026)	(0.0026)	(0.0026)	(0.0028)	(0.0028)	(0.0028)	(0.0033)
Assortative	-0.0752***	-0.0746***	-0.0700***	-0.0675***	-0.0606***	-0.0500***	-0.0432***	-0.0633***	-0.0534***	-0.0397***	-0.0347***
mating	(0.0018)	(0.0019)	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0017)	(0.0020)	(0.0019)	(0.0020)	(0.0023)
Opportunities	0.0514***	0.0588***	0.0640***	0.0613***	0.0533***	0.0453***	0.0393***	0.0337***	0.0391***	0.0287***	0.0226***
	(0.0022)	(0.0022)	(0.0020)	(0.0019)	(0.0020)	(0.0019)	(0.0020)	(0.0021)	(0.0021)	(0.0021)	(0.0025)
CR: N	55321	52732	51447	52860	51648	43407	41434	21309	23129	23285	18482
Sweden: N	36424	34059	38139	40184	44439	44885	45587	42732	43883	42025	31960

Notes: Standard errors in parentheses. Standard errors for difference and decomposition terms were estimated via bootstrapping with 500 replications. Outcomes: *Homogamy* (equal education level for wife and husband), *marrying down* (wife more educated), *marrying up* (husband more educated). Significance: * p < .05, ** p < .01, *** p < .001.

Table A4.7. Decomposition of differences in educational sorting outcomes in marriages between Italy and the Czech Republic

	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020
Homogamy											
Italy: Level	0.6432***	0.6318***	0.6165***	0.6533***	0.6565***	0.6698***	0.6786***	0.6927***	0.6690***	0.7048***	0.5324***
	(0.0009)	(0.0009)	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0011)	(0.0010)	(0.0010)	(0.0016)
Czech Republic:	0.5596***	0.5739***	0.5705***	0.5841***	0.5778***	0.5554***	0.5447***	0.5973***	0.5735***	0.5513***	0.5485***
Level	(0.0021)	(0.0022)	(0.0022)	(0.0021)	(0.0022)	(0.0024)	(0.0024)	(0.0034)	(0.0033)	(0.0033)	(0.0037)
Difference	0.0837***	0.0579***	0.0459***	0.0692***	0.0787***	0.1144***	0.1339***	0.0954***	0.0955***	0.1536***	-0.0161***

CR – Italy	(0.0023)	(0.0023)	(0.0025)	(0.0024)	(0.0024)	(0.0025)	(0.0027)	(0.0035)	(0.0034)	(0.0033)	(0.0040)
Assortative	0.0549***	0.0312***	0.0213***	0.0514***	0.0617***	0.0939***	0.1137***	0.0763***	0.0874***	0.1372***	-0.0208***
mating	(0.0023)	(0.0022)	(0.0024)	(0.0023)	(0.0023)	(0.0024)	(0.0026)	(0.0034)	(0.0033)	(0.0033)	(0.0039)
Opportunities	0.0288***	0.0267***	0.0246***	0.0177***	0.0170***	0.0205***	0.0202***	0.0191***	0.0081***	0.0163***	0.0047***
	(0.0009)	(0.0008)	(0.0007)	(0.0007)	(0.0008)	(0.0009)	(0.0010)	(0.0012)	(0.0013)	(0.0017)	(0.0014)
Marrying down											
Italy: Level	0.2193***	0.2244***	0.2348***	0.2237***	0.2249***	0.2206***	0.2189***	0.2099***	0.2357***	0.1984***	0.2914***
	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0015)
Czech Republic:	0.2447***	0.2366***	0.2392***	0.2369***	0.2485***	0.2722***	0.2875***	0.2654***	0.2806***	0.3022***	0.3044***
Level	(0.0018)	(0.0019)	(0.0019)	(0.0018)	(0.0019)	(0.0021)	(0.0022)	(0.0030)	(0.0030)	(0.0030)	(0.0034)
Difference	-0.0255***	-0.0121***	-0.0043*	-0.0131***	-0.0236***	-0.0516***	-0.0685***	-0.0555***	-0.0448***	-0.1037***	-0.0129***
CR – Italy	(0.0019)	(0.0020)	(0.0022)	(0.0021)	(0.0020)	(0.0023)	(0.0023)	(0.0031)	(0.0032)	(0.0032)	(0.0039)
Assortative	-0.0265***	-0.0149***	-0.0105***	-0.0269***	-0.0306***	-0.0450***	-0.0549***	-0.0357***	-0.0396***	-0.0614***	0.0132***
mating	(0.0012)	(0.0012)	(0.0013)	(0.0013)	(0.0012)	(0.0013)	(0.0014)	(0.0019)	(0.0018)	(0.0018)	(0.0022)
Opportunities	0.0010	0.0028	0.0061***	0.0138***	0.0069***	-0.0066***	-0.0136***	-0.0198***	-0.0053*	-0.0424***	-0.0261***
	(0.0016)	(0.0016)	(0.0016)	(0.0017)	(0.0016)	(0.0019)	(0.0019)	(0.0025)	(0.0026)	(0.0029)	(0.0031)
Marrying up											
Italy: Level	0.1375***	0.1437***	0.1487***	0.1230***	0.1187***	0.1096***	0.1024***	0.0974***	0.0953***	0.0967***	0.1762***
	(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0012)
Czech Republic:	0.1957***	0.1895***	0.1903***	0.1790***	0.1737***	0.1724***	0.1678***	0.1373***	0.1459***	0.1465***	0.1472***
Level	(0.0017)	(0.0017)	(0.0017)	(0.0017)	(0.0017)	(0.0018)	(0.0018)	(0.0024)	(0.0023)	(0.0023)	(0.0026)
Difference	-0.0582***	-0.0458***	-0.0416***	-0.0560***	-0.0550***	-0.0628***	-0.0654***	-0.0399***	-0.0506***	-0.0498***	0.0291***
CR – Italy	(0.0018)	(0.0018)	(0.0019)	(0.0019)	(0.0018)	(0.0020)	(0.0019)	(0.0024)	(0.0024)	(0.0023)	(0.0028)
Assortative	-0.0284***	-0.0163***	-0.0109***	-0.0245***	-0.0311***	-0.0489***	-0.0588***	-0.0406***	-0.0478***	-0.0758***	0.0076***
mating	(0.0012)	(0.0012)	(0.0013)	(0.0012)	(0.0012)	(0.0013)	(0.0014)	(0.0018)	(0.0018)	(0.0018)	(0.0021)
Opportunities	-0.0298***	-0.0295***	-0.0307***	-0.0315***	-0.0239***	-0.0139***	-0.0066***	0.0007	-0.0028	0.0260***	0.0214***
	(0.0014)	(0.0014)	(0.0014)	(0.0013)	(0.0013)	(0.0014)	(0.0013)	(0.0016)	(0.0016)	(0.0016)	(0.0021)
Italy: N	284410	270013	248969	245992	246613	217700	207138	189765	203258	195778	96841
CR: N	55321	52732	51447	52860	51648	43407	41434	21309	23129	23285	18482

Notes: Standard errors in parentheses. Standard errors for difference and decomposition terms were estimated via bootstrapping with 500 replications. Outcomes: *Homogamy* (equal education level for wife and husband), *marrying down* (wife more educated), *marrying up* (husband more educated). Significance: * $p < .05$, ** $p < .01$, *** $p < .001$.

8.2.2 Figures

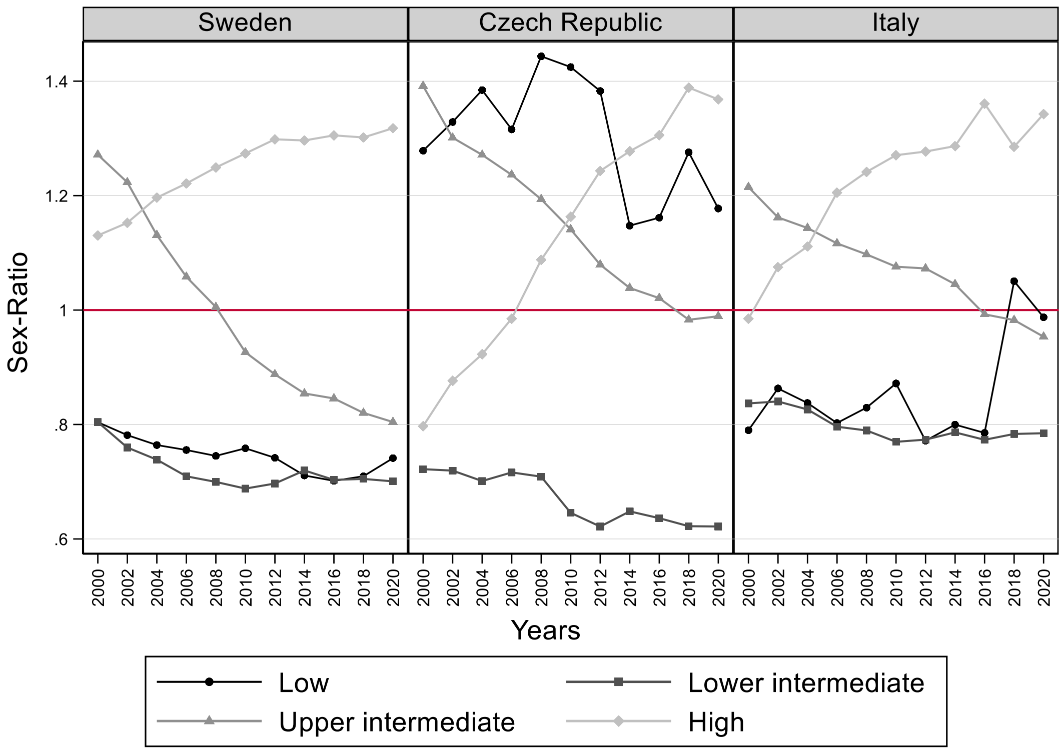

Fig. A4.1 Sex-ratios (wives/husbands) in educational attainment

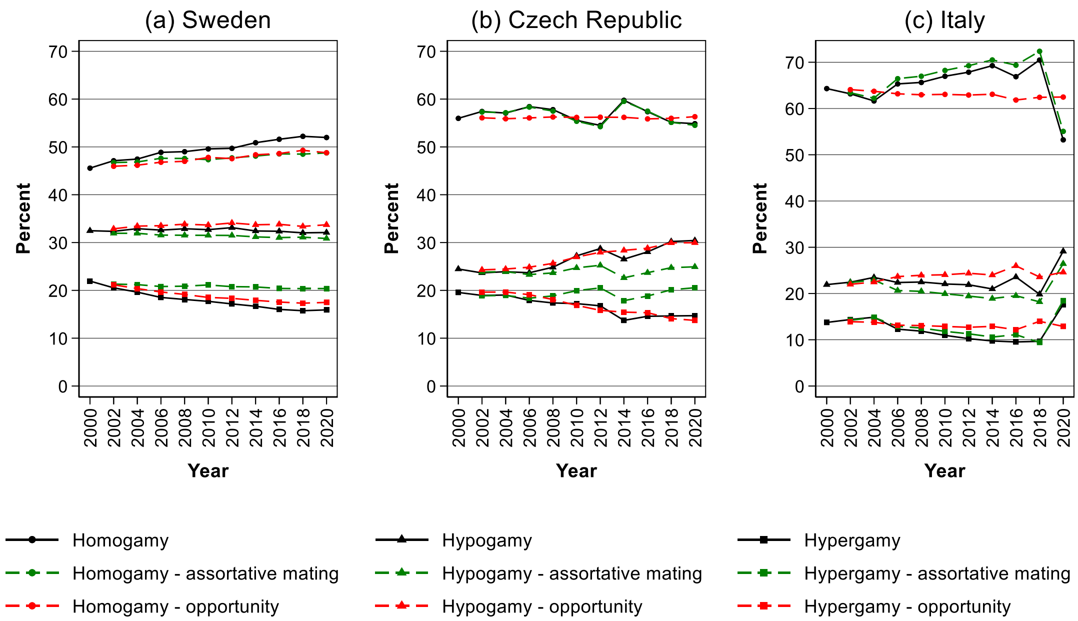

Fig. A4.2 Observed and counterfactual trends in educational sorting outcomes in marriages

8.2.3 Measure of education

Our measure of education is not strictly comparable between countries in terms of years of education. However, the educational categories do account for country-specific differences in their educational systems. The table below illustrates how the educational levels used in this study correspond to country-specific attainment levels and ISCED-11 levels (UNESCO, 2012).

Table D4.1: Education in Sweden, the Czech Republic, and Italy

Country	Educational level	Country-specific educational levels	ISCED levels
Sweden	Low	Förgymnasial utbildning	ISCED 1+2
	Lower intermediate	Gymnasial utbildning (1-2 år)	ISCED 2+3
	Upper intermediate	Gymnasial utbildning (3 år)	ISCED 3
	High	Eftergymnasial utbildning	ISCED 4+5+6+7+8
Czech Republic	Low	Licenza elementare	ISCED 1+2
	Lower intermediate	Licenza media inferior	ISCED 3+4
	Upper intermediate	Licenza media superior	ISCED 3+4
	High	Laurea	ISCED 5+6+7+8
Italy	Low	Základní	ISCED 1
	Lower intermediate	Střední bez maturity	ISCED 2
	Upper intermediate	Střední s maturity	ISCED 3+4
	High	Vysokoškolské	ISCED 5+6+7+8

8.3 Appendix Chapter 5

8.3.1 Tables

Table A5.1: Decomposition of trends in marital sorting outcomes of low-educated partnered French women

	1968	1975	1982	1990	1999	2006	2011
Both low-educated (11)							
Diff. to 1962	-0.1689***	-0.3382***	-0.3943***	-0.5043***	-0.6130***	-0.6416***	-0.6539***
	(0.0018)	(0.0019)	(0.0018)	(0.0017)	(0.0015)	(0.0012)	(0.0012)
Assort. mating	-0.0121***	-0.0203***	-0.0210***	-0.0254***	-0.0246***	-0.0160***	-0.0118***
	(0.0007)	(0.0007)	(0.0007)	(0.0008)	(0.0007)	(0.0005)	(0.0005)
Expansion	-0.1533***	-0.3134***	-0.3734***	-0.4758***	-0.5831***	-0.6158***	-0.6295***
	(0.0014)	(0.0014)	(0.0013)	(0.0012)	(0.0010)	(0.0009)	(0.0009)
Gender gap	0.0032***	0.0013***	0.0029***	0.0057***	0.0049***	0.0045***	0.0041***
	(0.0003)	(0.0004)	(0.0003)	(0.0003)	(0.0002)	(0.0002)	(0.0002)
Gradient	-0.0067**	-0.0057*	-0.0029	-0.0089***	-0.0102***	-0.0144***	-0.0166***
	(0.0022)	(0.0023)	(0.0021)	(0.0020)	(0.0017)	(0.0013)	(0.0013)
She low-educated, he medium-educated (12)							
Diff. to 1962	0.0409***	0.0797***	0.0687***	0.0365***	-0.0224***	-0.0587***	-0.0732***
	(0.0014)	(0.0014)	(0.0013)	(0.0014)	(0.0012)	(0.0010)	(0.0009)
Assort. mating	0.0106***	0.0158***	0.0178***	0.0194***	0.0166***	0.0076***	0.0036***
	(0.0007)	(0.0007)	(0.0007)	(0.0008)	(0.0007)	(0.0005)	(0.0005)
Expansion	0.0445***	0.0649***	0.0659***	0.0489***	0.0056***	-0.0222***	-0.0322***
	(0.0005)	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0005)	(0.0005)
Gender gap	-0.0141***	0.0038**	-0.0054***	-0.0217***	-0.0325***	-0.0315***	-0.0326***
	(0.0012)	(0.0013)	(0.0012)	(0.0012)	(0.0010)	(0.0007)	(0.0007)
Gradient	-0.0001	-0.0049*	-0.0096***	-0.0101***	-0.0121***	-0.0126***	-0.0120***
	(0.0018)	(0.0019)	(0.0017)	(0.0017)	(0.0015)	(0.0012)	(0.0011)
She low-educated, he high-educated (13)							
Diff. to 1962	0.0043***	0.0060***	0.0027***	0.0005	-0.0023***	-0.0030***	-0.0039***
	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0004)	(0.0004)
Assort. mating	0.0015***	0.0045***	0.0032***	0.0059***	0.0080***	0.0084***	0.0082***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0003)	(0.0002)	(0.0002)
Expansion	0.0030***	0.0105***	0.0088***	0.0086***	0.0085***	0.0098***	0.0090***
	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Gender gap	-0.0006	-0.0082***	-0.0076***	-0.0126***	-0.0167***	-0.0191***	-0.0193***
	(0.0003)	(0.0004)	(0.0003)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Gradient	0.0003	-0.0008	-0.0017***	-0.0015**	-0.0022***	-0.0021***	-0.0018***
	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0004)	(0.0004)	(0.0004)
N	122,928	142,809	166,685	135,267	147,298	913,094	894,952

Note: N refers to the weighted sum of wives in the census sample that is compared to T1 (1962), e.g. 1968 in the first column.

Table A5.2: Decomposition of trends in marital sorting outcomes of medium-educated partnered French women

	1968	1975	1982	1990	1999	2006	2011
She medium-educated, he low-educated (21)							
Diff. to 1962	0.0359***	0.0352***	0.0479***	0.0610***	0.0506***	0.0227***	0.0126***
	(0.0010)	(0.0009)	(0.0010)	(0.0011)	(0.0010)	(0.0007)	(0.0006)
Assort. mating	0.0105***	0.0159***	0.0178***	0.0209***	0.0185***	0.0105***	0.0067***
	(0.0007)	(0.0007)	(0.0007)	(0.0008)	(0.0007)	(0.0006)	(0.0006)
Expansion	0.0158***	0.0162***	0.0193***	0.0169***	-0.0024***	-0.0190***	-0.0255***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0003)	(0.0003)
Gender gap	0.0085***	-0.0003	0.0050***	0.0166***	0.0263***	0.0253***	0.0263***
	(0.0008)	(0.0007)	(0.0007)	(0.0008)	(0.0007)	(0.0006)	(0.0006)
Gradient	0.0010	0.0033***	0.0059***	0.0066***	0.0081***	0.0060***	0.0051***
	(0.0011)	(0.0010)	(0.0010)	(0.0011)	(0.0011)	(0.0008)	(0.0008)
Both medium-educated (22)							
Diff. to 1962	0.0546***	0.1080***	0.1462***	0.2092***	0.2461***	0.1982***	0.1859***
	(0.0010)	(0.0011)	(0.0012)	(0.0014)	(0.0014)	(0.0008)	(0.0008)
Assort. mating	-0.0103***	-0.0171***	-0.0187***	-0.0210***	-0.0202***	-0.0158***	-0.0136***
	(0.0007)	(0.0007)	(0.0008)	(0.0010)	(0.0011)	(0.0010)	(0.0012)
Expansion	0.0611***	0.1194***	0.1577***	0.2178***	0.2550***	0.2115***	0.2004***
	(0.0007)	(0.0010)	(0.0011)	(0.0013)	(0.0016)	(0.0017)	(0.0018)
Gender gap	0.0017***	0.0024***	0.0040***	0.0079***	0.0086***	0.0066***	0.0057***
	(0.0002)	(0.0003)	(0.0002)	(0.0003)	(0.0004)	(0.0004)	(0.0004)
Gradient	0.0020	0.0033*	0.0031*	0.0045**	0.0026	-0.0042*	-0.0066***
	(0.0011)	(0.0013)	(0.0014)	(0.0015)	(0.0018)	(0.0019)	(0.0019)
She medium-educated, he high-educated (23)							
Diff. to 1962	0.0185***	0.0263***	0.0337***	0.0381***	0.0461***	0.0502***	0.0527***
	(0.0006)	(0.0007)	(0.0006)	(0.0007)	(0.0007)	(0.0004)	(0.0004)
Assort. mating	-0.0002	0.0012*	0.0009	0.0000	0.0017	0.0053***	0.0069***
	(0.0004)	(0.0005)	(0.0006)	(0.0007)	(0.0009)	(0.0009)	(0.0009)
Expansion	0.0156***	0.0390***	0.0472***	0.0622***	0.0861***	0.0974***	0.1010***
	(0.0003)	(0.0005)	(0.0006)	(0.0008)	(0.0012)	(0.0013)	(0.0013)
Gender gap	0.0021***	-0.0143***	-0.0136***	-0.0239***	-0.0400***	-0.0499***	-0.0526***
	(0.0004)	(0.0006)	(0.0007)	(0.0009)	(0.0012)	(0.0013)	(0.0013)
Gradient	0.0010	0.0004	-0.0008	-0.0002	-0.0017	-0.0026*	-0.0026
	(0.0007)	(0.0008)	(0.0008)	(0.0010)	(0.0012)	(0.0012)	(0.0013)
N	122,928	142,809	166,685	135,267	147,298	913,094	894,952

Note: N refers to the weighted sum of wives in the census sample that is compared to T1 (1962), e.g., 1968 in the first column.

Table A5.3: Decomposition of trends in marital sorting outcomes of high-educated partnered French women

	1968	1975	1982	1990	1999	2006	2011
She high-educated, he low-educated (31)							
Diff. to 1962	0.0024***	0.0111***	0.0097***	0.0157***	0.0251***	0.0291***	0.0294***
	(0.0002)	(0.0003)	(0.0003)	(0.0004)	(0.0004)	(0.0002)	(0.0002)
Assort. mating	0.0016***	0.0044***	0.0032***	0.0044***	0.0061***	0.0055***	0.0051***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0001)
Expansion	0.0005***	0.0027***	0.0024***	0.0036***	0.0054***	0.0066***	0.0064***
	(0.0000)	(0.0001)	(0.0000)	(0.0001)	(0.0001)	(0.0000)	(0.0000)
Gender gap	0.0000	0.0033***	0.0030***	0.0062***	0.0110***	0.0134***	0.0142***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0001)
Gradient	0.0003**	0.0007***	0.0011***	0.0015***	0.0026***	0.0036***	0.0036***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0001)
She high-educated, he medium-educated (32)							
Diff. to 1962	0.0032***	0.0261***	0.0293***	0.0542***	0.1046***	0.1471***	0.1609***
	(0.0002)	(0.0004)	(0.0004)	(0.0006)	(0.0008)	(0.0004)	(0.0004)
Assort. mating	-0.0003	0.0012***	0.0009***	0.0015***	0.0036***	0.0081***	0.0099***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0001)	(0.0001)
Expansion	0.0035***	0.0160***	0.0191***	0.0336***	0.0624***	0.0830***	0.0903***
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0003)	(0.0001)	(0.0001)
Gender gap	-0.0005***	0.0075***	0.0072***	0.0157***	0.0319***	0.0448***	0.0489***
	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0003)	(0.0001)	(0.0001)
Gradient	0.0004**	0.0013***	0.0021***	0.0035***	0.0067***	0.0111***	0.0117***
	(0.0001)	(0.0002)	(0.0002)	(0.0003)	(0.0005)	(0.0002)	(0.0002)
Both high-educated (33)							
Diff. to 1962	0.0093***	0.0458***	0.0561***	0.0892***	0.1652***	0.2560***	0.2895***
	(0.0004)	(0.0006)	(0.0006)	(0.0008)	(0.0010)	(0.0005)	(0.0005)
Assort. mating	-0.0013***	-0.0057***	-0.0041***	-0.0059***	-0.0097***	-0.0137***	-0.0151***
	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0001)	(0.0001)
Expansion	0.0093***	0.0446***	0.0529***	0.0843***	0.1624***	0.2486***	0.2801***
	(0.0002)	(0.0003)	(0.0003)	(0.0004)	(0.0005)	(0.0002)	(0.0003)
Gender gap	-0.0004***	0.0045***	0.0044***	0.0061***	0.0064***	0.0059***	0.0054***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Gradient	0.0018***	0.0024***	0.0029***	0.0047***	0.0062***	0.0152***	0.0192***
	(0.0004)	(0.0004)	(0.0004)	(0.0005)	(0.0006)	(0.0003)	(0.0003)
N	122,928	142,809	166,685	135,267	147,298	913,094	894,952

Note: N refers to the weighted sum of wives in the census sample that is compared to T1 (1962), e.g., 1968 in the first column.

Table A5.4: Decomposition of trends in marital sorting outcomes of low-educated partnered US-American women

	1970	1980	1990	2000	2005	2010	2015
Both low-educated (11)							
Diff. to 1962	-0.1188***	-0.2072***	-0.2357***	-0.2308***	-0.2326***	-0.2347***	-0.2502***
	(0.0020)	(0.0016)	(0.0015)	(0.0015)	(0.0016)	(0.0015)	(0.0016)
Assort. mating	0.0013	0.0104***	0.0148***	0.0198***	0.0199***	0.0215***	0.0189***
	(0.0009)	(0.0006)	(0.0006)	(0.0005)	(0.0008)	(0.0008)	(0.0009)
Expansion	-0.1138***	-0.2135***	-0.2418***	-0.2494***	-0.2549***	-0.2524***	-0.2663***
	(0.0012)	(0.0009)	(0.0009)	(0.0009)	(0.0014)	(0.0014)	(0.0016)
Gender gap	0.0008***	0.0007***	0.0003*	-0.0003*	0.0005**	-0.0008***	-0.0008***
	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)
Gradient	-0.0071***	-0.0049***	-0.0090***	-0.0009	0.0019	-0.0029	-0.0021
	(0.0021)	(0.0013)	(0.0012)	(0.0013)	(0.0018)	(0.0018)	(0.0020)
She low-educated, he medium-educated (12)							
Diff. to 1962	-0.0043**	-0.0328***	-0.0488***	-0.0555***	-0.0586***	-0.0627***	-0.0694***
	(0.0013)	(0.0010)	(0.0010)	(0.0010)	(0.0012)	(0.0012)	(0.0011)
Assort. mating	-0.0004	-0.0094***	-0.0139***	-0.0195***	-0.0201***	-0.0212***	-0.0203***
	(0.0009)	(0.0006)	(0.0006)	(0.0006)	(0.0008)	(0.0008)	(0.0008)
Expansion	-0.0104***	-0.0334***	-0.0424***	-0.0427***	-0.0451***	-0.0449***	-0.0517***
	(0.0002)	(0.0003)	(0.0003)	(0.0004)	(0.0005)	(0.0005)	(0.0006)
Gender gap	0.0090***	0.0119***	0.0079***	0.0038***	0.0083***	-0.0002	-0.0013
	(0.0011)	(0.0007)	(0.0007)	(0.0007)	(0.0010)	(0.0009)	(0.0009)
Gradient	-0.0025	-0.0019*	-0.0005	0.0029**	-0.0017	0.0035**	0.0039**
	(0.0015)	(0.0010)	(0.0009)	(0.0009)	(0.0013)	(0.0014)	(0.0013)
She low-educated, he high-educated (13)							
Diff. to 1962	-0.0018***	-0.0031***	-0.0049***	-0.0048***	-0.0047***	-0.0053***	-0.0046***
	(0.0004)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Assort. mating	-0.0010**	-0.0011***	-0.0010***	-0.0003	0.0003	-0.0004	0.0014***
	(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0004)
Expansion	-0.0000	-0.0004***	-0.0016***	-0.0008***	-0.0005***	-0.0004***	-0.0011***
	(0.0001)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
Gender gap	-0.0005***	-0.0014***	-0.0025***	-0.0041***	-0.0044***	-0.0055***	-0.0064***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0003)
Gradient	-0.0003	-0.0002	0.0001	0.0004***	-0.0000	0.0010***	0.0015***
	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)
N	99,481	638,474	710,181	612,808	109,899	108,274	105,205

Note: N refers to the weighted sum of wives in the census sample that is compared to T1 (1960), e.g., 1970 in the first column.

Table A5.5: Decomposition of trends in marital sorting outcomes of medium-educated partnered US-American women

	1970	1980	1990	2000	2005	2010	2015
She medium-educated, he low-educated (21)							
Diff. to 1962	-0.0329***	-0.0826***	-0.0980***	-0.1023***	-0.1048***	-0.1072***	-0.1161***
	(0.0015)	(0.0012)	(0.0013)	(0.0012)	(0.0014)	(0.0014)	(0.0013)
Assort. mating	-0.0014	-0.0099***	-0.0139***	-0.0183***	-0.0179***	-0.0191***	-0.0173***
	(0.0009)	(0.0006)	(0.0006)	(0.0006)	(0.0008)	(0.0009)	(0.0009)
Expansion	-0.0227***	-0.0610***	-0.0726***	-0.0749***	-0.0778***	-0.0783***	-0.0885***
	(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0007)	(0.0007)	(0.0009)
Gender gap	-0.0103***	-0.0126***	-0.0075***	-0.0022*	-0.0082***	0.0029*	0.0042***
	(0.0015)	(0.0009)	(0.0009)	(0.0009)	(0.0013)	(0.0012)	(0.0012)
Gradient	0.0015	0.0009	-0.0040***	-0.0070***	-0.0009	-0.0127***	-0.0145***
	(0.0020)	(0.0013)	(0.0012)	(0.0012)	(0.0019)	(0.0018)	(0.0017)
Both medium-educated (22)							
Diff. to 1962	0.0965***	0.1627***	0.2234***	0.1706***	0.1400***	0.1172***	0.1005***
	(0.0022)	(0.0016)	(0.0015)	(0.0017)	(0.0021)	(0.0021)	(0.0022)
Assort. mating	0.0030**	0.0092***	0.0133***	0.0200***	0.0198***	0.0205***	0.0193***
	(0.0010)	(0.0009)	(0.0009)	(0.0009)	(0.0010)	(0.0011)	(0.0012)
Expansion	0.0821***	0.1367***	0.1897***	0.1400***	0.1182***	0.1001***	0.0935***
	(0.0015)	(0.0013)	(0.0014)	(0.0014)	(0.0018)	(0.0017)	(0.0019)
Gender gap	0.0060***	0.0131***	0.0166***	0.0183***	0.0194***	0.0185***	0.0186***
	(0.0004)	(0.0004)	(0.0003)	(0.0004)	(0.0005)	(0.0005)	(0.0005)
Gradient	0.0055*	0.0038	0.0038	-0.0078***	-0.0174***	-0.0219***	-0.0308***
	(0.0025)	(0.0020)	(0.0020)	(0.0021)	(0.0025)	(0.0025)	(0.0027)
She medium-educated, he high-educated (23)							
Diff. to 1962	0.0176***	0.0407***	0.0166***	-0.0030**	-0.0090***	-0.0144***	-0.0109***
	(0.0013)	(0.0010)	(0.0010)	(0.0009)	(0.0013)	(0.0012)	(0.0012)
Assort. mating	-0.0016*	0.0008	0.0007	-0.0018*	-0.0018*	-0.0014	-0.0020*
	(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0009)	(0.0009)	(0.0010)
Expansion	0.0343***	0.0795***	0.0756***	0.0839***	0.0881***	0.0879***	0.0960***
	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0007)	(0.0007)	(0.0008)
Gender gap	-0.0154***	-0.0396***	-0.0635***	-0.0853***	-0.0921***	-0.1061***	-0.1097***
	(0.0013)	(0.0012)	(0.0012)	(0.0012)	(0.0014)	(0.0014)	(0.0015)
Gradient	0.0003	0.0001	0.0038**	0.0002	-0.0031	0.0052**	0.0048**
	(0.0019)	(0.0016)	(0.0015)	(0.0015)	(0.0016)	(0.0016)	(0.0017)
N	99,481	638,474	710,181	612,808	109,899	108,274	105,205

Note: N refers to the weighted sum of wives in the census sample that is compared to T1 (1960), e.g., 1970 in the first column.

Table A5.6: Decomposition of trends in marital sorting outcomes of high-educated partnered US-American women

	1970	1980	1990	2000	2005	2010	2015
She high-educated, he low-educated (31)							
Diff. to 1962	0.0003	-0.0005*	-0.0007***	0.0004	0.0008**	0.0010***	0.0014***
	(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0003)
Assort. mating	0.0001	-0.0005*	-0.0009***	-0.0016***	-0.0020***	-0.0024***	-0.0017***
	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Expansion	-0.0005***	-0.0012***	-0.0020***	-0.0019***	-0.0018***	-0.0019***	-0.0026***
	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Gender gap	0.0006***	0.0012***	0.0023***	0.0038***	0.0039***	0.0052***	0.0055***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)
Gradient	0.0001	0.0001	-0.0001	0.0001	0.0006***	0.0000	0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
She high-educated, he medium-educated (32)							
Diff. to 1962	0.0096***	0.0338***	0.0558***	0.0830***	0.0999***	0.1146***	0.1237***
	(0.0006)	(0.0005)	(0.0005)	(0.0005)	(0.0011)	(0.0011)	(0.0011)
Assort. mating	-0.0026***	0.0002	0.0006	-0.0005	0.0004	0.0007	0.0011
	(0.0005)	(0.0006)	(0.0007)	(0.0007)	(0.0008)	(0.0009)	(0.0010)
Expansion	0.0061***	0.0174***	0.0236***	0.0325***	0.0377***	0.0418***	0.0458***
	(0.0001)	(0.0003)	(0.0003)	(0.0004)	(0.0005)	(0.0005)	(0.0006)
Gender gap	0.0053***	0.0154***	0.0306***	0.0474***	0.0547***	0.0670***	0.0699***
	(0.0005)	(0.0005)	(0.0007)	(0.0008)	(0.0010)	(0.0011)	(0.0011)
Gradient	0.0008	0.0008	0.0010	0.0036**	0.0071***	0.0052***	0.0070***
	(0.0006)	(0.0007)	(0.0010)	(0.0012)	(0.0014)	(0.0015)	(0.0016)
Both high-educated (33)							
Diff. to 1962	0.0336***	0.0889***	0.0923***	0.1424***	0.1690***	0.1916***	0.2257***
	(0.0012)	(0.0008)	(0.0008)	(0.0008)	(0.0014)	(0.0015)	(0.0016)
Assort. mating	0.0026***	0.0003	0.0003	0.0021**	0.0016*	0.0017*	0.0006
	(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0008)	(0.0009)	(0.0009)
Expansion	0.0248***	0.0759***	0.0717***	0.1133***	0.1362***	0.1482***	0.1749***
	(0.0007)	(0.0008)	(0.0008)	(0.0010)	(0.0012)	(0.0012)	(0.0013)
Gender gap	0.0047***	0.0112***	0.0156***	0.0185***	0.0177***	0.0190***	0.0200***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0005)	(0.0005)
Gradient	0.0016	0.0014	0.0048***	0.0085***	0.0136***	0.0227***	0.0301***
	(0.0013)	(0.0014)	(0.0012)	(0.0015)	(0.0017)	(0.0017)	(0.0017)
N	99,481	638,474	710,181	612,808	109,899	108,274	105,205

Note: N refers to the weighted sum of wives in the census sample that is compared to T1 (1960), e.g. 1970 in the first column.

Table A5.7: Decomposition of trends in marital sorting outcomes of low-educated partnered French women aged 35 to 44

	1968	1975	1982	1990	1999	2006	2011
Both low-educated (11)							
Diff. to 1962	-0.0977***	-0.2219***	-0.3515***	-0.4907***	-0.6150***	-0.6729***	-0.7057***
	(0.0017)	(0.0018)	(0.0019)	(0.0016)	(0.0015)	(0.0012)	(0.0012)
Assort. mating	-0.0067***	-0.0134***	-0.0169***	-0.0248***	-0.0303***	-0.0230***	-0.0175***
	(0.0006)	(0.0007)	(0.0007)	(0.0008)	(0.0007)	(0.0006)	(0.0006)
Expansion	-0.0902***	-0.2023***	-0.3316***	-0.4629***	-0.5814***	-0.6432***	-0.6794***
	(0.0013)	(0.0014)	(0.0014)	(0.0014)	(0.0012)	(0.0009)	(0.0009)
Gender gap	0.0021***	0.0013**	0.0037***	0.0055***	0.0081***	0.0084***	0.0077***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.0002)
Gradient	-0.0030	-0.0075***	-0.0066**	-0.0085***	-0.0114***	-0.0151***	-0.0166***
	(0.0021)	(0.0022)	(0.0022)	(0.0021)	(0.0019)	(0.0015)	(0.0013)
She low-educated, he medium-educated (12)							
Diff. to 1962	0.0339***	0.0856***	0.0966***	0.0991***	0.0632***	0.0155***	-0.0170***
	(0.0012)	(0.0013)	(0.0014)	(0.0014)	(0.0012)	(0.0009)	(0.0008)
Assort. mating	0.0066***	0.0123***	0.0162***	0.0220***	0.0238***	0.0159***	0.0108***
	(0.0005)	(0.0007)	(0.0008)	(0.0008)	(0.0007)	(0.0007)	(0.0006)
Expansion	0.0342***	0.0688***	0.0888***	0.0907***	0.0681***	0.0367***	0.0119***
	(0.0006)	(0.0007)	(0.0008)	(0.0008)	(0.0008)	(0.0007)	(0.0006)
Gender gap	-0.0079***	0.0046***	-0.0040**	-0.0066***	-0.0202***	-0.0272***	-0.0299***
	(0.0011)	(0.0012)	(0.0013)	(0.0012)	(0.0011)	(0.0009)	(0.0007)
Gradient	0.0011	-0.0001	-0.0045*	-0.0069***	-0.0085***	-0.0099***	-0.0098***
	(0.0016)	(0.0018)	(0.0019)	(0.0018)	(0.0017)	(0.0013)	(0.0012)
She low-educated, he high-educated (13)							
Diff. to 1962	0.0027***	-0.0001	0.0024***	0.0028***	-0.0011*	-0.0039***	-0.0069***
	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0005)	(0.0004)	(0.0004)
Assort. mating	0.0001	0.0011*	0.0007	0.0028***	0.0064***	0.0071***	0.0067***
	(0.0004)	(0.0004)	(0.0005)	(0.0004)	(0.0004)	(0.0003)	(0.0003)
Expansion	0.0020***	0.0064***	0.0110***	0.0150***	0.0125***	0.0120***	0.0119***
	(0.0003)	(0.0003)	(0.0003)	(0.0005)	(0.0004)	(0.0004)	(0.0003)
Gender gap	0.0001	-0.0077***	-0.0084***	-0.0135***	-0.0189***	-0.0214***	-0.0239***
	(0.0004)	(0.0004)	(0.0005)	(0.0006)	(0.0006)	(0.0005)	(0.0005)
Gradient	0.0005	0.0001	-0.0009	-0.0015*	-0.0011	-0.0016**	-0.0016**
	(0.0007)	(0.0006)	(0.0006)	(0.0007)	(0.0006)	(0.0005)	(0.0005)
N	140,442	134,897	126,166	141,770	165,343	1,031,548	1,000,068

Note: N refers to the weighted sum of wives in the census sample that is compared to T1 (1962), e.g. 1968 in the first column.

Table A5.8: Decomposition of trends in marital sorting outcomes of medium-educated partnered French women aged 35 to 44

	1968	1975	1982	1990	1999	2006	2011
She medium-educated, he low-educated (21)							
Diff. to 1962	0.0220***	0.0313***	0.0478***	0.0573***	0.0684***	0.0577***	0.0429***
	(0.0008)	(0.0009)	(0.0009)	(0.0010)	(0.0009)	(0.0006)	(0.0006)
Assort. mating	0.0065***	0.0115***	0.0157***	0.0214***	0.0243***	0.0182***	0.0130***
	(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0006)	(0.0006)
Expansion	0.0113***	0.0186***	0.0246***	0.0250***	0.0239***	0.0129***	0.0010***
	(0.0003)	(0.0003)	(0.0004)	(0.0004)	(0.0004)	(0.0003)	(0.0003)
Gender gap	0.0042***	-0.0010	0.0037***	0.0061***	0.0153***	0.0212***	0.0240***
	(0.0006)	(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0006)	(0.0006)
Gradient	-0.0000	0.0021*	0.0038***	0.0048***	0.0049***	0.0054***	0.0048***
	(0.0009)	(0.0009)	(0.0010)	(0.0010)	(0.0010)	(0.0009)	(0.0008)
Both medium-educated (22)							
Diff. to 1962	0.0220***	0.0313***	0.0478***	0.0573***	0.0684***	0.0577***	0.0429***
	(0.0008)	(0.0009)	(0.0009)	(0.0010)	(0.0009)	(0.0006)	(0.0006)
Assort. mating	0.0065***	0.0115***	0.0157***	0.0214***	0.0243***	0.0182***	0.0130***
	(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0006)	(0.0006)
Expansion	0.0113***	0.0186***	0.0246***	0.0250***	0.0239***	0.0129***	0.0010***
	(0.0003)	(0.0003)	(0.0004)	(0.0004)	(0.0004)	(0.0003)	(0.0003)
Gender gap	0.0042***	-0.0010	0.0037***	0.0061***	0.0153***	0.0212***	0.0240***
	(0.0006)	(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0006)	(0.0006)
Gradient	-0.0000	0.0021*	0.0038***	0.0048***	0.0049***	0.0054***	0.0048***
	(0.0009)	(0.0009)	(0.0010)	(0.0010)	(0.0010)	(0.0009)	(0.0008)
She medium-educated, he high-educated (23)							
Diff. to 1962	0.0104***	0.0121***	0.0296***	0.0425***	0.0474***	0.0555***	0.0577***
	(0.0005)	(0.0005)	(0.0007)	(0.0007)	(0.0006)	(0.0004)	(0.0004)
Assort. mating	-0.0004	-0.0004	-0.0015**	-0.0023***	-0.0038***	-0.0026*	-0.0006
	(0.0004)	(0.0004)	(0.0005)	(0.0007)	(0.0009)	(0.0011)	(0.0011)
Expansion	0.0085***	0.0195***	0.0398***	0.0638***	0.0823***	0.0998***	0.1114***
	(0.0002)	(0.0003)	(0.0005)	(0.0008)	(0.0011)	(0.0014)	(0.0014)
Gender gap	0.0018***	-0.0082***	-0.0096***	-0.0198***	-0.0321***	-0.0420***	-0.0527***
	(0.0003)	(0.0004)	(0.0006)	(0.0008)	(0.0010)	(0.0012)	(0.0014)
Gradient	0.0005	0.0011*	0.0009	0.0008	0.0010	0.0003	-0.0005
	(0.0005)	(0.0006)	(0.0008)	(0.0011)	(0.0011)	(0.0013)	(0.0014)
N	140,442	134,897	126,166	141,770	165,343	1,031,548	1,000,068

Note: N refers to the weighted sum of wives in the census sample that is compared to T1 (1962), e.g. 1968 in the first column.

Table A5.9: Decomposition of trends in marital sorting outcomes of high-educated partnered French women aged 35 to 44

	1968	1975	1982	1990	1999	2006	2011
She high-educated, he low-educated (31)							

Diff. to 1962	0.0002	0.0056***	0.0057***	0.0120***	0.0208***	0.0228***	0.0272***
	(0.0001)	(0.0003)	(0.0002)	(0.0003)	(0.0004)	(0.0002)	(0.0002)
Assort. mating	0.0001	0.0019***	0.0012***	0.0034***	0.0060***	0.0048***	0.0044***
	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0001)
Expansion	0.0002***	0.0011***	0.0016***	0.0032***	0.0047***	0.0049***	0.0060***
	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0000)	(0.0000)
Gender gap	-0.0001*	0.0026***	0.0024***	0.0046***	0.0087***	0.0110***	0.0141***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0001)
Gradient	-0.0000	0.0001	0.0005***	0.0009***	0.0014***	0.0021***	0.0027***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
She high-educated, he medium-educated (32)							
Diff. to 1962	0.0009***	0.0097***	0.0156***	0.0334***	0.0638***	0.0972***	0.1296***
	(0.0002)	(0.0003)	(0.0004)	(0.0005)	(0.0006)	(0.0003)	(0.0003)
Assort. mating	-0.0004**	-0.0012***	-0.0021***	-0.0030***	-0.0033***	-0.0003**	0.0017***
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0001)
Expansion	0.0017***	0.0067***	0.0122***	0.0242***	0.0430***	0.0611***	0.0783***
	(0.0000)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0001)	(0.0001)
Gender gap	-0.0004***	0.0040***	0.0046***	0.0104***	0.0208***	0.0304***	0.0416***
	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0001)	(0.0001)
Gradient	0.0000	0.0002	0.0008***	0.0018***	0.0033***	0.0061***	0.0080***
	(0.0001)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0002)	(0.0002)
She high-educated, he high-educated (33)							
Diff. to 1962	0.0035***	0.0177***	0.0410***	0.0797***	0.1171***	0.1691***	0.2342***
	(0.0003)	(0.0004)	(0.0006)	(0.0008)	(0.0008)	(0.0004)	(0.0004)
Assort. mating	0.0002	-0.0007***	0.0008***	-0.0005*	-0.0027***	-0.0045***	-0.0062***
	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0001)
Expansion	0.0035***	0.0143***	0.0337***	0.0696***	0.1050***	0.1541***	0.2170***
	(0.0001)	(0.0002)	(0.0003)	(0.0004)	(0.0004)	(0.0002)	(0.0002)
Gender gap	-0.0005***	0.0036***	0.0045***	0.0075***	0.0089***	0.0096***	0.0095***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0000)
Gradient	0.0003	0.0006	0.0019***	0.0031***	0.0058***	0.0099***	0.0138***
	(0.0003)	(0.0003)	(0.0004)	(0.0004)	(0.0005)	(0.0002)	(0.0002)
N	140,442	134,897	126,166	141,770	165,343	1,031,548	1,000,068

Note: N refers to the weighted sum of wives in the census sample that is compared to T1 (1962), e.g. 1968 in the first column.

Table A5.10: Decomposition of trends in marital sorting outcomes of low-educated partnered US-American women aged 35 to 44

	1968	1975	1982	1990	1999	2006	2011
Both low-educated (11)							
Diff. to 1962	-0.1041***	-0.2249***	-0.3031***	-0.3088***	-0.3090***	-0.3054***	-0.3047***
	(0.0021)	(0.0016)	(0.0016)	(0.0015)	(0.0016)	(0.0016)	(0.0016)

Assort. mating	-0.0028**	-0.0001	0.0114***	0.0162***	0.0174***	0.0215***	0.0217***
	(0.0009)	(0.0006)	(0.0005)	(0.0005)	(0.0007)	(0.0007)	(0.0008)
Expansion	-0.0975***	-0.2197***	-0.3074***	-0.3180***	-0.3245***	-0.3220***	-0.3283***
	(0.0015)	(0.0009)	(0.0010)	(0.0010)	(0.0014)	(0.0015)	(0.0015)
Gender gap	0.0011***	0.0013***	0.0004**	0.0007***	0.0011***	0.0005**	0.0010***
	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)
Gradient	-0.0050*	-0.0064***	-0.0075***	-0.0076***	-0.0030	-0.0054**	0.0010
	(0.0024)	(0.0015)	(0.0013)	(0.0012)	(0.0018)	(0.0019)	(0.0019)
She low-educated, he medium-educated (12)							
Diff. to 1962	0.0009	-0.0113***	-0.0477***	-0.0523***	-0.0557***	-0.0593***	-0.0610***
	(0.0013)	(0.0009)	(0.0010)	(0.0009)	(0.0010)	(0.0010)	(0.0011)
Assort. mating	0.0027**	0.0008	-0.0101***	-0.0153***	-0.0169***	-0.0209***	-0.0222***
	(0.0009)	(0.0006)	(0.0005)	(0.0005)	(0.0006)	(0.0007)	(0.0008)
Expansion	-0.0036***	-0.0190***	-0.0401***	-0.0433***	-0.0452***	-0.0441***	-0.0473***
	(0.0001)	(0.0002)	(0.0003)	(0.0003)	(0.0005)	(0.0005)	(0.0005)
Gender gap	0.0046***	0.0104***	0.0052***	0.0079***	0.0105***	0.0068***	0.0094***
	(0.0011)	(0.0008)	(0.0007)	(0.0006)	(0.0009)	(0.0009)	(0.0009)
Gradient	-0.0028	-0.0035***	-0.0028**	-0.0015	-0.0041***	-0.0011	-0.0009
	(0.0015)	(0.0010)	(0.0009)	(0.0008)	(0.0011)	(0.0011)	(0.0012)
She low-educated, he high-educated (13)							
Diff. to 1962	0.0017***	0.0002	-0.0031***	-0.0036***	-0.0034***	-0.0035***	-0.0027***
	(0.0004)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Assort. mating	0.0001	-0.0007*	-0.0013***	-0.0009***	-0.0005	-0.0005*	0.0005
	(0.0004)	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0003)
Expansion	0.0012***	0.0011***	-0.0003***	-0.0008***	-0.0004***	-0.0000	0.0003***
	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Gender gap	0.0008***	0.0003**	-0.0013***	-0.0020***	-0.0023***	-0.0034***	-0.0042***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Gradient	-0.0003	-0.0005**	-0.0002	0.0002	-0.0002	0.0005**	0.0007***
	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
N	95,362	493,453	702,210	797,502	153,491	137,521	126,459

Note: N refers to the weighted sum of wives in the census sample that is compared to T1 (1962), e.g. 1968 in the first column.

Table A5.11: Decomposition of trends in marital sorting outcomes of medium-educated partnered US-American women aged 35 to 44

	1968	1975	1982	1990	1999	2006	2011
She medium-educated, he low-educated (21)							
Diff. to 1962	-0.0158***	-0.0557***	-0.1008***	-0.1102***	-0.1129***	-0.1162***	-0.1197***
	(0.0016)	(0.0012)	(0.0012)	(0.0012)	(0.0013)	(0.0013)	(0.0013)
Assort. mating	0.0024*	0.0011	-0.0096***	-0.0141***	-0.0148***	-0.0182***	-0.0184***

	(0.0010)	(0.0007)	(0.0006)	(0.0006)	(0.0007)	(0.0007)	(0.0008)
Expansion	-0.0144***	-0.0462***	-0.0855***	-0.0834***	-0.0861***	-0.0831***	-0.0824***
	(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0007)	(0.0007)	(0.0007)
Gender gap	-0.0072***	-0.0137***	-0.0059***	-0.0092***	-0.0129***	-0.0077***	-0.0110***
	(0.0016)	(0.0011)	(0.0009)	(0.0009)	(0.0013)	(0.0012)	(0.0013)
Gradient	0.0034	0.0031*	0.0002	-0.0035**	0.0009	-0.0072***	-0.0080***
	(0.0022)	(0.0014)	(0.0013)	(0.0012)	(0.0017)	(0.0017)	(0.0017)
Both medium-educated (22)							
Diff. to 1962	0.0564***	0.1426***	0.1950***	0.2129***	0.1775***	0.1427***	0.1021***
	(0.0020)	(0.0015)	(0.0015)	(0.0014)	(0.0019)	(0.0019)	(0.0020)
Assort. mating	-0.0002	0.0039***	0.0111***	0.0162***	0.0186***	0.0218***	0.0210***
	(0.0010)	(0.0008)	(0.0009)	(0.0009)	(0.0011)	(0.0011)	(0.0011)
Expansion	0.0544***	0.1318***	0.1754***	0.1925***	0.1618***	0.1306***	0.1017***
	(0.0015)	(0.0012)	(0.0015)	(0.0015)	(0.0019)	(0.0019)	(0.0018)
Gender gap	-0.0002	0.0040***	0.0107***	0.0134***	0.0148***	0.0146***	0.0146***
	(0.0004)	(0.0003)	(0.0004)	(0.0003)	(0.0004)	(0.0004)	(0.0004)
Gradient	0.0024	0.0029	-0.0021	-0.0092***	-0.0178***	-0.0244***	-0.0351***
	(0.0023)	(0.0019)	(0.0020)	(0.0020)	(0.0025)	(0.0025)	(0.0024)
She medium-educated, he high-educated (23)							
Diff. to 1962	0.0330***	0.0597***	0.0704***	0.0464***	0.0359***	0.0287***	0.0219***
	(0.0012)	(0.0009)	(0.0009)	(0.0009)	(0.0011)	(0.0012)	(0.0011)
Assort. mating	-0.0022***	-0.0050***	-0.0015*	-0.0021**	-0.0039***	-0.0036***	-0.0026**
	(0.0006)	(0.0006)	(0.0007)	(0.0008)	(0.0009)	(0.0009)	(0.0009)
Expansion	0.0310***	0.0730***	0.1083***	0.0997***	0.1038***	0.1033***	0.1047***
	(0.0006)	(0.0006)	(0.0008)	(0.0008)	(0.0009)	(0.0009)	(0.0009)
Gender gap	0.0048***	-0.0062***	-0.0356***	-0.0534***	-0.0615***	-0.0735***	-0.0807***
	(0.0011)	(0.0011)	(0.0013)	(0.0012)	(0.0014)	(0.0014)	(0.0014)
Gradient	-0.0006	-0.0020	-0.0008	0.0023	-0.0026	0.0026	0.0005
	(0.0016)	(0.0016)	(0.0017)	(0.0015)	(0.0017)	(0.0017)	(0.0017)
N	95,362	493,453	702,210	797,502	153,491	137,521	126,459

Note: N refers to the weighted sum of wives in the census sample that is compared to T1 (1962), e.g. 1968 in the first column.

Table A5.12: Decomposition of trends in marital sorting outcomes of high-educated partnered US-American women aged 35 to 44

	1968	1975	1982	1990	1999	2006	2011
She high-educated, he low-educated (31)							
Diff. to 1962	0.0001	-0.0013***	-0.0020***	-0.0018***	-0.0012***	-0.0009**	0.0004
	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0003)	(0.0003)
Assort. mating	0.0004	-0.0010***	-0.0018***	-0.0021***	-0.0026***	-0.0033***	-0.0033***
	(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0003)

Expansion	0.0001***	-0.0007***	-0.0022***	-0.0025***	-0.0024***	-0.0021***	-0.0017***
	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Gender gap	-0.0008***	-0.0001	0.0016***	0.0025***	0.0028***	0.0039***	0.0044***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Gradient	0.0004*	0.0005***	0.0005***	0.0004**	0.0010***	0.0006***	0.0010***
	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
She high-educated, he medium-educated (32)							
Diff. to 1962	0.0027***	0.0161***	0.0529***	0.0732***	0.0886***	0.1037***	0.1232***
	(0.0007)	(0.0005)	(0.0005)	(0.0005)	(0.0009)	(0.0009)	(0.0011)
Assort. mating	-0.0025***	-0.0047***	-0.0010	-0.0009	-0.0017*	-0.0009	0.0012
	(0.0005)	(0.0005)	(0.0007)	(0.0008)	(0.0009)	(0.0009)	(0.0009)
Expansion	0.0060***	0.0160***	0.0328***	0.0391***	0.0452***	0.0498***	0.0571***
	(0.0001)	(0.0002)	(0.0004)	(0.0005)	(0.0006)	(0.0006)	(0.0007)
Gender gap	-0.0018***	0.0025***	0.0171***	0.0300***	0.0369***	0.0468***	0.0554***
	(0.0004)	(0.0004)	(0.0007)	(0.0007)	(0.0009)	(0.0010)	(0.0011)
Gradient	0.0010	0.0023***	0.0040***	0.0050***	0.0083***	0.0079***	0.0095***
	(0.0006)	(0.0006)	(0.0009)	(0.0011)	(0.0013)	(0.0015)	(0.0017)
She high-educated, he high-educated (33)							
Diff. to 1962	0.0251***	0.0747***	0.1385***	0.1440***	0.1803***	0.2103***	0.2405***
	(0.0010)	(0.0007)	(0.0007)	(0.0007)	(0.0011)	(0.0013)	(0.0014)
Assort. mating	0.0022***	0.0057***	0.0028***	0.0030***	0.0043***	0.0042***	0.0021*
	(0.0005)	(0.0006)	(0.0007)	(0.0008)	(0.0009)	(0.0009)	(0.0009)
Expansion	0.0227***	0.0638***	0.1190***	0.1168***	0.1478***	0.1677***	0.1960***
	(0.0006)	(0.0008)	(0.0010)	(0.0010)	(0.0013)	(0.0013)	(0.0014)
Gender gap	-0.0013***	0.0015***	0.0079***	0.0102***	0.0106***	0.0119***	0.0110***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0004)	(0.0004)
Gradient	0.0016	0.0037***	0.0088***	0.0140***	0.0176***	0.0265***	0.0314***
	(0.0010)	(0.0011)	(0.0013)	(0.0014)	(0.0016)	(0.0017)	(0.0017)
N	95,362	493,453	702,210	797,502	153,491	137,521	126,459

Note: N refers to the weighted sum of wives in the census sample that is compared to T1 (1962), e.g. 1968 in the first column.

8.3.2 Figures

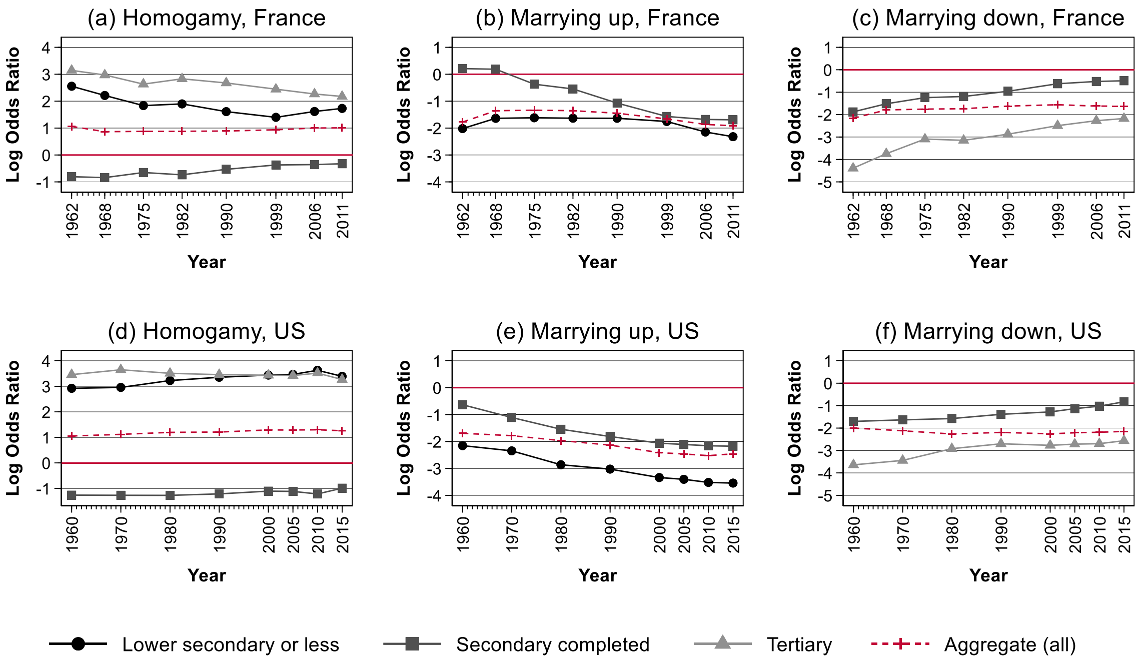

Fig. A5.1 Trends in assortative mating

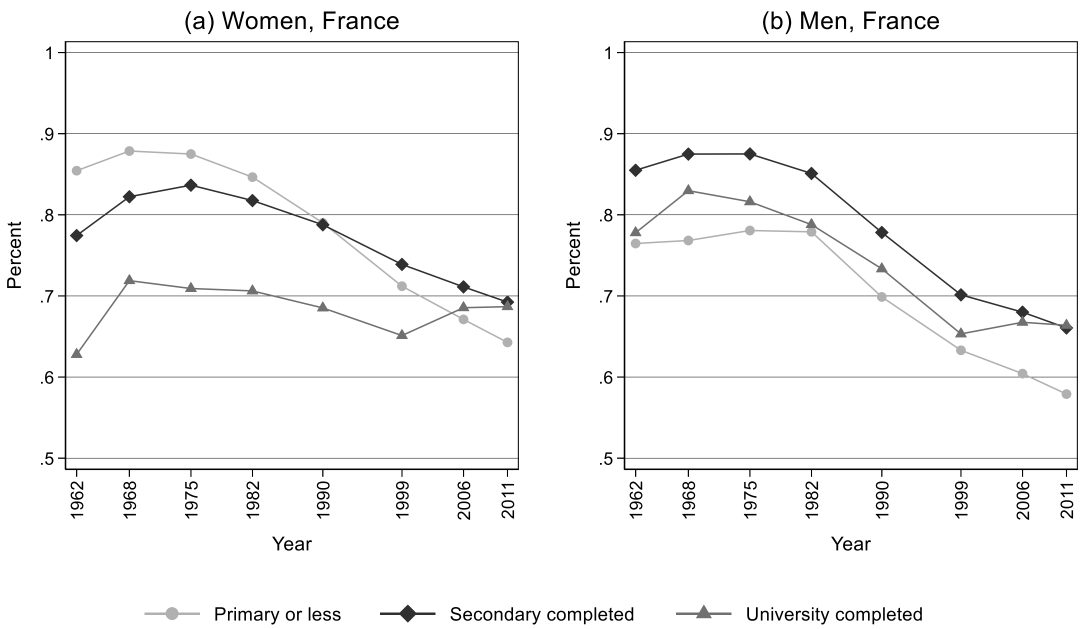

Fig. A5.2 Trends in the educational gradient in marriage in France

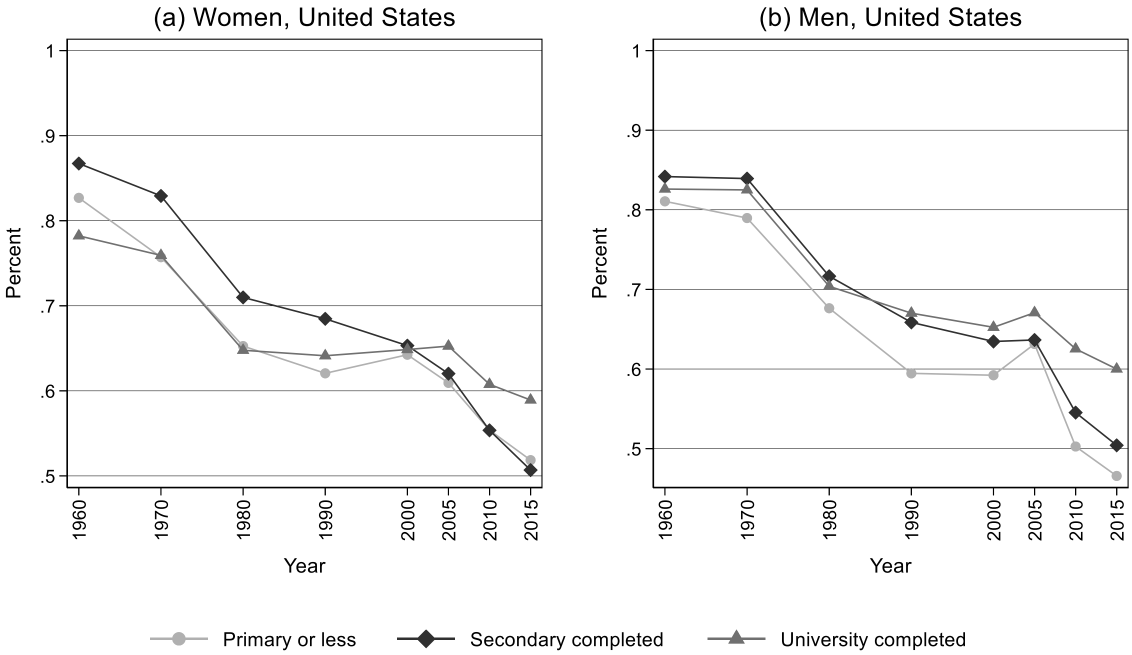

Fig. A5.3 Trends in the educational gradient in marriage in the United States

8.3.3 Educational systems of the United States and France

In the United States, primary education, classified as ISCED 1, spans six years and typically begins when children are six years old. Secondary education runs until grade 12 and concludes with a high school diploma. The first cycle of secondary education, ISCED 2, refers to grades 7 to 9, while the second cycle, ISCED 3, covers grades 10 to 12. The completion of ISCED 3 provides access to tertiary education. Since the first cycle of secondary education (ISCED 2) is not completed with a degree, it refers to high school dropouts. ISCED 4 can be achieved through post-secondary certificate programs. A college or university degree leads to ISCED 5 or higher (UNESCO, 2021).

In France, after five years of primary education (ISCED 1), students complete the first cycle of secondary education (grades 6-9) and earn the Brevet National Diploma (ISCED 2). The second cycle of secondary education, which encompasses grades 10 to 12 (ISCED 3), concludes with either the general or vocational baccalauréat, providing access to tertiary education. However, some schools offer vocational higher secondary education that provides certificates of vocational ability but does not grant access to tertiary education. ISCED 4 refers to vocational post-secondary education or specific programs designed to facilitate access to tertiary education. All tertiary degrees that can be obtained within the French educational system are represented by ISCED 5 or higher (UNESCO, 2021).

8.3.4 Measuring the gender imbalance in education

This section uses a numerical example to illustrate that neither the sex ratios nor the F-index are independent of educational expansion. Table A7 illustrates how educational expansion, i.e., the overall growth in the educational attainment of individuals, may affect the sex ratios within educational groups and the F-index, while the association between gender and education (represented by odds ratios) remains constant. Table A shows three sex ratios, one for each educational category (low: 1.5, medium: 1.0, high: 0.33). That means, for example, the number of low-educated women is 1.5 times larger than the number of low-educated men. The education-gender association is reflected by two odds ratios: 1.5 (the odds that a low-educated person is a woman divided by the odds that a medium-educated person is a woman) and 4.5 (the odds that a low-educated person is a woman divided by the odds that a highly educated person is a woman)[41].

Suppose educational attainment expanded, but the association between education and gender remained constant. Table B displays a marriage table with the same education-gender association as Table A, albeit with minor numerical differences due to rounding issues. However, the overall educational attainment is substantially higher in Table B. Also, the absolute gender gaps in education vary between Tables A and B. The education-specific sex ratios have increased across all educational groups (low: 2.7, medium: 1.8, high: 0.6). This means that even if the ratio of women to men increased among the highly educated, the association between gender and education did not change because the ratio of women to men also increased in lower educational groups. Although the F-index provides a more comprehensive measure considering all educational levels, it also differs

[41] The third odds ratio, which represents the odds that a medium educated person is a woman divided by the odds that a low educated person is a woman, is a function of these two odds ratios: 1.5/4.5 = 1/3.

between the tables (Table A: F=0.35, Table B: F=0.32).[42] In summary, in our example, the odds ratios are independent of the expansion in higher education that occurred in Table B. Our study utilizes this feature to analytically distinguish between expansion 'effects' and gender-education association 'effects'. In contrast, the education-specific sex ratios and the F-index did change as education expanded.

Table A5.7: Number of women and men per educational level

Table A	Education			
Gender	Low	Medium	High	Total
Female	300	150	50	500
Male	200	150	150	500
Total	500	300	200	1000

Table B	Education			
Gender	Low	Medium	High	Total
Female	146	129	225	500
Male	54	71	375	500
Total	200	200	600	1000

[42] The index of female educational advantage shares similarities with the odds ratio structure in a contingency table that depicts education and gender. For instance, in a 2x2 table, the odds ratio can be transformed into the F-index (F=1/(1+OR)). Therefore, in a 2x2 table, both measures are invariant to changes in the marginal distribution. However, in larger tables the index is not independent of the marginal distributions. The F-index offers only a single measure of the female educational advantage across all educational levels, making it unsuitable to recover the association between gender and education. To accurately describe and recover the association in all cells, more than one measure is required in tables exceeding four cells. For example, in a 2x3 table, which has two degrees of freedom, two measures are necessary to depict the associations between the cells.

8.3.5 Numerical examples for constructing counterfactuals

To determine counterfactual marital sorting outcomes that involve swapping the educational gradient in marriage, we ask, "How would the educational distribution of husbands and wives look like if the educational gradient in marriage had not changed?". This implies that, within each educational level, we maintain a constant percentage of women and men who select themselves into marriages. To illustrate that, Table A5.8 presents examples of a marriage table and the educational distribution of all men (married and unmarried). The last row of the marriage table depicts the educational distribution of husbands (in bold). In our example, all medium-educated and high-educated men get married, while only 75% (1000/750) of the low-educated men do. If men's educational attainment had changed, but we would like to keep the educational gradient in marriage constant, we would select 75% of the low-educated men and all medium-educated and highly educated men and standardize the distribution to match the number of partnered women. The resulting hypothetical marginal distributions are used to determine the cells of the marriage table by applying IPF. Leesch and Skopek (2023) provide a formal elaboration of the procedure.

Table A5.8: Examples of a marriage table and all men's education distribution

Marriage table	Husband's education			
Wife's education	Low	Medium	High	Total
Low	250	250	200	700
Medium	250	250	200	700
High	250	250	100	600
Total	**750**	**750**	**500**	**2000**

Men's education			
Low	Medium	High	Total
1000	**750**	**500**	**2250**

How would trends in marital sorting outcomes have evolved if the education-gender association on the partner market had remained unchanged? And how would these outcomes have developed if there had been no educational expansion? To answer these questions, we use women's and men's educational distributions to construct an 'education table' – a 2x3 contingency table that displays educational attainment by gender. Table A5.9 provides an example of such an educational table. From Table A5.8, we already know how education is distributed among men. To create the education table, we added women's education to the educational distribution of men. A comparison between Tables A5.8 and A5.9 reveals that all low- and medium-educated women, but only approximately 70% (600/850) of the highly educated women, are married. In such an education table, the marginal distributions correspond to educational expansion, and the odds ratios reflect the gender gap in education.

Table A5.9: Example of an education table

	Education			
Gender	Low	Medium	High	Total
Men	1000	750	500	2250
Women	700	700	850	2250
Total	1700	1450	1350	4500

To learn about the role of educational expansion and changes in the education-gender association for trends in marital sorting outcomes, we swap the marginal distributions in the education tables of Time 1 and Time 2 while maintaining the table's odds ratios. Subsequently, the cell frequencies in the educational tables are obtained through IPF, which provides the required counterfactual educational distributions. For example, to obtain the counterfactual marginal distributions that are needed for the h_{1211} counterfactual, we take the odds ratios from the education table (education-gender association) of Time 2, pair them with the marginal distributions from the education table of Time 1 (educational expansion) and fit the table with IPF. From this, we subtract the education-specific proportions of unpartnered individuals that were present at Time 1. This process results in the required counterfactual marginal distributions of the marriage table, which we match with the odds ratios of Time 1 to derive h_{1211}.