Employment Instability, Family Formation, and Motherhood Penalties: Comparative and Life Course Perspectives

Inauguraldissertation

zur Erlangung des akademischen Grades eines

Doctor rerum politicarum

der Fakultät für Sozial- und Wirtschaftswissenschaften

der Otto-Friedrich-Universität Bamberg

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Bamberg 2024

Kumulative Dissertation

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Datum der mündlichen Prüfung: 23. April 2024

URN: urn:nbn:de:bvb:473-irb-949444
DOI: https://doi.org/10.20378/irb-94944

Acknowledgement

This dissertation would have not been possible without the support and guidance of numerous friends, colleagues, and my family members. First and foremost, I would like to thank my first supervisor, Michael Gebel, for his support of my academic career throughout my PhD study. As a teacher, he introduced me to the world of modern causal analyses and comparative studies of social sciences, which eventually become my major research interests and expertise for doing empirical research. As an employer and a mentor, he plays a crucial role in supporting my lives as an immigrant, helping me to integrate into the German and international academic community, and giving me the largest freedom (yet with insightful instructions) to develop my own research agenda. I have profited vastly from his guidance and willingness to share his expertise and experiences.

Moreover, I want to thank Henriette Engelhardt-Wölfler, my second supervisor, for her immense supports in various stages of my PhD journey. I particularly thank her for providing me with many opportunities for collaborations. As a very experienced social demographer, she always provides valuable insights for improving my research. It has been and will continue to be a pleasure working with and learning from her in my academic career.

I also thank Stefani Scherer for her support as the third supervisor of my dissertation. My dissertation has been very much inspired by her excellent work on the relationship between work and family from a comparative perspective. I greatly appreciated her valuable feedback and comments on my studies that I presented in different occasions.

I am thankful for the time that I spent with my other colleagues and learning peers at the BAGSS, the SECCOPA project, and the Chair. Your friendships have made my working and private lives in Germany much more enjoyable.

Throughout my study, I am lucky to have the financial and administrative supports from numerous institutes or projects including the DAAD, the BAGSS, the ifb at the University of Bamberg, and the SECCOPA project of the ERC. Thanks to their supports, I can complete my PhD study without any financial concerns.

Finally, none of this would have been possible without the support of my family. To my parents, I thank you for your unwavering support and love throughout my whole life. To my dear wife, Wei Huang, no word can precisely express how grateful I am that you walked into my life. You have made me a stronger, better, and more fulfilled person than I could have ever imagined. Finally, to my beloved son, Lukas Haolin, I thank you for bringing all the joy and happiness into my life. You are my sunshine. Love you always.

Bamberg, November 2023
Chen-Hao Hsu

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Overview Chapter

1 Introduction

Women's work and family life courses have experienced remarkable changes since the 1970s. Almost all developed countries across Europe, Northern America, and East Asia have to some extent experienced a delaying and declining trend of marriage and fertility (Geist, 2017; Morgan & Taylor, 2006). Meanwhile, with women's increasing education and labour force participation, a gender revolution against the conventional male-breadwinning family model has placed women's gainful employment at the center of household economics (England, 2010; Goldscheider et al., 2015). Over the past few decades, population and family researchers across disciplines have been dedicated to exploring whether and how these two macro-level trends are coevolving, reinforcing, or inhibiting each other. In the centrality of this issue is to understand the micro-level relationship between women's work and family behaviours. Specifically, two literature lines have emerged to examine how women's working careers are *affecting* and *being affected* by family formation, including marriage or cohabiting union formation and childbirth.

While previous research on women's work-family relationships from both directions has flourished and accumulated rich theoretical and empirical findings, scholarly debates on these topics are still intense because the work-family relationship is continuously evolving over time and across different social contexts. In the current era of population aging and high labour market uncertainty, studies on work-family relationship are gaining more importance to inform effective policy makings. On one hand, our knowledge about how women's employment situations affect family formation is the backbone of unpacking the ongoing demographic transition and predicting the future population structure (Esping-Andersen & Billari, 2015). On the other hand, to understand how family formation affects women's working careers helps to evaluate the long-term potential and obstacles of women's labour force integration. Besides, our knowledge of both topics lays the foundation for understanding how and under what circumstances are social inequalities emerging in the work-family interface over women's life courses. Such knowledge is particularly important for promoting

gender equality and crafting supportive policies that fulfill women's demands in both work and family regimes.

In this dissertation, I consider women's family formation as a stepwise process consisting of three parts: (1) forming a partnership union (marriage or cohabitation), (2) the transition to motherhood, and (3) the post-motherhood life course. With a particular focus on the work-related causes and consequences of family formation, this dissertation covers the following three general questions. First, how women's employment situations affect their transition to partnership union, including cohabitation and marriage? Second, how women's employment situations affect their birth transitions? Third, how motherhood transitions affect women's post-motherhood career outcomes? Building on these three general questions, I further investigate advanced topics regarding the institutional embeddedness of work-family relationship and their life course dynamics (Buhr & Huinink, 2014; Mayer, 2009).

In the remaining part of this section, I will briefly review the historical development and the state of the art of the abovementioned research topics. In Section 2, I will provide an overview to introduce the structure of this dissertation and its contributions to the literature. The theoretical framework and the meta research hypotheses of this dissertation will be introduced in Section 3. Following the theoretical discussions, Section 4 reviews the specific research designs of the four empirical studies in this dissertation. Finally, Section 5 concludes the Overview Chapter by summarizing key findings and discussing their limitations and implications for future research.

1.1 Women's employment and family formation: An evolving relationship

In earlier economic and demographic literature, a dominant perspective was to relate the declining marriage and fertility rates since the 1960s with women's rising economic autonomy following their increased education and labour force participation (Becker & Tomes, 1986; Lesthaeghe, 1995). Such a perspective was supported by earlier empirical studies (up to the mid-1980s) at both the macro and micro levels, where female labour force participation rates (FLFPR) were negatively correlated with total fertility rates (TFR) (Engelhardt et al., 2004); and individual women's employment, especially in high-status occupations, was associated with later marriage timing, lower marriage probabilities (Spitze, 1988), as well as later motherhood transitions and smaller family sizes (Lehrer & Nerlove, 1986).

Since the late 1980s, however, such a classic perspective regarding the influences of women's employment on family formation, especially on fertility, became questionable. At the macro level, empirical studies for OECD countries have shown that the between-country correlation between FLFPR and TFR has turned from negative to positive in the late 1980s (Ahn & Mira, 2002). Meanwhile, the within-country negative relationship between FLFPR and TFR has been weakening in many countries (Engelhardt et al., 2004; Engelhardt & Prskawetz, 2004). At the micro level, empirical findings are rather mixed across countries. Despite country variations, a meta-analysis of European studies has shown that the negative impacts of women's employment on fertility have significantly reduced over time (Matysiak & Vignoli, 2008). A systematic literature review also indicates that women's economic attributes including income and employment are increasingly and positively linked to union formation in the 2000s, especially in high-income countries (Sassler & Lichter, 2020).

It is worth noting that the reversal of the influences of female employment on union formation and fertility in Europe during the late 1980s came simultaneously with the emergence of high unemployment rates (Ahn & Mira, 2002). From the mid-1970s to the mid-1990s, European countries have experienced two decades of rising unemployment rates, less competitive product markets, and stagnated economic growth (Barbieri, 2009; Esping-Andersen & Regini, 2000). Some scholars called this phenomenon *Eurosclerosis* and argued that such high unemployment rates were resulted from labour market over-regulation in most European countries. The unemployment rate of EU-15 has increased from around 2.5% in 1975 to its plateau in the mid-1990s, reaching more than 10% (Blanchard, 2006). In the meantime, many European governments in the 1990s were deregulating the labour market and promoting several types of non-standard employment relationship such as temporary contract employment or part-time work to enhance employment flexibility (Barbieri, 2009; Hipp et al., 2015; Kalleberg, 2009). As a result, the share of temporary employment in the European labour force has increased mildly from less than 10% at the beginning of the 1990s to 14% in 2018. A recent calculation using panel data (Latner, 2022) has shown that not only the temporary employment *rate* was rising in the 1980s and the early 1990s in Europe, but also people's *risks* of experiencing at least one temporary employment during prime working ages (25–54 years old) rose dramatically in the 2010s (risks increased by 36% from 2013 to 2019).

In East Asia, a demographic transition toward a late marriage and low fertility regime in the late 1990s (Jones, 2007) was also accompanied by a trend of increasing unemployment rates and a rising share of non-standard employment in the labour force (Hsiao et al., 2015;

Kalleberg & Hewison, 2013). While such a coevolving trend between labour market and demographic changes is most represented in the case of Japan's "Lost 20 Years" (Raymo & Shibata, 2017), other East Asian countries including South Korea and Taiwan have also experienced an upward trend of unemployment rates — especially during the 1997 Asian Economic Crisis — and the rising prevalence of non-standard employment relationship such as temporary contract employment and part-time work (Hsiao et al., 2015). In summary, comparing to workers of older generations, who mostly have stable and regular full-time employment careers in permanent positions, the rising risks of unemployment and temporary employment in Europe and East Asia indicate that individuals' employment careers are becoming more unstable, uncertain, and insecure after the 1990s (Barbieri, 2009; Esping-Andersen & Regini, 2000; Kalleberg, 2009; Latner, 2022).

In such a background, a growing body of literature has examined how *employment instability* affects individuals' family formation behaviours. In family sociology, such a topic is studied under the umbrella topic of rising *economic uncertainty* and its demographic impacts (Blossfeld et al., 2005; Kreyenfeld et al., 2012; Sobotka et al., 2011). In this line of literature, *economic uncertainty* arises when individuals cannot expect or feel secure about their future economic outcomes (Vignoli, Guetto, et al., 2020). Such an inclusive concept covers multiple aspects across macro and micro levels. At the macro level, *economic uncertainty* may arise when individuals experience economic recessions (Matysiak et al., 2021; Sobotka et al., 2011), when economic policies are uncertain (Comolli, 2017), or when media conveys mostly negative economic narratives (Guetto et al., 2023). At the micro level, the impacts of *economic uncertainty* on family formation are usually studied through the lens of *income insecurity* or *employment instability*. The concept of *income insecurity* captures the difficulty of securing sufficient incomes with which to support a decent standard of living. On the other hand, the concept of *employment instability* reflects the current experiences or future tendency to lose jobs or be unemployed (Grotti & Scherer, 2014; Kalleberg, 2009; Olsthoorn, 2014). Empirically, the concept of employment instability is mostly operationalized using objective measurements, such as employment status (e.g., unemployed vs. employed), contract type (e.g., temporary/fixed-term contract employment vs. permanent contract employment), job characteristics (e.g., whether the job-specific skills are easy to be replaced), or the intersection of these factors (Buh, 2023).

Following the mainstream empirical studies (Alderotti et al., 2021; Blossfeld et al., 2005; Matysiak & Vignoli, 2008), the first two studies of this dissertation (*Study I* and *Study*

II) examined how women's employment instability measured by having an insecure employment status or contract type is affecting family formation behaviours. Specifically, I use the objective measurement of employment instability and define people who are unemployed or temporarily employed by fixed-term contracts as having higher employment instability comparing to those who are permanently employed by open-ended contracts.

There have been ample studies about the impacts of women' employment instability on union formation or childbirth during the past two decades. However, it is worth noting that empirical findings were mixed across studies. Regarding the impacts of employment instability on union formation, several studies found that unemployment or temporary employment compared to permanent employment may reduce women's risks of getting married or cohabiting (Bolano & Vignoli, 2021; Müller & Dräger, 2019; van Wijk et al., 2021). On the other hand, some studies found that temporary employment or unemployment could accelerate women's transition into cohabitation or marriage unions (de Lange et al., 2014). Evidence was also mixed regarding the impacts of women's employment instability on childbirth transitions, with negative (inhibiting) effects found in some studies while positive (promoting) effects found in others (see empirical literature reviews in Alderotti et al., 2021; Blossfeld et al., 2005; Kreyenfeld et al., 2012).

The mixed empirical findings regarding the effects of employment instability on family formation were mainly resulted from three issues. First, there are considerable variations in the estimands (i.e., the target quantity of inference) and estimators (i.e., the methods used to obtain this target quantity) applied in previous studies. In family sociology and demography, a large share of empirical studies investigated the effects of employment instability on the timing of first union or first birth transitions using event history models (Bolano & Vignoli, 2021; Kreyenfeld, 2010). However, some other studies focused on the effects of employment instability on further partnering or higher-order birth transitions (Adsera, 2011a; Baizan, 2007); and others used different estimators such as discrete-time logistic regression models to estimate the impacts of employment instability on the transition probabilities (e.g., Kalmijn, 2011; Vignoli et al., 2012). In the recent literature, an emerging methodological trend is to apply the potential outcome framework for causal inference and use advanced methods such as propensity score matching (e.g., Vignoli, Tocchioni, et al., 2020) or panel estimators (e.g., Andersen & Özcan, 2021) to investigate the effects of employment instability on family formation. In summary, cross-study variations in estimands and estimation strategies have caused challenges in comparing empirical results.

Second, empirical strategies regarding sample selection and model specification were inconsistent across studies. In particular, model misspecification has been a serious issue, either in the case of missing or overcontrolling some variables. For example, to account for the confounding factors in the relationship between individual's employment instability and fertility outcomes, some studies followed theoretical suggestions to control for partner's characteristics such as educational levels and working status while others did not. A meta-analysis on this topic has shown that studies where none of the partners' characteristics were controlled for have reported, on average, a stronger effect of employment instability on fertility (Alderotti et al., 2021). Some studies, on the other hand, encountered the problem of overcontrol bias or endogenous selection bias by including too many variables that should be left out of a model (Elwert & Winship, 2014). For example, some studies on the total effect of individuals' employment instability on fertility included mediation variables such as individual income and work hours in the models, which may result in an overcontrol bias. These problems of model misspecification and the variations in sample selection (e.g., the age range of analytical samples may differ across studies) hinder the comparability of empirical results across studies.

Third, I argue that the cross-national heterogeneity in the impacts of employment instability on women's family formation was underemphasized because most of the previous studies were based on single-country case analyses. Moreover, the empirical literature on this topic mainly builds on single-country studies f. Such an empirical limitation was primarily due to the lack of comparable datasets or cross-national data harmonization projects. However, from a theoretical perspective, cross-national variations in macro level contexts including policies, institutions, and culture play crucial roles in shaping work-family relationship (Pfau-Effinger, 2005). It is thus inappropriate to generalize how women's employment instability affects family formation, either from a European perspective or in the developed world per se, without accounting for the moderating role of macro contexts.

In summary, the inconclusiveness of findings across studies calls for a more cautious research design of cross-national comparative analyses in a unified empirical framework (to address the first two issues) and a deeper investigation into how country-specific factors are moderating the influences of employment instability on family formation (to address the third issue). Regarding the last point, several macro-level moderators have been highlighted to influence women's roles in both work and family lives, including economic or labour market institutions, family welfare policies, living standards, and gender-cultural norms (Baizan et

al., 2016; Blossfeld et al., 2005; Esping-Andersen, 2009; Matysiak, 2011; Matysiak & Vignoli, 2008; Pfau-Effinger, 2005). To address these unresolved issues in the current literature, the first two empirical chapters of this dissertation (*Study I* and *Study II*) will focus on the first two macro-level moderators and use comparative panel data from nearly 30 European countries to investigate how labour market regulations moderate the effects of women's employment instability on union formation (*Study I*) and how family policies moderate the effects of women's employment instability on childbirth transitions (*Study II*).

1.2 A life course approach for work-family research

Up to this point, the literature covered in the previous section has discussed the impacts of women's employment situations on family formation from a rather static perspective. However, such a static perspective cannot fully capture the dynamic and interdependent nature of work-family life courses, in which people continuously evaluate their objective constraints and adjust their career and family decisions (Aisenbrey & Fasang, 2017; Bernardi et al., 2019; Matysiak, 2011). In this section, I will briefly introduce the life course approach in sociological research and discuss its implication for the research of work-family relationship.

Life-course theories argue that individuals unfold their life courses according to experiences accumulated in the past, choices and constraints encountered in the present, and life prospects anticipated for the future (Abbott, 2016; Elder et al., 2003; Mayer, 2009). According to Bernardi et al. (2019), a life course is conceptualized as a multidimensional behavioral process marked by sequences of events and social transitions that individuals enact over time. Following this perspective, a life-course approach emphasizes that changes in human lives (including the changes in personal characteristics as well as transitions between states) should be considered holistically across several life domains, such as work and family, and studied over a long stretch of a lifetime (Mayer, 2009). Applying this life-course approach to the research of work-family relationship (Huinink & Feldhaus, 2009), our understanding of how women's stable or unstable employment is related to their family formation behaviours will be refreshed.

First, the concept of employment situations must be adjusted. Instead of understanding it as a discrete-time, static status (such as unemployment), life course researchers apply a holistic perspective to identify the characteristics of an "employment career". However,

measuring and defining individuals' employment career is a complex task involving a close examination of the timing, frequency, duration, and sequencing of multiple employment states over the life course. Given such complexity, it is not appropriate to classify one's employment career as stable or unstable based only on one or several discrete-time employment states or transitions (Biemann et al., 2012; Devillanova et al., 2019; Fuller & Stecy-Hildebrandt, 2015). Therefore, following the life course approach, I redefine an "unstable" career as a sequence of multiple incidences or long duration of unemployment or non-standard employment states (including part-time jobs and temporary employment), which contrasts a "stable" employment career featuring continuous employment in standard full-time positions (Kalleberg, 2009).

Second, women's family formation outcomes should also be redefined to account for their "processual" nature (Abbott, 2016). As for women's fertility outcomes, it is crucial to consider that the timing, spacing, and the number of births over the life course are contingent on past fertility experiences (Buhr & Huinink, 2014; Huinink & Feldhaus, 2009). Therefore, rather than focusing only on the timing or the occurrence of a specific childbirth event, a life course approach suggests a holistic examination of the whole "fertility history", including the timing of each birth parity and the quantum of complete fertility, during women's reproductive age.

Finally, a key principle of this approach is that individuals' family life courses have interdependent relationships with other life domains, particularly with one's work and employment careers (Aisenbrey & Fasang, 2017; Krüger & Levy, 2001; Pollock, 2007).

With the growing popularity of life course research in family sociology, several methods are developed to capture these special characteristics of life courses. One of the most popular methods to examine the long-term relationship between women's employment careers and fertility outcomes in work-family life course research is sequence analysis and its extensions. For example, studies in Italy (Mynarska et al., 2015; Tocchioni, 2018) and in the Netherlands (Keizer et al., 2008) examined the career sequences of childless women and found that the majority of childless women had a stable rather than an interrupted or inactive employment career. Using multi-channel sequence analyses, some other studies showed that a disrupted or low-prestige employment career associated with a family life course of delayed family formation and parenthood transition (Aisenbrey & Fasang, 2017; Simonson et al., 2011; Sirniö et al., 2017).

Drawing on the abovementioned life course approach, *Study III* in this dissertation combines the strength of sequence analyses with event history analysis and regression models to re-examine the influences of women's employment situations on childbirth behaviours discussed in *Study II*, with an aim to demonstrate how different types of employment careers up to midlife are associated with women's different timing and quantum of fertility.

1.3 Women's employment careers after motherhood: The motherhood penalty

Following the life course perspective discussed in the previous section, we've noticed that women's working careers and family lives are two life domains that coevolve over the lifetime. From a theoretical perspective, this means that the causal relationship linking the states and events between these two life domains is bidirectional (Matysiak, 2011; Matysiak & Vignoli, 2008). In fact, in contrast to demographers' interests in the influences of women's employment on union formation and fertility, a larger body of literature in family economics and sociology has been devoted to investigating how women's family formation affects their employment careers. In particular, studies on "motherhood penalty" have been gaining prominent interest in the past two decades.

Previous studies on the issue of motherhood penalty have shown that women's motherhood transition may lead to fewer labour force participation and reduced work hours (Doren, 2019; García-Manglano, 2015; Gash, 2008; Gutiérrez-Domènech, 2005; Kleven, Landais, Posch, et al., 2019; Raymo & Iwasawa, 2016; W. Yu, 2002, 2009). In addition, research also found that women tend to earn lower hourly wages following their motherhood transition (Budig et al., 2012; Budig & England, 2001; Cukrowska-Torzewska & Matysiak, 2020; de Hoon et al., 2017; de Linde Leonard & Stanley, 2020; Kühhirt & Ludwig, 2012; J. Yu & Xie, 2018). Eventually, the reduced labour supply and lower wage rates following the motherhood transition may cause remarkable losses in women's earnings over the lifetime (Cools et al., 2017; Kleven, Landais, Posch, et al., 2019; Kleven, Landais, & Søgaard, 2019; Lundberg & Rose, 2000).

The persistence of motherhood career penalty has profound social influences. First, from a perspective of labour economics, the long-term reduction of women's labour supply due to motherhood is inefficient and pose serious threats to a sustainable working population (Matysiak, 2011). Second, motherhood penalty is an obstacle on the way to the development of a gender-equal society (Goldin, 2014). Until recently, women's career penalty of

motherhood remains one of the most crucial factors that explain the remaining gender gaps in wages and earnings observed in many developed countries (Cukrowska-Torzewska & Lovasz, 2020; Musick et al., 2020; Van Winkle & Fasang, 2020). Third, the remarkable career costs of motherhood that mismatch the ongoing trend of a gender revolution of women's and men's work-family roles may further reduce women's fertility intentions (Esping-Andersen & Billari, 2015; Goldscheider et al., 2015). All these three social influences of motherhood penalty are against the policy targets of major international organizations to build a fairer and more resilient society (European Commission, 2020; OECD, 2017).

In this dissertation, I will examine the issue of motherhood penalty in *Study IV* using an innovative empirical design. Different from previous studies on this topic, *Study IV* emphasizes the life course dynamics of motherhood career penalty not only over time but also across different birth events.

2 Structure of this dissertation and its relevance

2.1 The general structure and research questions

Drawing on the ongoing debates, this dissertation aims to enrich the theoretical framework guiding the research of work-family relations and to close the research gaps in the empirical literature by applying innovative research designs on multiple types of panel data. This cumulative dissertation consists of an Overview Chapter and four empirical studies that explore various topics across different stages of family formation to advance our knowledge in the research of women's work-family relationship. Table 1 provides an overview of the titles and publication status of these four studies. All studies have been published in international peer-reviewed sociological journals listed in the Social Science Citation Index (SSCI). Another article has been revised and resubmitted to an SSCI-listed journal.

The overarching goal of this dissertation is to advance the theoretical framework and to enrich the empirical methods in the study of women's work-family relationship. As mentioned earlier, the dissertation covers three general questions regarding the relationship between women's work and family behaviours across three stages of women's family formation process:

(1) How do women's employment situations affect their union formation?

(2) How do women's employment situations affect their childbirth behaviours?

(3) How do women's childbirth transitions affect their employment careers?

Table 1. Overview of studies included in the dissertation.

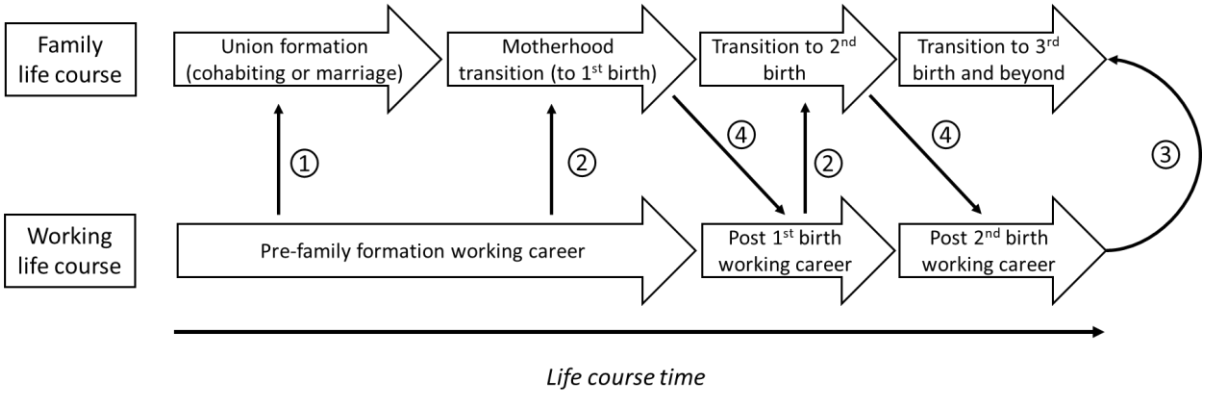
Study	Author(s)/Share	Year	Title	Status/Journal
I	Hsu, C.-H. / 90% Engelhardt, H. / 10%	2024	A Precarious Path to Partnership? The Moderating Effects of Labour Market Regulations on the Relationship Between Unstable Employment and Union Formation in Europe.	Published in *European Journal of Population*
II	Hsu, C.-H. / 100%	2023	How women's employment instability affects birth transitions: The moderating role of family policies in 27 European countries	Published in *European Sociological Review*
III	Hsu, C.-H. / 100%	2022	Work and fertility in Taiwan: how do women's and men's career sequences associate with fertility outcomes?	Published in *Longitudinal and Life Course Studies*
IV	Hsu, C.-H. / 100%	2021	Parity-specific motherhood penalties: Long-term impacts of childbirth on women's earnings in Japan	Published in *Advances in Life Course Research*

These three general questions are addressed by four empirical studies in this dissertation. More specific research questions derived from these three general questions regarding the institutional factors and the life course dynamics behind the work-family relationship will also be discussed in the follows. Figure 1 illustrates the structure and the connections between these four studies.

The general question (1) is addressed in *Study I "A Precarious Path to Partnership? The Moderating Effects of Labour Market Regulations on the Relationship Between Unstable Employment and Union Formation in Europe",* in which my coauthor and I investigate how women's (and men's) employment instability, measured as being temporarily employed or

unemployed, affects their likelihood of transitioning into marriage or cohabiting unions and how such a micro-level relationship is moderated by labour market regulations.

Figure 1. The general structure of this dissertation



In *Study II "How women's employment instability affects birth transitions: The moderating role of family policies in 27 European countries"*, I address the general question (2) by investigating how women's employment instability affects their first and second childbirth transitions. Using a similar comparative framework, *Study II* further examines how these micro-level effects of women's employment instability on childbirth transitions are moderated by macro-level family welfare policies.

In *Study III "Work and fertility in Taiwan: how do women's and men's career sequences associate with fertility outcomes?"*, the general question (2) is reexamined from another perspective. Drawing on a life course approach, the specific question of *Study III* is to investigate how women's (and men's) various employment careers associate with their fertility trajectories.

Finally, the general question (3) is addressed by *Study IV "Parity-specific motherhood penalties: Long-term impacts of childbirth on women's earnings in Japan"*. Applying a life course perspective, the general question (3) is further derived into three specific research questions. First, does motherhood transition reduce women's income, wage, and labour supply? Second, how long does this "motherhood penalty" persist? Third, does motherhood penalty occur mostly during the first-time motherhood transition? or during the following parity progression?

In summary, a common feature of *Study I* and *Study II* is using the comparative research approach to investigate how macro-level institutions or policies are shaping the micro-level impacts of women's employment instability on family formation in Europe. *Study III* and *Study IV*, on the other hand, apply different methods under the general guideline of the life course approach to investigate how women's working careers are influencing and being influenced by their childbirth behaviours in two East Asian countries. In the following section, I will briefly discuss the contributions of these studies.

2.2 Contributions of this dissertation

Study I and *Study II* together contribute to the current literature in three major aspects. First, they advance our theoretical understanding of *how* specific types of macro-level institutions moderate the micro-level relationship between employment instability and family formation. In the field of family sociology and demography, the first systematic discussion of this topic was in a collective work by Blossfeld et al. (2005). In this book, Blossfeld and colleagues specified four pillars of institutions including employment systems, education systems, welfare regimes, and family systems as core "institutional filters" through which the impacts of rising economic uncertainty on individuals' family formation are modified. Their framework has inspired numerous researchers and becomes the foundation of empirical studies on this topic in the following decade. Despite this crucial contribution of Blossfeld et al. (2005), its theoretical discussions were at a more general level, focusing on how institutional filters may work *collectively* to moderate the micro-level work-family relationship across welfare states (e.g., how work-family relationship differs between Conservative welfare state like Germany and Social-democratic welfare state like Sweden); it did no cover enough details about how different institutions in each pillar moderate the impacts of employment instability on family formation through *specific macro-micro mechanisms* (e.g., how stricter employment protection legislation change the work-family relationship). Adding to the existing theoretical framework, *Study I* and *Study II* systematically discuss the moderation mechanisms behind various labour market and family welfare institutions to derive testable hypotheses regarding how micro-level theories linking women's employment and family formation are modified.

Second, from a methodological point of view, *Study I* and *Study II* deviated from previous comparative studies by applying an *indicator-based comparative approach*.

Following the framework of Blossfeld et al. (2005), there are already several empirical studies exploring the role of macro-level contexts in shaping the micro-level linkage between individuals' work and family behaviours (Adsera, 2011a, 2011b; Barbieri et al., 2015; Bernardi et al., 2008; Blossfeld et al., 2005; Matysiak & Vignoli, 2013; Özcan et al., 2010). However, most of these studies applied a *typology-based comparative approach*, which operates by assigning specific countries into country clusters and then discussing to what extent are the cross-national or cross-cluster differences in the individual-level work-family relationship reflect the contextual differences. Common theoretical typologies for clustering in work-family research include family policy and welfare regimes (Esping-Andersen, 2009; Korpi et al., 2013), employment relation or labour market systems (Diprete et al., 1997; Esping-Andersen & Regini, 2000; Gallie & Paugam, 2000; Hall & Soskice, 2001), and gender-cultural systems (Pfau-Effinger, 1998; Therborn, 2004). The major advantage of this *typology-based comparative approach* is its holistic perspective to cover the complex interplay between micro-level work-family relationship and a bundle of structural, institutional, or cultural factors. However, this holistic perspective also comes with the costs of not being able isolate the impact of a specific macro factor. Due to this feature, it is particularly difficult for researchers to translate the empirical evidence of typology-based studies into concrete policy advice. The *indicator-based comparative approach*, on the other hand, is a useful tool to this end. It breaks down the complex macro context into separate dimensions using macro indicators with an aim of isolating the effect of respective macro variables. The isolation of the policy or institutional effects of interest is done by statistically controlling for other confounding variables measured by macro indexes (see more details in the method section).

Third, *Study I* and *Study II* extend the empirical scope of European research on the impacts of women's employment instability on family formation by including multiple countries in Central and Eastern Europe (CEE) and other post-socialist countries. As mentioned earlier, there have been many single-country studies on this research topic in countries across Western, Nordic, and Southern Europe. However, empirical research in CEE and other post-socialist countries is scant; and these post-socialist countries are mostly excluded from previous comparative studies (Adsera, 2011b, 2011a; Baizan et al., 2016; Blossfeld et al., 2005; Greulich et al., 2017) and meta-analysis (Alderotti et al., 2021; Matysiak & Vignoli, 2008). Such an empirical gap if problematic, especially when one of our

major goals is to identify to what extent is women's work-family relationship influenced by the macro-level labour market regulations and family welfare institutions.

During the years of state socialism, labour market policies in socialist CEE countries and Baltic States were marked by relatively high levels of employment protection, unionization, and collective bargaining coverages, as well as generous unemployment benefits provisions. During the same period, family policies in these countries used to be strongly oriented to facilitating high levels of female labour force participation through a wide coverage of public childcare arrangements (Rostgaard, 2004). However, in the post-socialist era, all these transition economies across CEE and the Baltics have experienced remarkable labour market liberalization and family policy transformation. While these reforms were initially targeted at a swift transition of the labour market and welfare systems toward the resemblance to Western European countries, the unfolding of these reforms has been a lengthy process of compromises and adaptations due to the financial constraints and the institutional path dependency following the socialists legacy (Lehmann & Muravyev, 2012; Matysiak, 2011). Against this background, the post-socialists states have nowadays evolved to become a unique economic and welfare regime, in which the labour market regulations and family policies are structured differently from those in other European countries (Fenger, 2007; Robila, 2012). For example, compared to countries in Western Europe, many CEE and Baltic countries have much more generous parental leave policies, yet at the same provide fewer public childcares (Frejka & Gietel-Basten, 2016).

By including multiple CEE (including Poland, Czechia, Hungary, Slovakia, Slovenia, Croatia) and Baltic countries (Estonia, Latvia, Lithuania) in our analyses, *Study I* and *Study II* are among the first comparative studies that cover almost all European Union member states to analyze the institutional moderation effects on the work-family relationship from a European perspective. The findings of these studies also provide valuable implications for the European Union's population policies.

* * *

Study III contributes to the literature on women's employment-fertility relationship in two major aspects. First, it provides an innovative research design combining the strengths of sequence analysis, event history analysis, and Poisson regression models to investigate the associations between individuals' employment careers and their fertility histories up to midlife. Using this design, it is one of the few empirical studies that systematically investigate

not only the tempo but also the quantum effects of employment situations on fertility outcomes (see Pailhé and Solaz (2012) for another example). This allows demographic researchers to better examine the holistic life course relationship between individuals' work and fertility behaviours.

Second, *Study III* also extends the scope of the empirical literature by investigating the life course associations between women's (and men's) employment careers and their fertility histories in an East Asian developed country—Taiwan. As mentioned earlier in Section 1.2, the demographic transition toward later and lower fertility as well as a trend of rising employment instability since the 1990s not only happened in Europe, but also presented, if not even more significantly, in East Asian countries including Japan, South Korea, and Taiwan. However, in sharp contrast to the rich empirical literature about the influences of women's employment situations on fertility behaviours in the European context, empirical studies in East Asia have been very limited and mostly concentrated in Japan (Ogawa et al., 2020; Raymo & Shibata, 2017; W. Yu & Kuo, 2017).

In *Study III*, I argued that Taiwan is an important case for studying the life course associations between work and family trajectories. The country has a high level of economic development (nominal GDP per capita = $33,907 in 2023), high female labour force participation rates (75.5% for females aged 25–54 in 2020), and one of the lowest total fertility rates among developed countries (TFR = 0.87 in 2022). At the institutional level, Taiwan is known for its limited family policy supports for women to combine work with childbirth (Gauthier, 2016; Jones, 2007; McDonald, 2009). Comparing to other East Asian countries such as Japan or Continental European countries such as Germany, labour market regulations in Taiwan are featured by higher flexibility, lower unionization, and lower employment protections for labour market insiders. From a comparative perspective, such a combination of loose labour market regulations and inadequate family policies in Taiwan is similar to the institutional settings of the US or the UK. However, following the legacy of the Confucianist family system (Cheng, 2020), the gender norms in Taiwan are arguably more conservative comparing to that in Western Europe. Through a cautious comparison with previous studies in Western countries, *Study III*'s empirical findings could serve as a valuable reference point for family researchers to evaluate to what extent the relationship between individuals' work and fertility is shaped by the complex interactions between gender norms, labour market structures, and family welfare policies.

* * *

Finally, *Study IV* of this dissertation deviated from the mainstream studies of motherhood penalty and thus contributed to the literature in four aspects. First, different from most studies that focus only either on women's employment or on the wage outcomes following motherhood (Budig & England, 2001), *Study IV* applies a holistic perspective to examine how motherhood affects women's employment, work hours, wage rates, and eventually earnings. Recent studies have shown that the impacts of motherhood could differ significantly across all these different channels of motherhood penalty (Cools et al., 2017; Kahn et al., 2014; Kleven, Landais, & Søgaard, 2019; Mari & Cutuli, 2020). In many cases, women's long-term earnings losses due to motherhood are driven more by their reduced labor supply (including employment and work hours) rather than by a lower wage rate (Cools et al., 2017; Kleven, Landais, & Søgaard, 2019). Such a pattern is also found in *Study IV*, which implies that future research on motherhood penalty should cautiously consider multiple dimensions of women's post-motherhood careers.

Second, in contrast to most studies' static perspectives about motherhood penalty (see literature reviews in Cukrowska-Torzewska & Matysiak (2020) and de Linde Leonard & Stanley (2020)), *Study IV* applies a life course approach to examine the dynamics of motherhood career penalty not only over time but also across different birth transitions. In particular, the latter innovation (i.e., across different birth transitions) is a crucial extension beyond the latest studies' focus on the dynamic career penalty since the first-time childbirth (Cools & Strøm, 2016; Kleven, Landais, & Søgaard, 2019; Sieppi & Pehkonen, 2019; Van Winkle & Fasang, 2020). In summary, *Study IV* advances the frontier of motherhood penalty research by bringing another life course dimensions (i.e., the parity status) into investigation and clarifying the theoretical mechanisms leading to the aggregation of "parity-specific" opportunity costs of childbirth over the lifetime (Diprete et al., 2003).

Third, to capture the abovementioned life course dynamics of motherhood penalty resulting from different birth transitions, *Study IV* proposed a novel research design using a dynamic sample construction strategy and the fixed effects panel estimator (more technical details discussed in Section 4 and in *Study IV*). This innovative design is tailored to solve the issue of selection into consecutive treatment (e.g., the second and the higher-order births) based on the heterogeneous treatment effects of the previous treatment (e.g., the first birth). It

thus contributes to the motherhood penalty research by providing a more accurate analytical strategy in quantifying how motherhood penalties evolve over the life course.

Fourth, *Study IV* joins the effort *of Study III* to extend the empirical literature beyond the Western context by choosing Japan as a special case to study motherhood career penalties. Like Taiwan, Japan has a high level of economic development (nominal GDP per capita = $ 35,385 in 2023) and low fertility rates (TFR = 1.26 in 2022). At the institutional level, Japan is known for the high level of gender inequality in its labour market (Tsuya & Bumpass, 2004), which has been structured around male breadwinners and predisposes employers against hiring women with children. Comparing to countries in Western and Nordic Europe, Japan also has relatively inadequate provisions of childcare services and lower uptake rates of parental leaves (Boling, 2015), making it difficult for working mothers to combine their work with family duties. As a result, the country has recorded one of the highest gender earnings gaps among developed countries (OECD, 2020). This special context makes Japan an interesting case for studying the long-term impacts of childbirth transitions on women's career outcomes. However, there are surprisingly very few studies examining the motherhood career penalties in Japan (Kawaguchi, 2008; Takeuchi, 2018); and none of the existing Japanese studies examined how these career penalties evolve over women's post-motherhood lifetime. *Study IV* takes on this empirical gap and quantifies the long-term and parity-specific career costs of motherhood in Japan, which not only contributes to Japan's policy debates over gender inequality in the labour market but also adds to the literature of cross-national variations in motherhood penalty (Budig et al., 2012; Gangl & Ziefle, 2009; Kleven, Landais, Posch, et al., 2019).

3 Theoretical framework and hypotheses

This section discusses the general theories and the hypotheses of this dissertation. Section 3.1 briefly introduces the theoretical mechanisms for the first two general questions discussed in Section 2.1. In Section 3.2, I further present how micro-level relationship between women's employment situations and family formation is moderated by macro-level institutional factors including labour market regulations and family welfare policies. Next, Section 3.3 discusses the theoretical mechanisms leading to motherhood penalties in career outcomes. Based on

these discussions, Section 3.4 proposes several meta-hypotheses that highlight the key concepts to be examined in this dissertation.

3.1 The impact of employment instability on family formation

So, *why* employment instability may affect women's union formation and childbirth transitions? Existing explanations of this micro-level relationship are following three meta-theoretical traditions. First, the economic tradition following Becker's New Home Economics (Becker, 1991) argues that individuals are rationally making their partnership and childbirth decisions to maximize the utility function. Therefore, individuals' demand for marriage and children is contingent on the corresponding costs and benefits (Cigno & Ermisch, 1989; Grossbard, 2015). In this tradition, employment instability affects women's family formation through two channels. On one hand, the channel of *income effects* predicts that employment instability may suppress individual's demand for marriage and children because it reduces the availability and the security of financial resources to support such long-term "consumption". On the other hand, the channel of *substitution effects* predicts that employment instability could increase women's demand for marriage and children because it lowers the opportunity costs of family formation.

The second tradition following Oppenheimer's theory of marriage timing (Oppenheimer, 1988) focuses on how career uncertainty delays individuals' family formation via the social-structural constraints (therefore, this theory is sometimes called the "uncertainty theory"). According to Oppenheimer (Oppenheimer, 1988, 2003), employment instability leads to uncertain career prospects and lifestyle, which in turn reduces men's attractiveness in the marriage market and raises the difficulty of matching an ideal partner. Moreover, these men who have a breadwinning mindset may also perceive their current career stage as "immature," and thus intentionally choose to postpone union formation until a stable labour market position is achieved (Kalmijn, 2011). While this theory was originally proposed to explain men's marriage postponement, it has later been extended to fertility research and applied to women's experiences as well (Blossfeld et al., 2005; Kreyenfeld, 2010; Vignoli, Tocchioni, et al., 2020). The rationale is that women's employment career is becoming as important as men's in the modern dual-earner family system, where social expectations on women's economic roles in starting a family have increased. As a result, women's career uncertainty could also hamper their attractiveness on the marriage market; and starting a

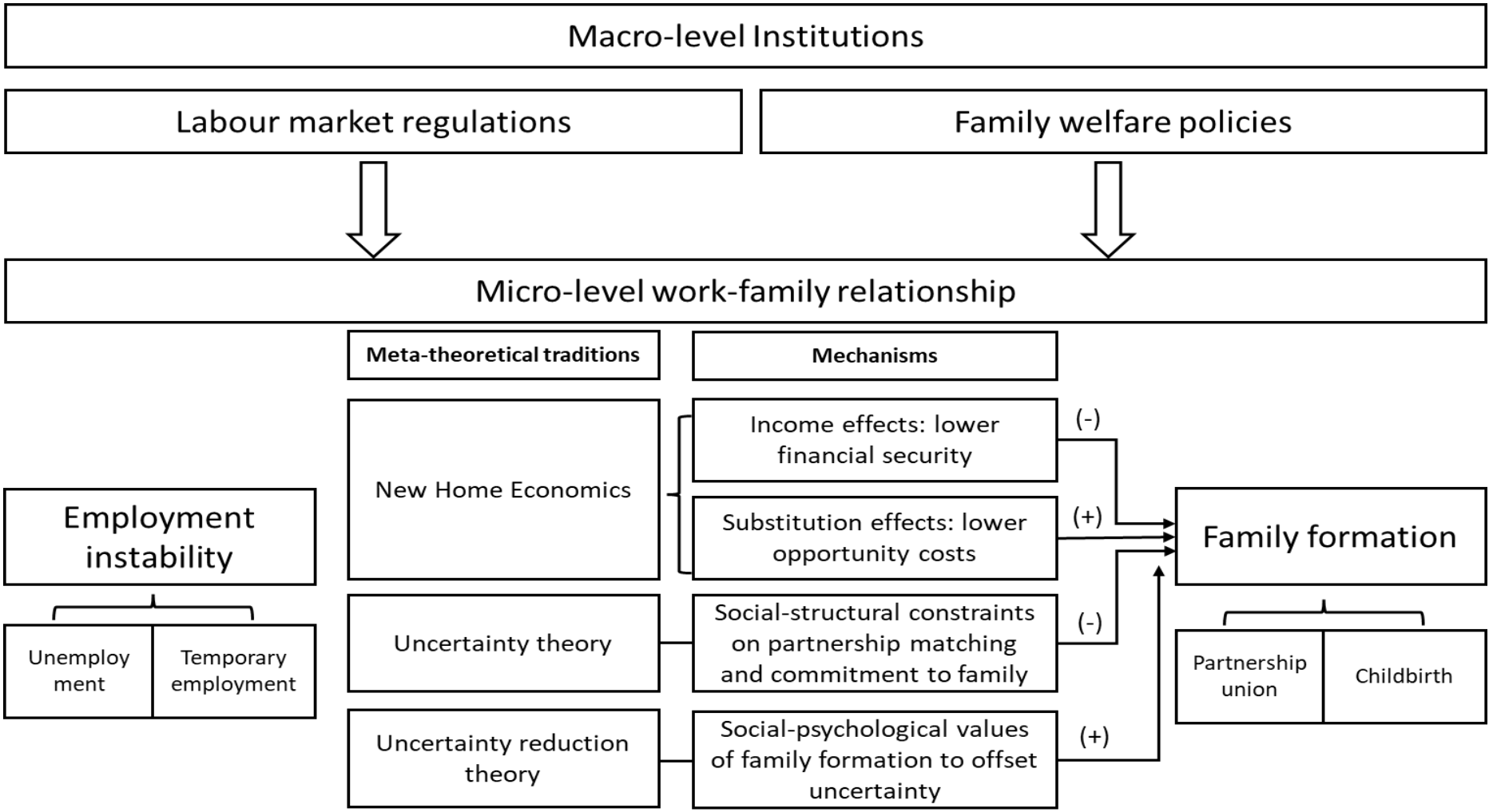
family before establishing a mature career has also become a less attractive life option from women's perspective.

The third theory tradition following Friedman et al. (1994) highlights the social-psychological aspects of women's family formation decisions. This tradition assumes that marriage and childrearing have intrinsic values and can be socially recognized as an "alternative career" for women. Under this assumption, the "uncertainty reduction theory" argues that women may strategically consider starting a family to offset the uncertainty experienced in other aspects of life, such as in their employment careers. Accordingly, experiencing employment instability should accelerate women's family formation.

The lower panel of Figure 2 summarizes the micro-level theoretical framework discussed above. As clearly illustrated, the causal effect of women's employment instability on family formation is inconclusive from a theoretical perspective. Among the four mechanisms discussed across the three traditions, half predict negative effects (i.e., depressing effects) of employment instability on family formation, while the other half predict positive effects (i.e., enhancing effects). Such a theoretical ambiguity is also reflected in the mixed empirical findings across countries (Alderotti et al., 2021). For example, women's unemployment was found to depress motherhood transition in Italy, Spain, and France (Barbieri et al., 2015; Pailhé & Solaz, 2012; Vignoli, Tocchioni, et al., 2020) but to enhance such transition in Denmark and Norway (Andersen & Özcan, 2021; Kravdal, 2002).

As mentioned earlier in the Introduction section (Section 1.2), one important explanation for such cross-country variation is that women's micro-level family formation responses to employment instability are to some extent contingent on the macro-level contexts. In particular, individual-level work-family relationship is largely dependent on two macro institutions that directly influence people's work and family behaviours: labour markets regulations (Barbieri, 2009; Esping-Andersen, 2009; Esping-Andersen & Regini, 2000) and family welfare policies (Billingsley & Ferrarini, 2014; Gauthier, 2007; Korpi et al., 2013; Thévenon, 2011).

Figure 2: The theoretical model of the micro-level work-family relationship and its macro-level institutional moderators



3.2 Institutional factors behind women's response to employment instability

According to Figure 2, the micro-level relationship between women's employment instability and family formation is contingent on the influences of the sets of income and opportunity costs (the economic theory), the structural uncertainty related to employment instability (the uncertainty theory), and the norms and social values attached to marriage and childrearing (the uncertainty reduction theory). Given this structure, macro-level institutions can moderate the micro-level relationship by changing the relevance of each micro-level mechanism. In this section, I briefly introduce the major operational logic behind these two institutions concerning their influences on women's family formation under employment instability. More detailed discussions on specific mechanisms are left out to be introduced in *Study I* (regarding the role of labour market regulations on partnership union formation) and *Study II* (regarding the role of family policies on childbirth).

3.2.1 The role of labour market regulations

Labour markets in European countries have traditionally been among the most regulated areas. In the past few decades, different types of regulations have been proposed and reformed on the premise of either enhancing employment stability, improving labour market efficiency, or eliminating employment-related social inequality (Esping-Andersen & Regini, 2000). However, it is also well-known that these goals are often mutually contradictory in the implementation of policies. For example, rigid regulations aiming to protect workers' employment usually lead to labour market segregation and dualization (Barbieri & Cutuli, 2016); generous unemployment benefits may come along with increased unemployment and lower labour market efficiency (Gallie & Paugam, 2000).

The crux of such dilemmas is that the incentives and benefits attached to specific policies do not distribute equally across labour market actors. For example, while employees with permanent contract benefit from strict employment protection legislation, the unemployed might suffer from such policy because the employers could be more reluctant to hire new employees due to high dismissal costs, causing even higher uncertainty for the unemployed. Such differential experiences in the labour market context could further diverge the family formation decisions across the employment status groups.

Study I of this dissertation specifically examines the moderating roles of three different dimensions of labour market regulations proposed by Esping-Andersen (2000). The

first dimension considers the strictness of employment protection legislations (EPL). Following the OECD's framework (OECD, 2014), I further distinguish between the regulations for dismissals of workers on regular contract (EPLR) and the regulations regarding the usage of temporary contracts (EPLT) for theoretical discussions. The second dimension deals with the wage setting mechanisms in the labour market, which are mainly operationalized through labour unions and collective bargaining agreements. In Europe, the degree of unionization measured by union density has fallen remarkably during the past three decades; meanwhile, although collective bargaining agreements as a collective have clearly become more decentralized, it remains an important institution for wage and working condition negotiations. "Even in countries with low unionization rates, a large proportion of workers is covered by collective contracts through so-called extensions, in which the working conditions set by a group of employers and employees in an industry or region become binding for all employees and employers" (Adamopoulou & Villanueva, 2022). Drawing on this background, this dissertation will focus on discussing the theoretical mechanisms of the moderating effects of collective bargaining agreements on the work-family relationship. Finally, the third dimension of labour market regulations refers to the unemployment-related social welfares, through which the disadvantaged employment groups are provided with an income safety net.

In the theoretical framework presented in Figure 2, these labour market regulations could moderate the micro-level relationship between employment instability and family formation mainly by changing the income and opportunity costs structures as well as the structural uncertainty related to unstable employment situations. Against this background, we should observe two major channels of the moderation effects.

First, if a specific type of labour market regulation has the potential to create a stronger insider-outsider segregation of employment opportunities and stability, it can aggravate the negative effect of people's employment instability on family formation because the gap of employment security between permanent workers and temporary workers or the unemployed are enlarged. In our analytical framework, stricter EPLR, stricter EPLT, and higher collective bargaining agreements coverage (CBC) are categorized as this type of regulations. Specifically, stricter EPLR raises the direct costs and procedure difficulties of dismissing a regular worker, which may discourage employers from hiring new workers with permanent contract, thus prolonging the duration of unemployment and lowering the risk of reemployment among the unemployed (Esping-Andersen & Regini, 2000) and decreasing the

chances of permanent employment transitions for temporary employees (Högberg et al., 2019). Stricter EPLT, on the other hand, constraints the usage, duration, and renewal of temporary contracts, which raises the costs of hiring temporary workers, thus discouraging reemployment of the unemployed; it may also cause more frequent unemployment outflows among temporary workers because the regulated duration of temporary contracts is shorter with high EPLT, and multiple contract renewals become difficult (Högberg et al., 2019). Finally, higher CBC may marginalize the unemployed because the negotiated rights and benefits covered by collective bargaining agreements only apply to those who are employed (Baranowska & Gebel, 2010; Dieckhoff et al., 2015). High CBC also tends to attenuate employment protections for labour market insiders, which might preclude temporary workers from getting a permanent job (Baranowska & Gebel, 2010).

Second, if a specific type of regulation can relieve the relative financial insecurity of temporary workers or the unemployed comparing to permanent workers, it has the potential to alleviate the negative effects of people's employment instability on family formation. Among the regulations that we discussed, a more generous provision of unemployment benefits clearly falls into this category. Generous unemployment benefits could largely offset the financial strain perceived by the unemployed during their unemployment (Voßemer, 2019). The existence of such an income safety net also relieves temporary workers' income insecurity when they are considering their financial capabilities after the termination of fixed-term contracts.

3.2.2 The role of family welfare policies

Comparative family policy studies have found that countries with more extensive family welfare supports tend to have higher fertility (Bergsvik et al., 2021; Gauthier, 2007; Kalwij, 2010). Studies also showed that people's childbirth behaviours are responsive to family policy reforms, such as the extension of parental leaves, the increase in family cash benefits, or the expansion of public childcare services (Cygan-Rehm, 2016; d'Albis et al., 2017; Duvander et al., 2019; Raute, 2019). However, to what extent are these variations in family welfare policies closing or enlarging the fertility gaps between different employment groups remains largely unknown. *Study II* of this dissertation aims to answer this question by examining women's heterogeneous childbirth responses to employment instability across 27 European countries. Drawing on two theoretical traditions, I argue that country-level differences in specific family policy provisions affect the micro-level relationship between women's

employment and fertility by changing the economic incentives and the normative conditions behind birth decision-making.

In this section and in *Study II*, my theoretical and empirical discussions on the institutional moderation effects are restricted to three mainstream family policies in Europe: (1) family cash benefits via transfers or tax breaks, (2) paid maternity and parental leaves, and (3) early childcare services (Bergsvik et al., 2021; Gauthier, 2007). With a focus on women, I leave aside the paternity or parental leaves for fathers because the influences of paternity quota on mothers' work and fertility decisions are mainly indirect, contingent on how fathers respond to their increased efforts at homecare (Bergsvik et al., 2021).

From an economic perspective, family policies influence people's fertility behaviours mainly by changing the costs of children (Diprete et al., 2003). Policy researchers in this tradition distinguish between the traditional income support and the earner-carer support policies (Bergsvik et al., 2021; Billingsley & Ferrarini, 2014). The former facilitates female childbirth by relieving the direct costs of children (i.e., moderating the income effects); the latter enhances female childbirth by reducing the opportunity costs of childrearing (i.e., moderating the substitution effects). Among the three most common family policies, family cash benefits belong to the traditional income support measures, while maternal paid leaves and childcare services are categorized as earner-carer support policies. Theoretical predictions from this economic perspective are that traditional income support policies may buffer the negative effects of employment instability on women's childbirth transitions because the income effects become less relevant with external income supports. In contrast, earner-carer support policies may strengthen the negative effects of employment instability on women's childbirth because such policies reduce the relevance of substation effects by externalizing the opportunity costs of childrearing.

From a sociological perspective, on the other hand, family policies are influencing women's childbirth behaviours by changing the social norms and social-psychological values of childrearing. Researchers in this tradition argue that advocating specific family policies can either familize or de-familize the gender norms and childcare arrangements (Esping-Andersen et al., 2002; Lohmann & Zagel, 2016). Among the three family policies, family cash benefits and maternal paid leaves are familization policies that reinforce the social recognition of women's income dependency and mothers' childcare role. Early childcare services, in contrast, are de-familization policies that break the traditional household division of labour by outsourcing parents' childcare roles. Theoretical predictions from this sociological

perspective are that familization policies may eliminate the negative effects of women's employment instability on childbirth transitions because the social-structural constraints due to economic uncertainty are largely reduced, and the social-psychological value of childcaring as an alternative career has increased. De-familization policies, on the other hand, are predicted to strengthen the negative impacts of women's employment instability on childbirth transitions because they largely reduce the social recognition of mothers' childcaring role as an alternative career and expose women who have a stable employment career to the structural uncertainty.

3.3 Motherhood career penalty in post-childbirth age

This section briefly introduces the theories regarding why women's motherhood transition may negatively affect careers, leading to the motherhood penalty. In theory, motherhood affects women's employment and wage outcomes via four mechanisms. First, women's childbirth-related employment interruptions may disrupt the process of human capital accumulation and depreciate working skills (Becker, 1985). Such a lower human capital causes mothers' lower productivity compared to non-mothers, who are supposed to accumulate their working experiences without interruption.

Second, women also have to adapt to their new work-family role and deal with the rising work-family conflicts after motherhood. During this career adaptation period, women's productivity tends to decrease because their energy and resources might be exhausted by taking care of children. Increased work-family role conflict due to inflexible childcare tasks lowers mothers' work efforts (Bielby & Bielby, 1988) and discourages their labour market attachment (Anderson et al., 2003; Greenhaus & Beutell, 1985). The need for time flexibility further reduces mothers' labour supply and triggers them to settle with "family friendly" jobs, which may disadvantage women's career mobility and wages in the long run (Fuller & Hirsh, 2019; Glass, 2004).

Third, motherhood transition may change women's preferences between work and family. Around the time of childbirth, women may adjust their work-family preferences in favor of their current role as a mother. Similarly, their work commitment tends to weaken due to the increased exposure to family-oriented environments (Bielby & Bielby, 1984). These changes might lead to women's lower labour supply and wage return.

Fourth, the motherhood penalty may also result from employers' systematic discrimination against working mothers. In the short run, statistical discriminations may occur because hiring mothers may involve higher risks of low productivity compared to hiring non-mothers (Arrow, 1973). In addition, status-based discrimination leads to employers' biased evaluation of working mothers' performance because the role of mothers as a social construct contradicts the role of ideal workers (Correll et al., 2007; Correll & Benard, 2006).

Over the years, these four theories have been examined by numerous empirical researchers. It is not surprising that many studies have found negative impacts of motherhood transition on women's labour supply (García-Manglano, 2015; Gash, 2009; W. Yu, 2009), hourly wage rates (Budig & England, 2001; de Hoon et al., 2017; Kühhirt & Ludwig, 2012; J. Yu & Xie, 2018), and earnings (Budig et al., 2016; Cools et al., 2017; Lundberg & Rose, 2000). However, earlier studies on motherhood penalty have been criticized for their static understanding of such issue. Applying the life course perspective mentioned in the previous section, new research on this topic shows that motherhood transition not only affects women's labour supply and wages around childbirth but might also trigger cumulative disadvantages to women's career outcomes in the long run (Kleven, Landais, & Søgaard, 2019; Musick et al., 2020; Stojmenovska & England, 2020; Van Winkle & Fasang, 2020). Moreover, women's fertility life courses are continuously unfolding throughout the reproductive age, indicating that motherhood penalty may not only occur following the first birth but also accumulate after the second and higher-order births (Doren, 2019; Van Winkle & Fasang, 2020).

Drawing on these debates, *Study IV* aims to enrich the theoretical framework and propose an empirical approach for analyzing the life course dynamics of motherhood penalty in two dimensions: (1) over time and (2) across different birth parity. In theory, the abovementioned four mechanisms causing motherhood penalty could either strengthen or diminish over the life course, leading to the time and parity heterogeneity of motherhood career impacts. For example, while the career interruption after childbirth may cause a short-term shock in mothers' human capital accumulation, such impact is not likely to last for a long time as long as mothers return to the labour market to accumulate their human capital again. On the other hand, women's career adaptation to their new work-family role is likely to change the household division of labour and push mothers into more "family friendly" working positions. In the long run, such housework specialization might decrease women's work efforts in order to avoid worker-mother role conflict; and settling with such family friendly positions might cause downward career mobility in the long run.

In the above example, whether the motherhood career penalty will strengthen or diminish over time in women's post-childbirth age remains, in theory, an unresolved question. Therefore, as we've discussed in the earlier sections, researchers should consider the relevance of each theoretical mechanisms in the specific empirical context to propose contextual hypotheses regarding the time and parity heterogeneity of motherhood penalty. In general, I argue that motherhood penalty is more likely to be cumulative (or at least not diminishing) and mostly triggered by the first childbirth in countries with the following characteristics: (1) the labour market is featured by a closed employment relationship system, where an interruption of firm-specific and tenure-based human capital accumulation is detrimental to women's careers; (2) public welfare supports for women to reconcile worker-carer role conflicts are lacking; and (3) the gender-cultural norm is dominated by a male-breadwinning-female-homemaking model, which reinforces the status-based discrimination against working mothers.

3.4 Hypotheses of this dissertation

Based on the theoretical framework discussed in Sections 3.1 to 3.3, several hypotheses were formulated across the four empirical studies in this dissertation. To highlight the key concepts to be examined, I streamlined my original hypotheses in each paper to formulate ten meta-hypotheses.

The first general question regarding how women's employment situations affect their union formation is discussed in *Study I* based on survey data in Europe during the past decade (i.e., 2010 to 2019). In such a European context, the dual-earner family models are already widespread (Oláh et al., 2021), making the income effect a dominant mechanism influencing women's family formation behaviours. Meanwhile, with the emergence of individualistic social norms during Europe's second demographic transition (Lesthaeghe, 2010)(Lesthaeghe, 2010), the intrinsic value of children and the social recognition of starting a family as women's "alternative career" has been decreasing. Against the background, the first hypothesis in *Study I* is that:

H1: Women's employment instability negatively affects (depresses) union formation.

Following this hypothesis, we utilized the theoretical framework discussed in Section 3.2.1 to further propose the second and the third meta-hypotheses that address the moderating role of labour market regulations:

H2: The effect of women's employment instability on family formation is more negative in the context of stronger insider-outsider labour market segregation policies.

H3: The effect of women's employment instability on family formation is less negative in the context of more generous provisions of unemployment welfares.

* * *

The second general question regarding how women's employment situations affect their childbirth behaviours is addressed in *Study II* at the same European context. Following my previous discussion, the fourth meta-hypothesis of this dissertation is:

H4: Women's employment instability negatively affects (depresses) birth transitions.

Drawing on the theoretical framework discussed in Section 3.2.2, I propose the fifth and the sixth meta-hypotheses about the moderating role of family welfare policies:

H5: The effect of women's employment instability on birth transitions is less negative in the context of stronger traditional income support and familization policies.

H6: The effect of women's employment instability on birth transitions is more negative in the context of stronger earner-carer support and de-familization policies.

* * *

Study III reexamines the second general question using a life course approach that differs from the focus on institutional moderations in *Study I* and *Study II*. Besides, *Study III* uses Taiwan as the empirical case for examination. As briefly mentioned in Section 2.2, Taiwan is a country where the female labour force participation rates are high and where the dual-earner family is the most prevalent household form. However, the development of a gender-equal division of labour within couple is still lagging, as Taiwanese women are still bearing a much heavier childcare and housework tasks than their male partners in the household (Cheng, 2020; Cheng & Hsu, 2020). Moreover, family policies aiming to reconcile women's dual roles as an earner and a carer, such as paid parental leaves or public childcare provisions, are especially lacking. In such a context, career-oriented women who aim for a stable employment career in a standard position will find it difficult to combine work with family because childcare supports from public policies and husbands' domestic help are generally lacking (Gauthier, 2016). As a results, to avoid the

conflicts between work and childrearing, Taiwanese women who have a stable employment career may have a higher incentive to postpone motherhood transition and to have fewer children comparing to those who have a rather unstable or interruptive working career. I propose two meta-hypotheses accordingly:

H7: Having a stable employment career associates with women's delayed timing of childbirth in Taiwan.

H8: Having a stable employment career associates with women's lower quantum of fertility in Taiwan.

* * *

Finally, Study IV addresses the third general question regarding how women's motherhood and childbirth transitions affect their employment careers using another East Asian country—Japan—as an empirical case. On one hand, the Japanese labour market is famous for its closed employment relationship system, where an interruption of firm-specific or tenure-based human capital accumulation is detrimental to individual's career development. On the other hand, like Taiwan, Japan is a country characterized by inadequate provisions of earner-carer supportive family policies. Moreover, under the influences of Confucianist gender-cultural norms, women in Japan are still expected to prioritize their family duties including childcare and domestic works over pursuing an employment career (Piotrowski et al., 2019). Meanwhile, Japanese women usually face strong social expectations of intensive parenting after family formation while receiving little help from their husbands (Raymo et al., 2015). These country-level characteristics fit to our discussions in Section 3.3 regarding the contextual background under which motherhood penalty is more likely to be cumulative and triggered mostly by the first birth. Accordingly, I propose the final two meta-hypotheses of this dissertation:

H9: Childbirth has a long-term, persistent negative impact on women's earnings (cumulative disadvantage hypothesis) in Japan.

H10: The most significant motherhood penalty occurs following women's first-time motherhood transition (first-birth pivotal transition hypothesis) in Japan.

Table 2: Overview of research designs

# / Title	Analytical framework	Data	Sample	Dependent variables	Key independent variables	Methods
1. A Precarious Path to Partnership? The Moderating Effects of Labour Market Regulations on the Relationship Between Unstable Employment and Union Formation in Europe.	Index-based comparative approach	EU-SILC panel data from 26 European countries, 2010-2019	Single women and men aged between 15 and 45 years	Union formation event (married or cohabiting)	Employment instability (Unemployment & Temporary employment)	Multilevel analysis / Country fixed effects and fixed slopes models
2. How women's employment instability affects birth transitions: The moderating role of family policies in 27 European countries	Index-based comparative approach	EU-SILC panel data from 27 European countries, 2010-2019	Parity-specific samples for women aged between 16 and 40 years	First and second birth transition events	Employment instability (Unemployment & Temporary employment)	Multilevel analysis / Country random effects and random slopes models
3. Work and fertility in Taiwan: how do women's and men's career sequences associate with fertility outcomes?	Life course approach	Taiwan Social Change Survey (TSCS), 2017	Women and men aged above 40 by 2017	Childbirth timing and quantum up to age 40	Employment career clusters	Sequence analysis / Event history analysis / Poisson and Logistic regressions
4. Parity-specific motherhood penalties: Long-term impacts of childbirth on women's earnings in Japan	Life course approach	Japanese Panel Survey of Consumers (JPSC), 1993-2015	Parity-specific samples for women aged above 24	labour supply (employment & work hours), wage rates, and earnings	First and second birth transitions	Fixed effects models / impact functions

4 Research designs

This section describes the research designs of the four empirical studies of this dissertation. I will provide an overview of the empirical materials (data, sample, and variables) and methods used in each study. The strengths and limitations of each data and method will also be discussed. These research designs complement each other and correspond to the two analytical frameworks that I have mentioned earlier: (1) the comparative approach, with a particular focus on the macro-level institutions, and (2) the life course approach.

4.1 Study I

Starting from the first stage of the family formation process, *Study I* examined how women's employment instability affected their union formation and how such micro-level linkage is moderated by variations in labour market regulations in European countries. The backbone of this study's analytical strategy is the *index-based comparative approach*, although a life course perspective is also featured due to our focus on individuals' union "transitions."

To model the moderation roles of macro-level labour market regulations on the micro-level employment-union formation relationship, constructing a multilevel dataset is needed. Micro-level data for this study came from the panel datafiles of the European Union Statistics on Income and Living Conditions (EU-SILC). The EU-SILC panel is the only (ongoing) micro panel dataset that features nationally representative samples across almost all European countries. It uses a rotational panel design, which means that each national-representative panel sample is drawn every year and is followed for up to four years before being replaced by another rotation group. Between the years 2010 and 2019, more than 500,000 women from 32 countries have been interviewed. The large geographical scope and the longitudinal nature of the EU-SILC panel make it one of the most powerful data sources for comparative life course research. Macro-level data of labour market regulations and other indexes were assembled from multiple sources including the OECD, Eurostat, and the KOF Globalization Index. These macro data were combined with ten waves of EU-SILC data, collected from 26 European countries in the years 2010-2019. Bulgaria, Croatia, Cyprus, Malta, Romania, and Russia were excluded due to missing data in key macro variables.

With a focus on the likelihood of single women's (and men's) union formation, we selected individuals aged between 15 and 45 years who lived without a partner in their first

interview. All person-years in the following waves were kept in the sample until one entered a partnership union, until attrition, or until the date of panel exit.

The dependent variable of *Study I* was a time-varying binary event variable measuring a transition into a coresidential partnership union, including both marriages and non-marital cohabitations, in a specific year. With an aim to model the effects of employment instability on the probability of union formation, we utilized the longitudinal nature of the EU-SILC data to rationalize the causal order between a prior employment situation and the following union formation outcomes. Therefore, our key independent variable was one's employment status lagged for one year before the outcome variable, in which the concept of employment instability was measured as being unemployed or temporarily employed comparing to being permanently employed.

For modeling, we used a linear probability model that adjusted for individual ages at the baseline and controlled for a set of confounding variables to estimate the effects of employment instability on the transition probability of union status. This model is a more parsimonious alternative to the standard discrete-time event-history model for modeling transition probabilities when a time-to-event dataset has a short observation period and left truncation issues (see Kalmijn (2011) or Vignoli et al. (2012) for similar applications).

To capture the hierarchical data structure, we specified a three-level multilevel model, where individual observations (level 3) are nested in country-years (level 2) and countries (level 1). To estimate the moderating effects of labour market regulations on individual-level employment-union formation relationship, we applied a multilevel estimator with country fixed effects and country fixed slopes for the key independent variables (Giesselmann & Schmidt-Catran, 2019). The most important advantage of this estimator was that it ruled out all time-constant, country-level, unobserved heterogeneities when we are estimating the moderating effects of macro-level indicators, thus largely relieving the assumption that the micro-level relationship and the country-level moderators should be uncorrelated with not only time-varying but also time-constant country-level unobserved heterogeneities. Since many unobservable country-level time-constant heterogeneities, such as cultural values or gender norms, may correlate with labour market regulations and influence the effects of employment instability on union formation (Kalmijn, 2011), applying this country fixed effects and slopes estimator may largely improve the accuracy of our estimation.

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Although the analytical sample in *Study I* included both women and men, we have included comprehensive discussions on the gendered effects of employment instability on union formation as well as the gendering influences of labour market regulations in reinforcing or attenuating such micro-level relationship.

4.2 Study II

Following the first study, *Study II* examined the impact of employment instability on the second stage of women's family formation process: childbirth transitions. It also applied the index-based comparative approach with an aim to tackle the institutional factors behind cross-country variations in women's fertility reactions of employment instability. Different from *Study I*, *Study II* highlighted the role of another institution—family welfare policies—in shaping the micro-level work-family relationship.

Micro-level data for *Study II* also came from the EU-SILC panel dataset; we use data collected from 27 European countries in the years 2010-2019. Macro-level data about family policies and other indicators came from multiple sources including the OECD Family Database, the OECD tax-benefit model (TaxBEN), Eurostat, and ILOSTAT.

There were two dependent variables in *Study II*: the first and the second birth transition. Like *Study I*, the probability of each birth transition was modeled by a linear probability model, in which women's employment status served as the key independent variable, together with a set of control variables that theoretically confound the relationship between women's employment situations and childbirth. To make the causal order more plausible, all independent variables were lagged for one year before the outcome variable.

To estimate the moderating effects of family policies on the relationship between women's employment instability and childbirth, *Study II* also specified a three-level multilevel model and included cross-level interaction terms between the macro-level family policies and the micro-level employment status. However, instead of using the country fixed effects and slopes model as we did in *Study I*, *Study II* specified multilevel mixed effects models in which country variations in micro- and macro-level variables are captured by country random effects and random slopes.

From a causal perspective, the "within estimator" of *Study I*'s country fixed effects and slopes model should yield superior estimations of the moderating effects of the macro-

level moderators (i.e., the labour market institutions or the family welfare policies) than the "between estimator" of *Study II*'s mixed effects model because the latter estimator treats country-level heterogeneities in outcomes and slopes as random intercepts and random slopes, assuming not only time-varying but also time-constant country-level unobserved heterogeneities to be uncorrelated with the independent variables (as discussed in the previous section).

However, the within estimator has an empirical limitation because its estimation rests on within-country "changes" in macro variables over time. Such a requirement is largely fulfilled in the European context of our *Study I*. In the aftermath of the 2008/2009 Great Recession, the European Commission has been promoting labour market reforms under the notion of "flexicurity," aiming to create higher employment flexibility and social security in a unified policy package (Eichhorst et al., 2017; Viebrock & Clasen, 2009). In this context, many European countries have experienced labour market reforms from 2010 to 2019. On the other hand, the development of family welfare policies in European countries during the past decade has been rather slow, particularly in comparison with their rapid expansion in the 1990s and the 2000s. Moreover, the heterogeneity in institutional logic behind family welfare provisions is largely reflected in the "between-country" variations during this period. Given this empirical context, *Study II* chose the mixed effects between estimator for modeling the moderating effects of family policies on the micro-level relationship between women's employment instability and childbirth.

Despite their different estimation strategies, *Study I* and *Study II* together comprised the first part of my dissertation. Both studies applied the indicator-based approach for comparative research and utilized the EU-SILC panel data collected in the past decade (from 2010 to 2019). As discussed earlier, comparing to the typology-based comparative approach, the indicator-based approach has the advantage of isolating specific effects of macro-level moderators and overcoming the within-heterogeneity of welfare regimes when estimating causal (moderation) effects. Taken together, our findings contribute to the first theoretical pillar regarding the institutional factors behind the work-family relationship (see Figure 2); they not only showed that labour market regulations and family policies *did* affect women's union or childbirth responses to employment instability, but also showed that *how* and *to what extent* were these micro-level relations dependent on specific policy or institution.

4.3 Study III

Departing from *Study I* and *Study II's* analytical focus on the short-term work-family relationship, *Study III* introduced a life course approach to investigate the holistic associations between women's employment careers and fertility histories.

Data of this research came from the 2017 Taiwan Social Change Survey (TSCS 2017). The 2017 TSCS data comprised a nationally representative sample of 1,917 Taiwanese adults aged 18 to 70. It included retrospective information on individuals' education, work, partnership, and fertility histories. Based on the biography data, I constructed the fertility histories regarding the timing and quantum of births and the employment trajectories during women's prime reproductive ages (i.e., from 18 to 40 years old). Several methods were utilized in *Study III*. First, I performed sequence and cluster analyses to identify several career patterns up to women's (and men's) midlife. Life course theories have a methodological affinity with sequence analyses, where life trajectories are identified as the successions of multiple states and transitions over time (Aisenbrey & Fasang, 2010; Mikolai & Lyons-Amos, 2017; Studer et al., 2018). Using different algorithms to calculate the distances between sequences, researchers can cluster similar sequences into categorical groups, classifying heterogeneous trajectories into operationalizable typology (Aisenbrey & Fasang, 2010; Studer et al., 2018). Comparing to the snapshot measurement of employment situations in a specific time point, as we did in *Study I* and *Study II*, the employment trajectories based on Sequence-cluster analyses in *Study III* provided high levels of granularity. This helps us to more accurately capture how women's (and men's) careers unfolded in real lives.

Second, to examine how these career groups were linked to specific fertility timing, I used the Nelson–Aalen estimators to calculate the group-specific cumulative hazards of the first three childbirth transitions. Presenting cumulative transition hazards using the Nelson–Aalen estimator is informative in describing the (timing) pace of fertility because the cumulative form of transition hazards implies the duration of waiting time for the occurrence of a birth transition (Mills, 2010).

Third, to investigate how women's (and men's) fertility quantum are affected by employment careers, I specified a count model and regressed the number of children by age 40 by one's career trajectory using the Poisson regression.

These innovations of *Study III* complement *Study I* and *Study II's* comparative approach by zooming in the details of the micro-level work-family relationship over women's (and men's) lifetime in an East Asian context that is very different from Europe.

4.4 Study IV

The final study in this dissertation examined the relationship between women's work and family dynamics from another direction. Specifically, *Study IV* investigated the long-term influences of the first and the second birth transitions on women's labor supply (employment and work hours), wage rates, and earnings.

I utilized panel data from 23 waves of the Japanese Panel Survey of Consumers (JPSC), collected between 1993 and 2015. The initial and the refresh samples of the JPSC targeted at young women aged between 24 to 34 years old. The long observational period of a relatively young sample across different cohorts makes the JPSC suitable for studying women's motherhood transitions and their long-term career impacts.

To tackle the causal effects of each parity transitions on women's labour market outcomes in the following ten years, *Study IV* proposed a novel event-study design based on fixed effects regression models. First, I used fixed effects estimators with the "dummy impact function" (Brüderl et al., 2019), also known as "distributed fixed effects models" (Stojmenovska & England, 2020), to identify the dynamic career impacts of motherhood over a ten-year observation window. From a methodological point of view, this research design combined the strengths of the *analytic* and the *holistic* approaches in life course research (Mayer, 2009). That is, the strength of the fixed effects estimator for causal analyses is integrated into the presentation of life trajectories in detail.

Second, to deal with the special issue of selection into a consecutive treatment (i.e., the second birth) based on the heterogeneous effect of the previous treatment (i.e., the first birth), I introduced a novel strategy in which *multiple estimation models and samples* were constructed. This strategy was combined with a dynamic specification of the treatment and control spells based on the event time relative to each childbirth, which extended the standard fixed effect estimator to a counterfactual causal analysis using the two-way fixed effect estimator. By doing so, we were able to de-trend the life cycle of career development (i.e., the maturation effect ages) for a more accurate estimation of the motherhood penalty.

5 Conclusion

The overarching goal of this dissertation is to systematically study the relationship between women's work and family formation. Taking a holistic perspective, I study the employment-related causes and consequences of women's family formation process including union formation, childbirth transitions, and post-motherhood life courses. Rather than conceptualizing the linkage between women's work and family behaviours as a static, homogeneous relationship, I added an institutional and a longitudinal dimension to emphasize the contextual embeddedness and time dynamics of individual life courses (Buhr & Huinink, 2014; Mayer, 2009). For women, work and family situations are both important factors triggering social stratification (Billari et al., 2019; Esping-Andersen, 2009; Gallie, 2013). Moreover, short-term disadvantages in these two dimensions could reinforce each other under certain conditions (Matysiak, 2011), which might result in cumulative disadvantages throughout individual life courses (Ferraro et al., 2009). Therefore, it is crucial for scholars and policymakers alike to better understand what are the contextual factors that could alleviate or intensify social inequalities emerging from the work-family relationship, and how these inequalities are cumulated over the life course.

The remaining part of this section summarizes the major findings of my empirical studies, followed by a discussion of how this dissertation contributes to the field of work-family study, comparative research, and life course approach. I conclude this Overview Chapter by discussing the unresolved issues in this dissertation and providing several suggestions for future research on the comparative life course dynamics of work-family relationship.

5.1 Key findings and contributions

Table 3 presents an overview of this dissertation's meta-hypotheses, together with the analytical frameworks from which they were derived, and to what extent they were supported by the empirical results. I hereby discuss several key findings.

Table 3: Overview of meta-hypotheses, analytical frameworks, and empirical supports

Meta-hypotheses for each topic	Analytical framework			Empirical support
	Comparative approach		Life course approach	
	Labour market regulations	Family welfare policies		
Study I: Employment instability and union formation in Europe				
1) Women's employment instability negatively affects (i.e., depresses) union formation. 2) The effect is more negative in the context of stronger insider-outsider labour market segregation policies. 3) The effect is less negative in the context of more generous provisions of unemployment welfares.	Employment protection, collective bargaining, unemployment benefits	Not tested (but discussed in the empirical design)	Short-term impacts of employment instability on union status transition	+ ~ +
Study II: Employment instability and childbirth in Europe				
4) Women's employment instability negatively affects (i.e., depresses) birth transitions. 5) The effect is less negative in the context of stronger traditional income support and familization policies. 6) The effect is more negative in the context of stronger earner-carer support and de-familization policies.	Not tested (but discussed in the empirical design)	Family cash benefits, paid leaves, early childcare services	Short-term impacts of employment instability on childbirth transitions	+ + +
Study III: Employment career and fertility history in Taiwan				
7) Having a stable employment career associates with women's delayed timing of childbirth in Taiwan. 8) Having a stable employment career associates with women's lower quantum of fertility in Taiwan.	TW: Open employment relationship (low LM segregation)	TW: Limited earner-carer support policies	Holistic life course associations between careers and fertility histories	+ +
Study IV: Motherhood penalty in Japan				
9) Childbirth has a long-term, persistent negative impact on women's earnings (cumulative disadvantage hypothesis) in Japan. 10) The most significant motherhood penalty occurs following women's first-time motherhood transition (first-birth pivotal transition hypothesis) in Japan.	JP: Closed employment relationship (high LM segregation)	JP: Limited earner-carer support policies	Long-term impacts of childbirth on post-motherhood career outcomes	+ +

Note: In the final column, + denotes empirical support, ~ denotes partial empirical support

First, *Study I* and *Study II* showed that a *pattern of disadvantage* has emerged at the European level during the past decade (2010–2019), in which women who experienced employment instability were also less likely to form partnership unions and to become mothers in the short term (supporting H1 and H4 in Table 3). Such findings provide empirical supports to Becker's home economic theory (Becker, 1991; Grossbard, 2015), which argues a positive relationship between employment stability and individual's marriage or childbirth transitions through the "income effects" mechanism (i.e., stable employment increases financial stability, which raises the demand for marriage and children). My findings also support Oppenheimer's uncertainty theory (Oppenheimer, 1988), which emphasizes the necessity of having a stable employment career when considering family formation. However, Becker's and Oppenheimer's theories were developed in the US during the early 1990s. Both theories hypothesized a negative relationship between employment instability and family formation only for men, not for women. My *Study I* and *Study II*, on the other hand, extended the empirical literature to the examination of women's work-family relationship in the European context. My findings of negative effects of women's employment instability on union formation and childbirth transitions indicate that the relationship between work situations and family behaviours have been converging across gender in Europe, which echo recent findings from other European studies about the gender convergence of work-family life courses (Lesnard et al., 2016; McMunn et al., 2015).

Adding to the first finding, my second key finding is that the degree to which women's employment instability affects family formation is contingent on the institutional context in which individuals are embedded. Two institutional dimensions were investigated in this dissertation (see Figure 2). First, *Study I* showed that changes in labour market regulations could moderate the impacts of women's employment instability on the probability of transitioning into a partnership union. Specifically, the negative effects of being unemployed on women's union formation were reinforced if EPLT became stricter or the CBC became higher. Such reinforcement effect might reflect the institutional mechanisms that stricter EPLT and higher CBC could strengthen labour market dualism (Baranowska & Gebel, 2010; Barton et al., 2021; Dieckhoff et al., 2015), which in turn enlarges the security gaps between labour market insiders and outsiders (Balz, 2017). However, I did not find any empirical evidence for the hypothesized reinforcement effect of stricter EPLR on the negative linkage between women's employment instability and union formation. In this regard, H2 in Table 3 was only partially supported by my analyses for Europe. On the other hand, increasing generosity of unemployment benefits did buffer the negative effects of temporary

employment and unemployment on union formation (supporting H3). For policy researchers, *Study I* also provides crucial evaluations regarding how "flexicurity" labour market reforms suggested by the European Commission (Eichhorst et al., 2017; Viebrock & Clasen, 2009), such as deregulating EPLs, lowering CBC, and increasing unemployment benefits, could shape the employment-partnering relationship in Europe.

The second institutional dimension behind the work-family linkage was discussed in *Study II*, which showed that country-level variations in family welfare policies could moderate the impacts of women's employment instability on the first and the second birth transitions. Specifically, I found that the impacts of women's employment instability on childbirth transitions were less negative in countries that provided stronger traditional income support and familization policies, such as more generous family benefits through cash transfers or tax breaks (supporting H5). In contrast, more comprehensive earner-carer support and de-familization policies at the country level, such as higher coverage rates of early childcare services, could enlarge the negative effects of women's employment instability on their first or second birth transitions (supporting H6). These findings have a crucial contribution to family policy research because while many studies have explored the impacts of family policy provisions on women's fertility outcomes (Bergsvik et al., 2021; Billingsley et al., 2022; Billingsley & Ferrarini, 2014), rather few have discussed whether these policies could reinforce or eliminate social inequalities in childbirth behaviours (Blossfeld et al., 2005; Matysiak & Vignoli, 2013).

Overall, the empirical findings of *Study I* and *Study II* contribute to work-family studies by highlighting the role of policy institutions in shaping the micro-level relationship between women's employment situations and family behaviours. Different from previous studies about the interplay between institutional factors and the work-family relationship (Adsera, 2011b; Barbieri et al., 2015; Blossfeld et al., 2005), which is mostly based on the typology-based comparative approach across welfare states or regimes (Kreyenfeld, 2021), *Study I* and *Study II* used index-based comparative approach and multilevel modeling strategies to quantify the moderating effects of specific policies or institutions. Such an index-based comparative approach has been useful for researchers and policymakers alike to better evaluate the effectiveness and social consequences of policy interventions.

Going beyond *Study I* and *Study II*, the third key finding of this dissertation is that the relationship between women's work and family behaviours is not fixed in time but unfolds over the life course. To capture this dynamic nature, it is necessary to integrate life course

approaches to the theoretical and methodological framework of work-family study. To this end, *Study III* combined sequence analyses, event history analysis, and regression techniques to investigate the holistic associations between women's working careers and fertility histories. It showed that having a stable employment career associated with women's delayed motherhood transition, slower parity progression, and eventually a lower total fertility by age 40 in Taiwan. These findings support the H7 and H8 in Table 3. At first glance, such findings in Taiwan contradict with *Study I* and *Study II*'s findings in Europe, where women's stable employment situations have been, on average, linked to accelerated family formation. However, if we take into account the institutional context of Taiwan, the observed negative relationship between women's employment "stability" and fertility in Taiwan reflects very well my hypotheses H2 and H6 regarding the institutional moderation effects. First, Taiwan has relatively loose labour market regulations, leading to its lower labour market segregation comparing to the European average, which is a background of a less negative relationship between women's employment instability and union formation (H2). Second, Taiwan has limited earner-carer family policy supports, which also favors a less negative relationship between women's employment instability on fertility (H6). Combining these two institutional factors with Taiwan's high demand for women's labour force participation as well as childcare responsibility (Cheng & Hsu, 2020), it is understandable that women's stable employment career may hinder rather than foster their motherhood transition and parity progressions, which eventually lead to lower complete fertility by midlife.

Finally, *Study IV* completed the final piece of this dissertation by examining the work-family linkage from another direction. Using longitudinal data from Japan, *Study IV* showed that women's childbirth transitions, especially the first birth, could trigger a short-term employment slump upon pregnancy and a long-term reduction in women's work hours and wage rates, leading to a remarkable "motherhood penalty" in earnings after a decade of motherhood. Such a pattern supports the cumulative disadvantage hypothesis as described in H9. Another crucial contribution of *Study IV* is that it proposed a research design to explore *not only* how motherhood penalties in women's career outcomes are cumulated over time *but also* how these penalties are allocated across different parity transitions. I found that the long-term motherhood earnings penalty in Japan was dominantly driven by a perpetual reduction of labour supply rather than by the wage penalty following the birth of the first child (supporting H10). Such a unique focus on motherhood penalty in terms of women's labour supply deviates from the mainstream motherhood penalty literature in European or North American countries (Cukrowska-Torzewska & Matysiak, 2020; de Linde Leonard & Stanley, 2020),

where the wage penalty of motherhood received most researchers' attention. Our unique findings in *Study IV* underscore the importance of placing life course analyses of motherhood penalty in their specific institutional and cultural context.

5.2 Unresolved issues and suggestions for future research

In summary, this dissertation contributes to the current debates in work and family research by highlighting the dynamic nature of work-family life courses and their institutional embeddedness (Buhr & Huinink, 2014; Mayer, 2009). Throughout the dissertation, I have demonstrated the potential of using an integrated theoretical framework and life course approaches to examine the influences of women's employment situations on union formation and childbirth as well as the impacts of childbirth on women's post-motherhood careers for specific contexts. However, investigation in this strand of research is far from complete. There are several theoretical topics and methodological challenges waiting to be explored. I conclude this Overview Chapter by pointing out these remaining issues and offering some suggestions for future work-family research.

The first issue is that the micro-level theoretical framework should be renovated in order to capture the new development of women's work-family relationship. The theoretical building blocks of contemporary work-family studies (either for the impacts of women's work on family behaviours or for the motherhood penalties) were developed in the 1980s and 1990s, during which the male-breadwinner-female-homemaker norm still prevailed in most countries across Europe, North America, and Asia. In this historical context, classic economic and sociological theories alike usually assumed that women's employment and financial stability would be submissive to their normative responsibility of forming a family and caring for children. However, such an assumption becomes problematic with the rise of dual-earner families and gender equality in developed countries. As a result, while many classic theories still provide useful insights in describing *why* women's working situations could affect or be affected by their family formation, their original predictions regarding *how* women's work and family processes are linked to each other could be misleading. In a more general aspect, work-family researchers should systematically reevaluate the assumptions behind each theory and adapt them with the contemporary context (see my literature review in *Study I* and *Study II* for examples). For country-specific case studies, researchers will also benefit from having

an extended discussion on the contextual backgrounds and formulating "contextualized hypotheses" for empirical testing (see *Study III* and *Study IV* for examples).

Second, under the background of an emerging polarization of partnering and fertility patterns in developed countries (Ohlsson-Wijk & Andersson, 2022; Sassler & Lichter, 2020), it is important to systematically examine how individual socio-economic characteristics interact with institutional factors to generate new forms of social inequality in the work-family interface. To study the impacts of women's employment situations on family behaviours, the empirical framework of my *Study I* and *Study II* could be a good starting point to integrate other institutional dimensions into investigation. In addition to labour market regulations and family policies, there remain a wide range of institutions that could affect individuals' work and family decisions, such as education policies, healthcare policies, or social security provisions (Bergsvik et al., 2021; Blossfeld et al., 2005; Esping-Andersen, 2009). It is also important to bear in mind that these policy institutions are always embedded in the broader social contexts where gender-cultural norms may reinforce or inhibit the policy influences on work-family relationship (Baizan et al., 2016; Esping-Andersen & Billari, 2015; Korpi et al., 2013; Pfau-Effinger, 2005). Therefore, future research will benefit from having an extended theoretical framework that systematically discusses the mechanisms involved in each macro-micro interactions between work-family relationship and other institutional or cultural factors.

Third, a similar effort is needed for motherhood penalty research to construct an integrative theoretical framework to investigate policy influences across countries. While several studies and meta-analysis have shown that motherhood penalty in earnings or wages did vary across countries (Cukrowska-Torzewska & Matysiak, 2020; de Linde Leonard & Stanley, 2020; Kleven, Landais, Posch, et al., 2019), there are rather limited discussions regarding how policies and institutions are shaping the cross-national heterogeneity. So far, the only policy dimension being discussed systematically is the moderating role of family policies (Budig et al., 2012, 2016), among which "policies that maintain maternal labor market attachment through moderate-length leaves, publicly funded childcare, lower marginal tax rates on second earners, and paternity leave are correlated with smaller motherhood wage penalties" (Budig et al., 2016: 119). Similar to the issue discussed earlier, there remain many other policy institutions (such as labour market regulations) as well as social norms and gender practices in the labour market that could influence women's post-motherhood careers.

Fourth, from a methodological point of view, a key message of this dissertation is that work-family researchers and policymakers alike would benefit from an *index-based comparative approach* where the policy or institutional effects are directly quantified. This index-based approach could supplement the popular *typology-based comparative approach* by looking into the black box of welfare states or regimes, showing how specific policy measures or their constellations are affecting individuals' work and family behaviours. A major challenge of this approach, however, is the difficulty to empirically isolate the targeted causal (moderation) effects of policies from other macro-level confounding factors, especially in the presence of country-level unobserved heterogeneities. Such a methodological challenge and researchers' fear of "oversimplifying" macro contexts have long discouraged comparative work-family studies from a direct investigation into policy effects (Blossfeld et al., 2005). Fortunately, the recent development of quantitative methods has opened up the possibility to combine policy evaluation methods using panel data with multilevel modeling techniques. As we have demonstrated in *Study I* and *Study II*, these modeling techniques can largely address the causality issue in earlier comparative policy research. Moreover, harmonizing national panel datasets for comparative research has become more efficient thanks to several data infrastructures such as the CNEF – Cross-National Equivalent File or the CPF – Comparative Panel File (Burkhauser & Lillard, 2005; Turek et al., 2021). Following this trend, we can expect more empirical studies join the camp of index-based comparative research to investigate to what extent are the cross-national polarization of employment-family formation patterns and the huge variations of motherhood earnings gaps are driven by the variety of policies and institutions across countries.

Fifth, another challenge of index-based comparative approach is that researchers should pay more attention to the validity and comprehensiveness of the measurements of macro indexes. In *Study I*, for example, while my coauthor and I have covered the most common measurements of labour market regulations across the three regulation dimensions according to Esping-Andersen and Regini (2000), there is still room for improvement by considering the multidimensionality of specific institution measures. For example, rather than using the original EPLR and EPLT indexes provided by OECD, which are weighted indexes comprising multiple items, Balz (2017) suggests using specific items of the indexes to capture the strictness of regulation in specific aspects (e.g., the definition of unfair dismissal). Regarding CBC measurements, research on industrial relations has shown that it's not only the CBC rate, but also the level of collective bargaining (Hayter & Weinberg, 2011) and the degree of bargaining centralization (Barton et al., 2021) that determine the degree of wage

and employment coordination. As for measuring the comprehensiveness of unemployment benefits, the entitlement, coverage, and duration are also important aspects besides the generosity measured by the income replacement rates (Gangl, 2006). Similarly, for *Study II*, we can also improve the comprehensiveness of family welfare measurements by further considering the variations in cash benefits entitlement, by separating the duration of parental leaves from their replacement rates, or by differentiating the quality, costs, and opening hours of childcare facilities (Daly & Ferragina, 2018; Thévenon, 2011).

Beyond the academic discussions, I hope that this dissertation's empirical findings can enhance the application of *Evidence-Informed Policy Making* in Europe, Taiwan, and Japan. I believe that this approach is the key to facilitating more efficient and less discriminating policy discussions for the good of the larger society.

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Study I:

A Precarious Path to Partnership? The Moderating Effects of Labour Market Regulations on the Relationship Between Unstable Employment and Union Formation in Europe.

Status: Published in *European Sociological Review*

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Citation: Hsu, C.-H., & Engelhardt, H. (2024). A Precarious Path to Partnership? The Moderating Effects of Labour Market Regulations on the Relationship Between Unstable Employment and Union Formation in Europe. *European Journal of Population*, 40 (12), 1–28. https://doi.org/10.1007/s10680-024-09698-3

Acknowledgements: The authors thank the participants of *the LabFam Conference: Family Life and Changing World of Work* at the University of Warsaw and of *the DiSIA Seminar* at the University of Florence for their insightful comments and suggestions to earlier versions of this article. This work is part of the SECCOPA project, which is funded by the European Research Council (ERC) under the Horizon 2020 research and innovation program (grant agreements No 758491). It is also funded by the State Institute for Family Research (ifb) at the University of Bamberg.

Abstract

Rising employment uncertainty featured by higher risks of being temporarily employed or unemployed is often seen as a driving force behind delayed and declined partnering in Western countries. However, such an employment-partnering relationship is contextualized by labour market institutions and thus could diverge across countries over time. Drawing on the debate, this paper aims to investigate how country-level changes in labour market regulations moderate individual-level effects of unstable employment on union formation, including the transitions into marriage or cohabitation unions. Using comparative panel data for 26 countries from the European Union Statistics on Income and Living Conditions (years 2010-2019; N = 203,969), our multilevel fixed effects models showed that temporary employment and unemployment have negative effects on union formation for both genders on the European average. Moreover, the negative effects of unstable employment on union formation were reinforced when labour market reforms were stimulating insider-outsider segregations or decreasing welfare provisions. Specifically, stricter employment protection legislations and higher coverage rates of collective bargaining agreements may result in more negative effects of temporary employment and unemployment on union formation, while more generous provisions of unemployment benefits could buffer such negative effects.

1 Introduction

Since the 1990s, labour market reforms in many European countries have dramatically changed individuals working conditions and life experiences (Esping-Andersen & Regini, 2000; Kalleberg, 2018). Comparing to workers of older generations, who mostly have stable employment careers in permanent positions, workers nowadays experience higher risks of unemployment and temporary employment by fixed-term contracts in their lives (Gallie & Paugam, 2000; Latner, 2022). Aligning with the trend of rising employment uncertainty (Blossfeld et al., 2005; Kreyenfeld et al., 2012), individuals' work and family life courses have also experienced remarkable changes in the past two decades (Balbo et al., 2013). To tackle the underlying mechanisms behind the ongoing demographic transition toward delayed and declined partnering and fertility patterns, it is crucial to study how people's unstable employment experiences, including temporary employment and unemployment, affect their union formation behaviours (i.e., the transition into marriage or cohabitating household unions).

Several studies found that temporary employment compared to permanent employment may reduce individuals' risks of getting married or cohabiting (Bolano & Vignoli, 2021; de Lange et al., 2014; Müller & Dräger, 2019; van Wijk et al., 2021). Unemployment was also found to decrease the likelihood of marriage or cohabitation transitions (Bolano & Vignoli, 2021; Kalmijn, 2011; Müller & Dräger, 2019). Although these studies provided valuable insights, they mostly relied on single-country case analyses and underemphasized the institutional factors behind the observed relationships between work and union formation.

In contrast, research on social consequences of changing labour markets usually utilized cross-national comparative analyses to highlight the role of institutions in eliminating or escalating social inequalities across different employment groups (Esping-Andersen & Regini, 2000). However, most studies in this tradition focused on labour market policies' impacts on economic wellbeing such as income and job security (Balz, 2017; Barbieri & Cutuli, 2016; Högberg et al., 2019); only few discussed how other life course dimensions such as childbirth and partnering are influenced by different institutional settings (Barbieri et al., 2015; Karabchuk, 2020; Scherer, 2009).

This paper aims to fill the gaps by linking the research on employment-partnering relationship to the literature discussing how changes in policy institutions lead to individuals' diverse life course experiences. Specifically, we highlight the role of labour market regulations in shaping the structural conditions of partnership behaviours, arguing that they may either mitigate or intensify the differentials in union formation probabilities across

employment groups. For example, stricter employment protection laws might arouse labour market segregation between the "core" and the "peripheral" labour forces and sharpen the social inequality in income and employment securities between these two groups (Barbieri, 2009). As a result, having stricter employment protection laws at the country level might enlarge the disadvantage of the unemployed or the temporarily employed in finding a partner or starting a family.

In summary, this study investigated two central questions: (1) How people's unstable employment situations including temporary employment and unemployment affect their likelihood of union formation? And (2) to what extent are such effects moderated by country-level variations in labour market regulations, including the strictness of the employment protection laws for both regular and temporary workers, the coverage rate of collective bargaining agreements, and the generosity of unemployment benefits. We also discussed the gendered impact of unstable employment on union formation and the gendering role of labour market contexts in shaping such work-family relationship.

Our empirical analyses were based on ten waves of comparative microdata from the European Union Statistics on Income and Living Conditions (EU-SILC), collected during years 2010-2019 across 26 European countries. Leveraging the longitudinal nature of the data, we applied multilevel analyses using country fixed effects and slopes models (Giesselmann & Schmidt-Catran, 2019) to provide more precise causal estimations of policy moderating effects. Being the first comparative studies to explore how individuals' partnering responses to unstable employment situations were influenced by labour market reforms in post-Great Recession Europe, our findings not only contribute to theoretical literatures by highlighting institutional factors behind the changing relationship between work and partnering (Blossfeld et al., 2005) but also add crucial policy implications to the debate on labour market "flexicurity" and its social consequences (Eichhorst et al., 2017; Viebrock & Clasen, 2009).

2 Background

2.1 Employment situations, insecurities, and union formation: micro-level theories

Compared to stable employment by permanent contract, unstable employment situations such as being unemployed or temporarily employed are usually characterized by (1) income insecurity—the difficulty to secure sufficient incomes with which to support a decent standard of living—and (2) employment insecurity—the tendency to lose jobs or remain unemployed in the near future (Grotti & Scherer, 2014; Kalleberg, 2009; Olsthoorn, 2014). In family

research, both income and employment insecurities are key mechanisms behind the delayed or decreased union formation among the unemployed and the temporarily employed (Ekert-Jaffe & Solaz, 2001; Kalmijn, 2011; Oppenheimer, 1988, 2003).

Due to the lack of salary, unemployment has always been a major factor of household income poverty (Haataja, 1999). Even in countries with generous welfare provisions, social insurance and benefits for the unemployed cannot entirely offset their losses of earnings (Gallie & Paugam, 2000). Among the employed, temporary employees have lower bargaining power over their wages and benefits (Gebel, 2010). Employers also have fewer incentives to provide on-job trainings for temporary workers (Forrier & Sels, 2003). Moreover, frequent employment interruptions following the end of each contract also render temporary employees higher difficulties to accumulate job-specific human capital, leading to poorer wage incomes. As a result, the unemployed and temporary employees generally have more financial problems and higher income insecurity compared to permanent employees (Gallie & Paugam, 2000; Scherer, 2009; Van Lancker, 2012).

According to the New Home Economics (Becker, 1991), income insecurity may discourage union formation through an "income effect" mechanism. Specifically, the economic theory assumes that individuals are rationally comparing the consumptions and resources—both monetary and non-monetary—that they would gain access to by partnering a particular person (for literature review see Grossbard, 2015). Demographic research also highlights the importance of financial affordability in people's union formation, particularly in forming a marriage union (Kravdal, 1999). Following this tradition, many studies have shown that a sufficient and secure income is an important factor for individuals, particularly for men, to successfully match a partner (Sassler & Lichter, 2020).

In addition to income insecurity, the unemployed and temporary employees face higher insecurity in their employment careers. Research on the "scar effects" argues that unemployment experiences not only cause income constraints but also stigmatize one's employment history, leading to long-term negative effects on the subsequent earnings and career mobility (Gangl, 2004, 2006). Even after re-employment, the once-unemployed may continue to perceive higher employment insecurity compared to the permanently employed (Dieckhoff, 2011; Voßemer, 2019). Among the employed, temporary workers suffer from higher employment insecurity than permanent employees (Balz, 2017). Because temporary workers' jobs are guaranteed within a fixed term (Kalleberg, 2009), their employment prospects dependent on the contract duration, the chance of another fixed-term contract renewal, and the possibility of a permanent contract transition.

In family sociology, Oppenheimer's theory of marriage timing (Oppenheimer, 1988, 2003) highlights the role of employment insecurity in delaying union formation. It argues that employment insecurity leads to uncertainty about future career paths and corresponding lifestyles. As a response, these individuals may perceive their current career stage as "immature" and choose to postpone union formation until a stable labour market position is achieved (Kalmijn, 2011). From a normative perspective, employment insecurity also disturbs assortative mating (Oppenheimer, 1988), particularly for men in a society with male-breadwinner family norms. Those who do not have a stable employment career might be labelled as incapable or unattractive. Derived from our theoretical considerations, we formulate the following hypotheses:

H1: Having an unstable employment situation such as temporary employment or unemployment has a negative effect on the probability of union formation among single individuals.

It is worth mentioning that New Home Economics and classic sociological theories usually predict a gender-asymmetric relationship between employment instability and union formation (Sassler & Lichter, 2020). Under a conservative assumption that women were financially dependent on men's breadwinning salaries, men's employment instability was seen as an unfavourable trait that deters partnership matching (Oppenheimer et al., 1997), while women's employment instability was referred to as a depressing factor of union formation (England & Farkas, 2017). However, such a perspective becomes flimsy with the rise of gender equality and dual-earner families in developed countries, where recent studies showed that women's precarious and unstable employment could discourage union formation in a similar way as men's (Bolano & Vignoli, 2021; Schneider et al., 2019). Nevertheless, although women's and men's work-family patterns are becoming similar in many European countries (Lesnard et al., 2016), such convergence seems to be driven by more women adopting traditional male employment patterns instead of more men reducing work commitment (McMunn et al., 2015). Therefore, having a stable employment career to support a family union might remain a social expectation that applies primarily to men than to women. We expect:

H2: The negative effect of having an unstable employment situation on the probability of union formation is stronger for men than for women.

2.2 Moderating roles of labour market regulations

While the abovementioned theories predict averagely negative effects of temporary employment and unemployment on union formation, such effects may vary across countries. Previous research found that variations in macro contexts, such as economic conditions (de Lange et al., 2014) and gender equality (Kalmijn, 2011), may partially explain the cross-national heterogeneity. In this study, we further highlight the roles of labour market regulations in shaping peoples' employment experiences (Esping-Andersen & Regini, 2000; Gallie & Paugam, 2000). Specifically, the degree to which temporarily employed and unemployed people feel insecure about their income and employment prospects is influenced by labour market contexts (Barbieri & Cutuli, 2016; Esping-Andersen & Regini, 2000). Following Esping-Andersen & Regini (2000), we classify labour market regulations in three dimensions including the employment protection legislations, the collective bargaining institutions, and the unemployment welfare policies. Variations in these regulations either reinforce or attenuate the income or employment insecurities related to unstable employment situations, leading to heterogeneous impacts of temporary employment and unemployment on union formation.

The first dimension of labour market regulations is the strictness of employment protection legislations (EPL), which regulate the procedures of employee recruitment and dismissal. According to the labour market insider-outsider hypothesis, a stricter EPL at the country-level may enlarge the employment "insecurity gap" between the labour market outsiders—the unemployed and temporary employees—and the insiders—permanent employees (Balz, 2017). In theory, it is important to discuss two sub-mechanisms behind such gap widening effect by differentiating the EPL of dismissing regular workers (EPLR) from the EPL of hiring temporary workers (EPLT) (Barbieri & Cutuli, 2016; OECD, 2014).

First, stricter EPLR raises the direct costs and procedure difficulties of dismissing a regular worker, which may discourage employers from hiring new workers and thus prolong the duration of unemployment and lower the risk of reemployment among the unemployed (Esping-Andersen & Regini, 2000). Because the cost of terminating a permanent contract is higher with stricter EPLR, employers also have more incentives using temporary contracts over permanent contracts to secure numerical flexibility, leading to deceased chances of permanent employment transitions for temporary employees (Högberg et al., 2019).

Second, stricter EPLT constraints the usage, duration, and the renewal of temporary contracts. This could raise the costs of hiring temporary workers, thus discouraging reemployment of the unemployed in such positions as entry-level jobs. The influences of

stricter EPLT on employment situations are more complex for temporary workers. On one hand, stricter EPLT prevents temporary workers from arbitrary dismissals, which buffers employment insecurity during the contract period. On the other hand, stricter EPLT may cause more frequent unemployment outflows or long-term unemployment among temporary workers because the regulated duration of temporary contracts is shorter, and multiple contract renewals become difficult (Högberg et al., 2019). Empirical findings in Europe seemed to support the primacy of the second mechanism because stricter EPLT were found to enlarge the employment insecurity gap between permanent and temporary workers (Balz, 2017).

Taken together, we argue that stricter EPLR and EPLT may both enlarge the employment insecurity gaps between labour market insiders and outsiders because the unemployed and temporary employees are more likely to be stuck in their current employment situations. Nevertheless, such reinforcement effects should be particularly strong for unemployment comparing to temporary employment because the latter may become a common employment alternative when EPLR becomes stricter and is more protected than the unemployed in the context of stricter EPLT. Accordingly, we hypothesize that:

H3a: Stricter EPLR may reinforce the negative effect of unstable employment situations on the probability of union formation.

H3b: The reinforcement effect of stricter EPLR is particularly strong in the negative relationship between unemployment and union formation.

H4a: Stricter EPLT may reinforce the negative effect of unstable employment situations on the probability of union formation.

H4b: The reinforcement effect of stricter EPLT is particularly strong in the negative relationship between unemployment and union formation.

The second dimension of labour market regulations deals with the degree to which wage and job qualities are settled by collective labour institutions, such as collective bargaining agreements. Although previous research has highlighted the within-sector wage-equalizing effect of higher collective bargaining coverage (CBC) rates for the employees (Hayter & Weinberg, 2011), some studies also show that higher CBC has the potential to attenuate labour market dualism by marginalizing the labour market outsiders (Baranowska & Gebel, 2010; Dieckhoff et al., 2015). Because the negotiated rights and benefits covered by collective bargaining agreements only apply to those who are employed, higher CBC may further

marginalize the unemployed, leading to a more negative effect of unemployment on union formation. For temporary workers, the influences of higher CBC on employment experiences are mixed. On one hand, higher CBC may provide temporary workers with stronger bargaining power over their employment wages and benefits. This characteristic, in turn, may reduce wage inequalities between temporary and permanent employees (Hayter & Weinberg, 2011) and close the income insecurity gap between the two groups. On the other hand, employment protections for labour market insiders are attenuated in countries with high CBC, which might preclude temporary workers from getting a permanent job (Baranowska & Gebel, 2010). As a result, an enlarged employment insecurity gap between permanent and temporary employees is expected. While acknowledging collective agreements' effort in eliminating wage and working condition inequalities, recent studies have shown that these inclusive strategies do not always extend to the workplace and may even reinforce the insider-outsider dualism because the contents of bargaining tend to overrepresent regular workers' interests (Barton et al., 2021; Bentolila et al., 2012). Therefore, we argue that the gap-widening effect of higher CBC on the employment insecurity gap should be the dominant mechanism that escalates the negative effect of temporary employment on union formation. According to these discussions, we expect:

H5a: Higher CBC may reinforce the negative effect of unstable employment situations on the probability of union formation.

H5b: The reinforcement effect of higher CBC is particularly strong in the negative relationship between unemployment and union formation.

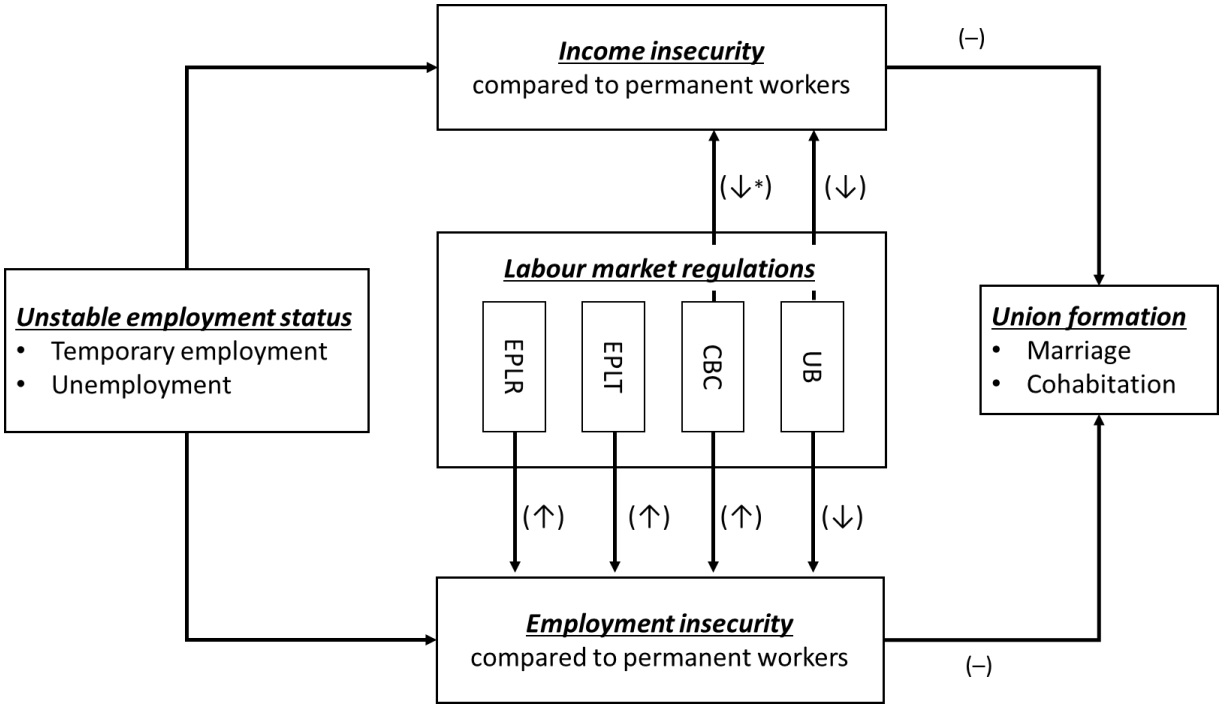
The third dimension refers to social welfares as income safety nets for the disadvantaged groups. The most employment-relevant welfare policy is the unemployment benefits (UB) system. Generous benefits for the unemployed could offset income insecurity perceived during unemployment (Voßemer, 2019), thus partially relieve the negative effects of unemployment on union formation. Generous benefits may also change job searching behaviours of the unemployed, permitting them to take the time to search for adequate reemployment without rushing into undermatched positions. As a result, the scar effects of unemployment on the subsequent employment and income prospects would be lower in the context of generous unemployment benefits (Gangl, 2004, 2006). For temporary employees, knowing the existence of income safety nets after ending fixed-term contracts may relieve their feelings of income insecurity. Generous benefits also reduce the employment instability

of temporary workers by increasing subsequent job tenure and the probability of transitioning into a permanent job (Rebollo-Sanz & García-Pérez, 2015). Accordingly, we predict that:

H6: More generous unemployment benefits may attenuate the negative effect of unstable employment situations on the probability of union formation.

Fig 1 offers an overview of the theoretical model discussed above. We also summarized the mechanisms behind each policy moderating effects in Supplementary Table S1.

Fig 1. Conceptual model regarding the moderating roles of labour market regulations



Note: The sign (↑) indicates that the corresponding micro-level mechanism is reinforced, while the sign (↓) indicates the corresponding mechanism is attenuated. * The moderating effect of CBC on attenuating the income insecurity mechanism only applies to temporary employment.

Finally, labour markets are gendered institutes in which individuals' economic behaviours are embedded in social and gender norms (Elson, 1999). Changes in labour market

regulations thus may have gendering impacts on individuals' union formation through interacting with the gender norms attached to specific employment status. Despite the gender convergence in life course employment patterns (Lesnard et al., 2016), in many European countries men still bear the expectation of fulfilling the primary family provider role while women's paid work is normatively expected to be subordinated to family responsibilities (Oláh et al., 2021; Van Lancker, 2012). Although permanent employment might be the only acceptable employment situation for most men, temporary employment could still be desirable for some women, especially considering its higher flexibility to combine work with family and better income security comparing to unemployment. In this regard, non-permanently employed men could be more vulnerable to policy reforms that create barriers to obtaining permanent jobs, such as a stricter EPLR. On the other hand, non-permanently employed women might be more vulnerable to reforms that decrease the employability of the unemployed and the flexibility of temporary employment, such as stricter EPLT. Therefore, we expect:

H7: Stricter EPLR may reinforce the negative effect of unstable employment situations on the probability of union formation especially for men.

H8: Stricter EPLT may reinforce the negative effect of unstable employment situations on the probability of union formation especially for women.

3 Research Design

3.1 Data and sample

We used data at both micro and macro levels. Micro-level data came from the 2010-2019 European Union Statistics on Income and Living Conditions (EU-SILC) panel data files, in which sampled individuals were interviewed annually for up to four years in a rotational panel design. The EU-SILC panel is the only (ongoing) micro panel dataset that features nationally representative samples across more than 30 European countries. This makes the dataset a valuable source for comparative life course research. Macro-level data regarding labour market regulations and other indices were assembled from multiple sources including the OECD, Eurostat, and the KOF Globalization Index. We combined the macro data with all available waves of EU-SILC data during the years 2010-2019. By excluding country-waves where macro data were unavailable, our final sample covered 215 country-waves from 26 countries. Bulgaria, Croatia, Cyprus, Malta, Romania, and Russia were excluded because yearly data for at least one macro variable were missing.

3.2 Micro-level data and variables

In this study, we selected those who were interviewed for at least two waves during the years 2010-2019 to model how individuals' unemployment and temporary employment in year *t* affected their probability of union formation in year *t+1*, and how such micro-level effects were moderated by macro-level labour market regulations.

The dependent variable—union formation event—was a time-varying binary event dummy (0=no event; 1=union formation). Following Kalmijn (2011) and Bolano & Vignoli (2021), we focused on the formation of coresidential partnership unions, which included both marriages and non-marital cohabitations. The dependent variable regarding union transition was operationalized as whether a person lived without a partner in year *t* but with a partner in year *t+1*. The dataset was organized like an event-history dataset. We selected individuals aged between 15 and 45 years who lived without a partner in their first interview. All person-years in the following waves were kept in the sample until the event occurred, attrition, or the date of panel exit. However, a standard discrete-time event-history analysis is not appropriate for the EU-SILC data because the dataset's short observation period and the left truncation of union status make it impossible to reconstruct a complete union history. Alternatively, we used a probability model that adjusted for individual ages at the baseline to estimate the effects of independent variables on the instantaneous transition probability of union status (see Kalmijn (2011) for similar applications). To examine whether gender heterogeneity in such effects exists, we stratified the sample by gender. The final sample for females included 87,670 person-years from 40,468 females who were living without a partner during their first interview, among whom 3,223 form a coresidential union in the subsequent years. The male sample included 115,666 person-years from 45,957 males, among whom 3,077 form a coresidential union.

The key independent variable was one's employment status in year *t*. We used respondents' self-defined working status to identify dependent employees, self-employees, the unemployed, and inactive individuals. Because our theoretical framework focuses on the micro-macro interactions between employment situations and labour market regulations, we restricted the sample to active labour market participants and thus excluded inactive individuals. According to different contract types, dependent employment was further differentiated into permanent employment (employed by open-ended contracts) and temporary employment (employed by fixed-term contracts). Taken together, the employment status variable comprised four categories: (1) permanent employment, (2) temporary

employment, (3) unemployment, and (4) self-employment, where the permanent employment served as the reference group.

All analyses controlled for a set of micro variables that theoretically confound the relationship between employment and union formation. First, educational attainment, which affects individuals in both the opportunities of stable employment (Kogan et al., 2011) and union formation (Coppola, 2004), was controlled for in three categories: low (ISCED 0-2), middle (ISCED 3-4), and high (ISCED 5-8). Second, we controlled for self-rated health status because better health might associate with greater employment stability (Pelkowski & Berger, 2004) and higher probability of union formation (Musick & Bumpass, 2012). The health status variable included three categories: good or very good, fair, and bad or very bad. Third, we controlled for the number of children at home in a binary dummy variable ("no child" versus "one or more children"). Such variable was used as a proxy of one's parenthood status, which may influence individual's employment patterns (Matysiak & Vignoli, 2008) and union status (Sassler & Lichter, 2020). Fourth, to control for the impact of household wealth on individual work and partnering behaviours (Kravdal, 1999), we included two subjective measures on household economic situations. The first variable reflected household financial ability to make ends meet, which were recategorized into a binary variable ("fairly easy, easy, or very easy" versus "with some difficulty, difficult, or very difficult" to make ends meet.) The second was a binary variable measuring whether a household had the capability to cope with unexpected financial expense ("yes" versus "no"). We chose these two subjective variables because they offered good comparability for European research regarding household wealth and income (Whelan & Maître, 2010), whereas thex` objective wealth variables in the EU-SILC data were often troubled by cross-national measurement inconsistency (Trindade & Goedemé, 2020). Finally, we included age and its squared term in the model to account for the baseline trend of work-family life course (Moen, 2018). All control variables were measured in year *t* to align with the key independent variable.

3.3 Macro-level data and variables

At the macro-level, our key variables were four indicators measuring the three dimensions of labour market regulations. First, the strictness of EPLs in a labour market was captured by two indicators from the OECD Employment Protection Legislation Database. On one hand, the EPLR indicator measured the strictness of regulations of individual dismissals of regular workers. We used Version 3 of the EPLR indicator, which incorporated nine items on different aspects of dismissal procedures (e.g., advanced notification, severance pay) and

ranges from 0 (not regulated) to 6 (highly regulated). On the other hand, the EPLT indicator, ranging also from 0 (not regulated) to 6 (highly regulated), reflected the regulations on hiring temporary workers. The EPLT indicator (Version 3) incorporates eight items that measured the valid case of using fixed-term contracts, the maximum time duration and the number of consecutive usages of fixed-term contracts, and the regulation on temporary agency works, etc. Second, we captured the prevalence of collective bargaining institutions using the CBC rates from the OECD.Stat. The indicator was a continuous variable measured in percentage points, ranging from 0 to 100. Third, we measured the generosity of unemployment benefits using the net income replacement rates data from the OECD.Stat. To emphasize its function as a longer-term income safety net for single individuals, we calculated the income replacement rates at the 18th month of unemployment for single person without children who earned an average wage before unemployment. Sensitivity analyses in Supplementary Table S7 showed that switching the unemployment duration to 12 or 24 months did not substantively change the estimated moderating effects. Following the default setting, social assistance benefits and housing benefits were included to calculate the net replacement rate. In theory, labour market institutions influence not only individuals' employment outcomes but also their family behaviours (Blossfeld et al., 2005; Esping-Andersen & Regini, 2000; Scherer, 2009). Therefore, the four labour market indicators were always included in our models as control variables. Moreover, a set of additional macro-level control variables were included in our multilevel models. First, because individuals' work and family behaviours are procyclical (Ebell, 2011; Sobotka et al., 2011), we controlled for a country's economic cycle using GDP per capita. Second, because people's employment stability and family formation could be negatively affected by the macro-level economic uncertainty (de Lange et al., 2014), our models included unemployment rates and temporary employment rates. Third, we controlled for female labour force participation rates as proxies of labour market gender egalitarian because previous research showed that men's unemployment discouraged union formation especially in a less gender egalitarian context (Kalmijn, 2011). Fourth, we controlled for the degree of economic globalization because globalization is arguably a driving factor behind the rising economic uncertainties and changing work-family life courses in the past three decades (Blossfeld et al., 2005). The macro indicators of GDP per capita, sex-specific unemployment rates, temporary employment rates, and female labour force participation rates came from the Eurostat; the economic globalization indicator was assembled from the KOF Globalization Index database (Gygli et al., 2019). Table 1 provides the general descriptive statistics of all micro- and macro-level variables used in our analyses.

Detailed statistics regarding how micro-level variables differ across countries in our female and male subsamples are presented in Supplementary Table S2.

Table 1. Descriptive statistics of variables

	Female sample			Male sample		
Dependent variable						
Union formation probability	3.68%			2.66%		
Union formation event	3,223			3,077		
Exposure (person-years)	87,670			115,666		
	Mean; %	SD	Range	Mean; %	SD	Range
Independent variables						
Micro variables						
Employment status						
Permanent employment	50.0%			47.0%		
Temporary employment	22.6%			18.9%		
Unemployment	21.6%			24.2%		
Self-employment	5.8%			10.0%		
Age	29.6	7.2	[15, 45]	29.2	7.1	[15, 45]
Educational level						
Low (ISCED 0-2)	13.4%			22.1%		
Middle (ISCED 3-4)	46.2%			54.5%		
High (ISCED 5-8)	40.4%			23.4%		
Health status						
Good/Very good	87.2%			89.3%		
Fair	10.7%			8.8%		
Bad/Very bad	2.1%			1.9%		
Number of children						
No child	85.9%			99.9%		
One or more children	14.1%			0.1%		
Ability to make ends meet						
Fairly easy	34.6%			34.3%		
With some difficulty/ difficult	65.4%			65.8%		
Capacity to face unexpected expense						
Yes	55.1%			57.3%		
No	44.9%			42.7%		
Macro variables						
EPLR	2.3	0.5	[1.2, 3.9]	2.3	0.5	[1.2, 3.9]
EPLT	2.4	0.7	[0.4, 3.8]	2.4	0.7	[0.4, 3.8]
CBC rate	60.5	32.6	[6.1, 100.0]	60.5	32.6	[6.1, 100.0]
UB replacement rate	38.2	21.4	[0.0, 75.0]	38.2	21.4	[0.0, 75.0]
GDP per capita	27.1	10.1	[15.8, 79.0]	27.1	10.1	[15.8, 79.0]
Unemployment rate (by sex)	11.9	7.1	[2.6, 31.7]	11.4	5.7	[1.8, 25.6]
Temporary employment rate (by sex)	15.2	6.9	[1.3, 28.0]	14.0	7.0	[1.7, 28.5]
Economic globalization	77.4	6.4	[66.0, 90.0]	77.4	6.4	[66.0, 90.0]
Female labour force participation rate	61.9	9.1	[42.9, 84.5]	61.9	9.1	[42.9, 84.5]

3.4 Methods

Three-level multilevel models were applied to capture the hierarchical data structure. Our first model aimed to estimate the European average effects of temporary employment and unemployment on the probability of union formation. The data-generation process (DGP) of individual *i*'s probability of union formation *y* at time *t+1* in country *j* is written as:

$$P\left(y_{j(t+1)i} = 1 \middle| \boldsymbol{X}_{jti}, \boldsymbol{Z}_{jt}\right) = \beta_0 + \boldsymbol{\beta_t} + \boldsymbol{X}_{jti}\boldsymbol{\beta_1} + \boldsymbol{Z}_{jt}\boldsymbol{\beta_2} + v_{0j} + u_{0jt} + e_{jti} \quad (1)$$

The right-hand side of Equation (1) includes: the grand average of the union formation probability β_0, the period fixed effects $\boldsymbol{\beta_t}$. The effects of micro-level variables $\boldsymbol{X}_{jti}$ are denoted by $\boldsymbol{\beta_1}$. The effects of macro-level variables $\boldsymbol{Z}_{jt}$ are denoted by $\boldsymbol{\beta_2}$. Aside from these observed effects, unobserved heterogeneities in the outcome probabilities at different levels are captured by three variance components: v_{0j} (country level), u_{0jt} (country-wave level), and e_{jti} (individual level).

In this model, the parameters of interests are $\boldsymbol{\beta_1}$ corresponding to individual employment situations. A common modelling strategy is applying a multilevel mixed-effect model with random intercepts on Equation (1), treating the unobserved heterogeneities at all levels as random components that are not correlated with the observed variables in the model (Heisig & Schaeffer, 2019). This approach, however, is usually problematic in cross-national comparative research because unobserved differences among countries may affect dependent and independent variables simultaneously (e.g., cultural differences affect both union formation and employment situations). To address this issue, we applied a country fixed effects model for multilevel analyses (Fairbrother, 2014). Instead of treating the country-level variances v_{0j} as random intercepts, we directly controlled for these variances using a set of country dummy variables $\sum_{j=1}^{N-1} \gamma_{0j}\, c_j$. The estimation model is written as:

$$P\left(y_{j(t+1)i} = 1 \middle| \boldsymbol{X}_{jti}, \boldsymbol{Z}_{jt}\right) = \beta_0 + \boldsymbol{\beta_t} + \boldsymbol{X}_{jti}\boldsymbol{\beta_1} + \boldsymbol{Z}_{jt}\boldsymbol{\beta_2} + \sum_{j=1}^{N-1} \gamma_{0j}\, c_j + u_{0jt} + e_{jti} \quad (2)$$

This model rules out confounding problems resulted from time-constant unobserved heterogeneities between countries. The estimated $\boldsymbol{\beta_1}$ denote the European average effects of employment statuses on union formation.

With an extension of Equation (1), our second model investigated how such effects of employment statuses on union formation were moderated by country-level variations in labour market regulations. Specifically, we introduced cross-level interactions between

employment and labour market regulations and allowed the effects of employment variables to vary across countries. The DGP of this model is written as:

$$P\left(y_{j(t+1)i} = 1 \middle| \boldsymbol{X}_{jti}, \boldsymbol{Z}_{jt}\right) = \beta_0 + \boldsymbol{\beta_t} + \boldsymbol{X}_{jti}\boldsymbol{\beta_1} + \boldsymbol{Z}_{jt}\boldsymbol{\beta_2} + (\boldsymbol{X}_{jti}\boldsymbol{Z}_{jt})\boldsymbol{\beta_3} + v_{0j} + \boldsymbol{X}_{jti}\boldsymbol{v_{1j}} + u_{jt} + e_{jti} \quad (3)$$

where the parameters $\boldsymbol{\beta_3}$ for the cross-level interactions $\boldsymbol{X}_{jti}\boldsymbol{Z}_{jt}$ reflect the moderating effects of the country- and time-variant labour market indicators on the micro-level effects of employment situations on union formation. The country-level unobserved effect heterogeneity of employment situations on union formation are represented by $\boldsymbol{v_{1j}}$.

For estimation, we applied a country fixed effects and fixed slopes model (cFES) (Giesselmann & Schmidt-Catran, 2019), which utilized within-country "changes" in labour market regulations to estimate their moderating effects on the micro-level relationship between employment and union formation. The cFES model is defined as follows:

$$P\left(y_{j(t+1)i} = 1 \middle| \boldsymbol{X}_{jti}, \boldsymbol{Z}_{jt}\right) = \beta_0 + \boldsymbol{\beta_t} + \boldsymbol{X}_{jti}\boldsymbol{\beta_1} + \boldsymbol{Z}_{jt}\boldsymbol{\beta_2} + (\boldsymbol{X}_{jti}\boldsymbol{Z}_{jt})\boldsymbol{\beta_3} + \sum_{j=1}^{N-1} \gamma_{0j}\, c_j + \sum_{j=1}^{N-1} \gamma_{1j}\, (c_j \boldsymbol{X}_{jti}) + u_{jt} + e_{jti} \quad (4)$$

This model controls for not only the time-constant country-level unobserved heterogeneity in union formation probability using $\sum_{j=1}^{N-1} \gamma_{0j}\, c_j$ but also the time-constant effect heterogeneity of employment statuses across countries using $\sum_{j=1}^{N-1} \gamma_{1j}\, (c_j \boldsymbol{X}_{jti})$. From a causal perspective, the cFES model yields superior estimations of the macro-level moderating effects $\boldsymbol{\beta_3}$ than the mixed-effects model because the latter treats both country-level heterogeneities as random intercepts and random slopes, assuming not only time-varying but also time-constant country-level unobserved heterogeneities to be uncorrelated with the independent variables. This assumption is problematic for union formation research because many unobservable country-level time-constant heterogeneities, such as cultural values or gender norms, may correlate with labour market regulations and influence the effects of individual employment status (Kalmijn, 2011). Using the cFES model, we ruled out biases resulted from time-constant country-level unobserved heterogeneities.

However, the cFES model has an empirical limitation because its estimation requires within-country "changes" in macro variables over time. In our data, some countries had relatively stable labour market regulations between years 2010 and 2019. As a result, some of the estimated moderating effects $\boldsymbol{\beta_3}$ from our cFES models, especially those of the EPLs, could be inflated and over-represent specific countries. To check the robustness of cFES, we

performed a set of supplementary analyses and discussed their implications to our main findings (more details in the "Robustness and additional analyses" section).

Throughout the paper, we specified linear probability models (LPM), instead of Logit models, for model analyses. Comparing to Logit models, LPM has the advantage of allowing straightforward interpretation of the coefficient estimates in units of "probability" (Breen et al., 2018). Moreover, Logit models for multilevel analyses have serious convergence issues in the empirical setting of a low-probability outcome event and a small group size at the higher level (Bryan and Jenkins, 2016). Recent applications among demographers have shown LPM's good characteristics of allowing easier estimation, interpretation, and cross-model results comparison (Billingsley et al., 2022; Hofmann et al., 2017).

4 Results

4.1 Descriptive results

Table 2 provides country-specific descriptive statistics of key labour market indicators and the average union formation probabilities across employment groups. Looking at mean levels of labour market regulations, we observed great institutional variety between European countries. More importantly, non-zero standard deviations were observed in the majority of our sampled countries, indicating that most countries had experienced labour market changes to some extent during 2010–2018. As illustrated in Supplementary Fig S1, the directions and sizes of labour market changes in each policy dimension differed significantly across countries. Taking EPLR for example, 13 out of the 26 countries in our sample had experienced EPLR changes to some extent during 2010–2018, with the most significant deregulation observed in Portugal during 2012–2014. Changes in CBC and unemployment benefits were common as well despite with smaller scales in many countries.

Table 2 also showed that individuals' union formation probabilities differed by their employment situations. Pooling all countries, permanently employed people had higher union transition probability (3.81%) than the temporarily employed (3.01%) and the unemployed (2.85%). However, country variations were noticeable. Some countries (e.g., Sweden) had larger gaps in union formation probabilities between employment groups while other countries (e.g., Ireland) had mild employment group differentials in union transition.
How cross-country variations in union formation patterns related to labour market heterogeneities? Table S3 presented the correlations between countries' average levels of labour market regulations and mean union formation probabilities. In general, country levels of EPLR and EPLT were negligibly correlated with mean union formation probabilities of all

employment groups, but CBC and unemployment benefits were positively, though weakly, correlated with mean union formation probabilities of all employment groups (Table S3, columns 1–3). Moreover, the correlations between country averages of labour market regulations and the gaps in union transition between employment groups were mostly negligible (Table S3, columns 4–5), except that CBC and unemployment benefits were negatively, though weakly, correlated with the union transition gaps between the unemployed and permanent workers for men.

At first glance, these results seemed to contradict our theoretical expectations because countries with higher levels of EPLs and CBC were not necessarily linked to more negative union transition gaps between non-permanent and permanent employment groups; and the negative gaps in union transition for men were even larger in countries with high levels of unemployment benefits. Nevertheless, we should not conclude too early to the absence of labour market policy moderating effects because these descriptive results only reflected static correlations between union transition gaps and labour market regulations by country means, in which confounding factors such as micro-level differences in population characteristics and country-level heterogeneities over the observation period were ignored. To investigate whether the union transition gaps between employment groups were influenced by changes in labour market regulations during the past decade, multilevel regressions proposed in the method section are necessary.

Table 2. Descriptive statistics of labour market indicators and union formation probabilities by country, average over years

Country	ISO Code	EPLR		EPLT		CBC rate		Unemployment benefits income replacement rate		Union formation probability by employment status			N (number of country-round)	n (number of obs.)
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Permanent workers	Temporary workers	Unemployed		
Austria	AT	2.1	0.0	2.2	0.0	98.0	0.0	52.1	2.1	4.42%	4.82%	3.73%	9	7,087
Belgium	BE	2.1	0.2	2.2	0.1	96.0	0.0	51.4	0.8	6.71%	6.73%	3.85%	9	6,106
Switzerland	CH	1.3	0.0	1.5	0.0	48.0	5.3	71.0	0.0	6.09%	2.37%	3.63%	7	3,922
Czechia	CZ	3.2	0.1	2.1	0.1	35.2	1.4	30.7	0.6	2.49%	1.68%	1.81%	9	5,986
Germany	DE	2.4	0.0	1.8	0.1	55.2	1.0	34.6	0.8	4.36%	1.84%	2.38%	4	2,701
Denmark	DK	1.4	0.0	1.9	0.1	81.9	1.8	62.3	0.4	10.53%	7.80%	8.94%	9	1,143
Estonia	EE	1.7	0.0	2.8	0.4	17.5	5.6	24.3	1.2	4.53%	2.37%	3.40%	9	4,880
Spain	ES	2.0	0.1	3.2	0.1	80.9	1.9	56.8	1.4	3.94%	3.18%	1.86%	9	20,576
Finland	FI	2.3	0.0	1.8	0.0	88.2	3.6	56.0	1.9	9.68%	11.13%	5.02%	9	4,612
France	FR	2.7	0.0	3.2	0.1	98.0	0.1	67.2	0.9	6.73%	6.14%	4.13%	9	4,594
Greece	GR	2.4	0.1	2.9	0.1	29.8	25.5	11.8	6.8	1.50%	0.93%	0.68%	9	19,332
Hungary	HU	1.6	0.2	2.0	0.0	26.2	1.7	15.9	2.9	1.59%	1.92%	1.50%	9	13,146
Ireland	IE	1.3	0.1	1.1	0.2	34.6	2.3	45.7	1.2	1.52%	0.27%	0.99%	9	4,736
Iceland	IS	1.9	0.0	1.4	0.1	90.0	0.0	46.0	2.6	7.27%	6.07%	6.40%	7	1,215
Italy	IT	2.7	0.2	2.6	0.2	100.0	0.0	17.5	21.1	2.26%	1.03%	0.89%	9	29,841
Lithuania	LT	2.3	0.1	3.1	0.4	8.4	0.3	23.1	5.6	0.84%	1.25%	1.36%	5	1,539
Luxembourg	LU	2.2	0.0	3.8	0.0	57.1	1.2	45.7	0.6	3.31%	1.89%	1.41%	8	4,186
Latvia	LV	2.8	0.0	1.8	0.0	19.3	6.7	35.6	4.5	2.53%	2.19%	0.81%	7	6,031
Netherlands	NL	3.4	0.1	1.3	0.1	83.1	4.4	64.6	9.4	4.43%	4.51%	2.74%	9	5,654
Norway	NO	2.2	0.0	3.2	0.2	70.9	1.3	64.8	0.5	9.13%	8.14%	3.44%	9	3,500
Poland	PL	2.3	0.0	2.2	0.0	16.9	1.3	21.7	0.5	2.81%	2.21%	1.51%	9	16,289
Portugal	PT	3.2	0.3	2.4	0.1	74.7	1.6	69.9	3.1	3.73%	3.56%	2.08%	9	12,938
Sweden	SE	2.5	0.0	1.5	0.2	88.5	0.3	44.6	1.8	10.15%	7.00%	5.81%	9	2,796
Slovenia	SI	2.2	0.2	2.3	0.2	70.3	3.8	34.0	1.2	5.23%	5.79%	3.16%	9	6,171
Slovakia	SK	2.5	0.2	2.4	0.1	31.6	4.3	18.0	0.8	2.21%	2.26%	0.86%	7	8,314
United Kingdom	UK	1.5	0.1	0.5	0.1	29.0	1.5	37.8	0.9	3.70%	1.81%	1.57%	8	6,041
All		*2.3*	*0.5*	*2.4*	*0.7*	*60.5*	*32.6*	*38.2*	*21.4*	*3.81%*	*3.01%*	*2.85%*	*215*	*203,336*

4.2 Micro-level effect of employment status on union formation

Starting with the micro-level relationship, Table 3 presents the modelling results of union formation from country fixed effects models. On the European average, unstable employment situations had substantively negative and statistically significant effects on the transition to partnership unions for both sexes (supported Hypothesis 1). Comparing to permanent employment, temporary employment and unemployment decreased women's union formation probability by 0.6 and 1.1 percentage points respectively. Considering that the union formation probability of female permanent employees was 4.1 percentage points, such effects amounted to reductions in union formation probability by 14.6% (0.6/4.1) and 27% (1.1/4.1). The negative effects were even stronger for men (supported Hypothesis 2). Comparing to permanently employed men, whose average union transition probability was 3.1 percentage points, being temporarily employed and being unemployed decreased men's union formation probability by 0.6 and 1.4 percentage points; such effects amounted to a 19.3% (0.6/3.1) and a 45.1% (1.4/3.1) reduction in the union transition probability.

In a supplementary analysis (see Fig S2), we stratified the samples by educational levels (Low, Middle, and High) to examine whether the negative effects of temporary employment and unemployment apply to females and males in different socio-demographic groups. Previous studies have hypothesized that the negative effects of unstable employment on family formation could pertain to the higher educated, particularly for women, because they are generally more career-oriented and face higher opportunity costs of starting a family compared to the lower educated (de Lange et al., 2014; Kreyenfeld, 2010). Results in Fig S2 largely supported this expectation. Comparing to lower-educated women, the negative effects of temporary employment and unemployment on union formation were stronger for middle and highly educated women. For men, temporary employment depressed union formation to a similar magnitude across education groups. Yet, the strongest negative effect of unemployment on union formation was found among highly educated men. In summary, these findings were consistent with the major findings in Table 3: while the effects of unstable employment situations on union formation might differ by education, their directions were mostly negative (except for the null effects among lower-educated women).

Table 3. Country fixed-effects linear probability models on union formation

	Females			Males		
	β	*S.E.*	*Pr(Y)*	*β*	*S.E.*	*Pr(Y)*
Employment status						
Permanent employment	ref.		0.041	ref.		0.031
Temporary employment	-0.006*	(0.002)	0.035	-0.006*	(0.002)	0.025
Unemployment	-0.011*	(0.002)	0.030	-0.014*	(0.002)	0.017
Self-employment	-0.002	(0.004)	0.038	0.002	(0.002)	0.033
Educational level						
Low (ISCED 0-2)	ref.			ref.		
Middle (ISCED 3-4)	-0.003	(0.002)		0.002	(0.002)	
High (ISCED 5-8)	0.004	(0.003)		0.008*	(0.003)	
Health status						
Good	ref.			ref.		
Fair	-0.004	(0.003)		-0.006*	(0.002)	
Bad	-0.004	(0.003)		-0.010*	(0.002)	
Number of children						
No child	ref.			ref.		
One or more children	0.012*	(0.003)		0.299*	(0.091)	
Ability to make ends meet						
Fairly easy	ref.			ref.		
With some difficulty/ difficult	-0.005*	(0.002)		-0.003+	(0.002)	
Capacity to cover unexpected expense						
No	ref.					
Yes	0.003	(0.002)		0.003+	(0.002)	
Age	0.011*	(0.002)		0.010*	(0.002)	
Age2	-0.000*	(0.000)		-0.000*	(0.000)	
GDP per capita	-0.007	(0.004)		-0.007	(0.006)	
Unemployment rate (by sex)	-0.014*	(0.007)		-0.016*	(0.003)	
Temporary employment rate (by sex)	-0.003	(0.006)		-0.006	(0.005)	
Economic globalization	-0.012+	(0.006)		-0.008	(0.005)	
Female labour force participation	-0.011	(0.010)		-0.012	(0.008)	
EPLR	-0.003	(0.003)		-0.004	(0.003)	
EPLT	-0.009	(0.007)		-0.007	(0.006)	
CBC	-0.002	(0.002)		-0.008*	(0.003)	
UB generosity	-0.005*	(0.002)		0.000	(0.002)	
Country fixed effects	✓			✓		
Period fixed effects	✓			✓		
Number of countries	87,670			115,666		
Number of country-waves	215			215		
Number of observations	26			26		
R-squared	0.0218			0.0236		

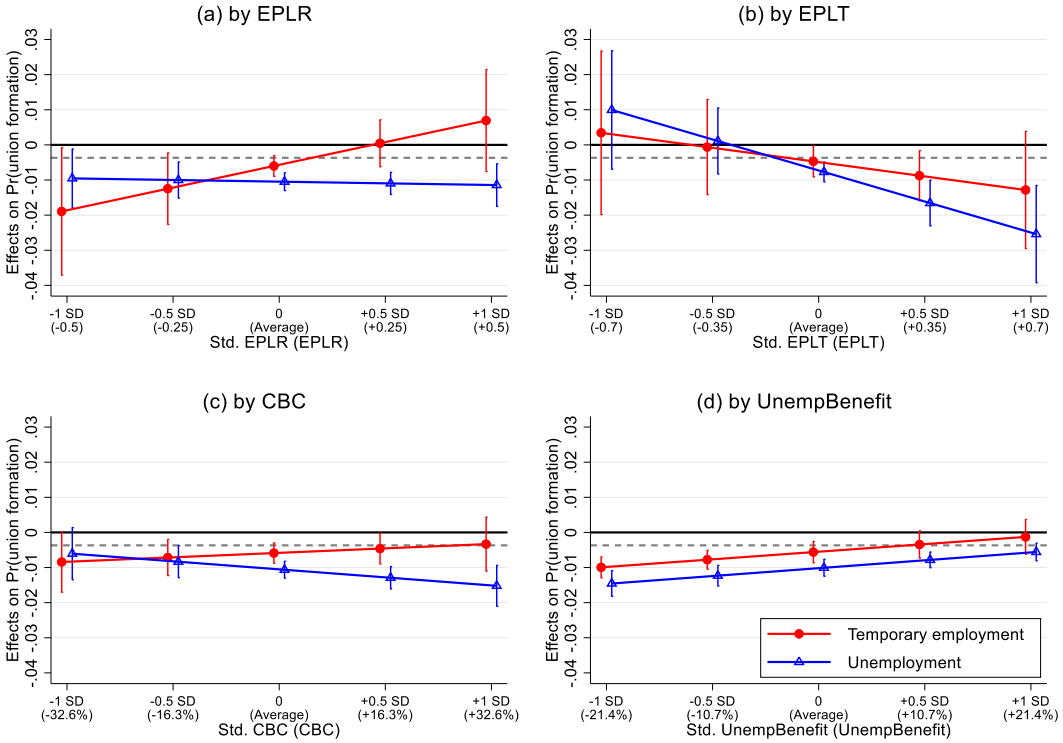
Note: All models control for country and period fixed effects using the LSDV approach. Standard errors are clustered at the country level. Significance levels: + p<0.1, * p < 0.05

Supplementary Table S4 presented another robustness analysis using multinomial logistic regression models, where we distinguished between the competing risks of transitions into non-marital cohabitation and into marriages to check whether the negative effects of temporary employment and unemployment applied to both channels of union formation. The coefficients in Table S4 were relative risk ratios of the occurrence of a specific event compared to staying single in time *t*+1. Results showed that temporarily employed and unemployed single women were less likely to transition to either cohabitation or marriages compared to permanently employed women. For single men, those who were temporarily employed or unemployed were less likely to form either cohabiting or marriage unions. These results justified our analytical design in Table 3's models, indicating that unstable employment could negatively affect women's and men's union formation regardless of the type of unions being considered.

4.3 Moderating roles of labour market regulations

Based on previous section's results, our second analysis examined whether and how such negative relationships between unstable employment situations and union formation were moderated by variations in labour market regulations in European countries. Supplementary Table S4 and Table S5 presented full results from the cFES models for women and men. Coefficients of the interaction terms were standardized, which can be interpreted as the degree to which one standard deviation (SD) increase in labour market indicators moderated the micro-level effect of temporary employment or unemployment on union formation. For illustration, we plotted the estimated effects of both employment statuses (y-axis) against the standardized indicators of four labour market regulations (x-axis) in Fig 2 (for women) and Fig 3 (for men). Following Bernardi et al.'s (2017) approach to evaluate social significance of estimated effects, we plotted the benchmark values to compare against our point estimates and 95% confidence intervals of the effects of unstable employment over different policy scenarios. We defined a 10% decrease in the sample means of union formation probability as the minimum relevant values of substantive significance (θ_{female}= –0.00368; θ_{male}= –0.00266).

Fig 2. Effects of women's temporary employment and unemployment on union formation by labour market regulations



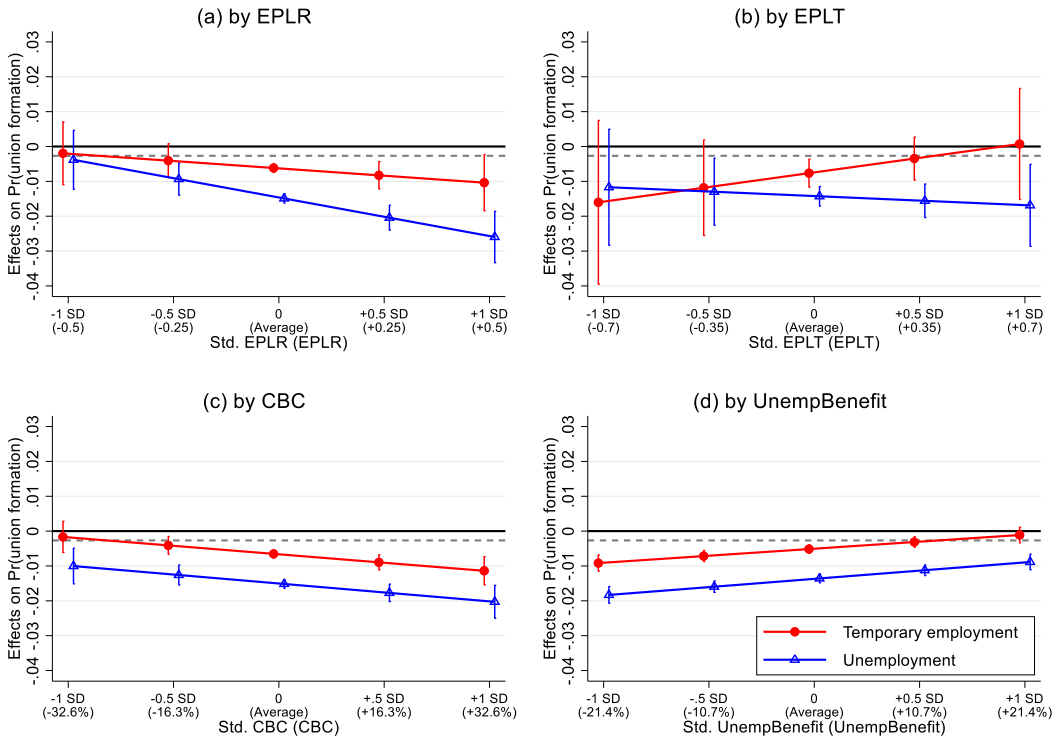
Note: Point estimates with 95% confidence intervals. The major scale in the x-axis presents the standardized regulation indicators, with the corresponding original values presented in parentheses. The dashed line in each graph denotes a 10% decrease in union transition probability, which benchmarks the minimum value of substantive significance. See Table S5, Models 2-5 for the full estimation results.

For men, Fig 3-a showed that stricter EPLR could reinforce the negative effects of men's unstable employment situations on union formation (supported Hypothesis 3a); and such reinforcement effect was particularly strong in the negative relationship between unemployment and union formation (supported Hypothesis 3b). The negative effect of men's unemployment on union formation probability strengthened from –0.015 to –0.026 when EPLR increased by one SD (+0.5). At odds with Hypothesis 4a, Fig 3-b showed that the negative effect of men's temporary employment on union formation became insubstantial with the increase of EPLT by one SD (+0.7), although the wide 95% CIs indicated high uncertainty in such estimates. The moderating effects of stricter EPLT on the relationship between men's unemployment and union formation was insignificant. Fig 3-c showed that increases in CBC could substantively reinforce the negative effects of men's unstable

employment situations on union transition (supported Hypotheses 5a); such reinforcement operated on the negative effects of temporary employment and unemployment to a similar extent (contradicted Hypothesis 5b). In contrast, Fig 3-d showed that increasing generosity of unemployment benefits could substantively attenuate the negative effects of men's temporary employment and unemployment on union formation (supported Hypothesis 6).

Finally, we observed gender nuances between the results in Fig 2 and Fig 3. As expected, stricter EPLR reinforced the negative effect of unstable employment on union formation only for men (supported Hypothesis 7), while stricter EPLT reinforced the negative effect only for women (supported Hypothesis 8).

Fig 3. Effects of men's temporary employment and unemployment on union formation by labour market regulations



Note: Point estimates with 95% confidence intervals. The major scale in the x-axis presents the standardized regulation indicators, with the corresponding original values presented in parentheses. The dashed line in each graph denotes a 10% decrease in union transition probability, which benchmarks the minimum value of substantive significance. See Table S6, Models 2-5 for the full estimation results.

With a theoretical focus on social inequalities in union formation, the paper's empirical analyses so far centred around the "gaps" in union formation between permanent and non-permanent employment groups. Our results generally supported the theoretical perspective that higher labour market flexibility (i.e., lower EPLR, lower EPLT, or fewer CBC) and more

generous unemployment benefits may close the union formation gaps between employment groups. However, the gap closing effects of labour market reforms could result from either an upward equalization (i.e., unstable employment individuals benefited more than permanent workers) or a downward equalization (i.e., permanent workers became worse off). To evaluate the holistic social influences of labour market reforms, Supplementary Fig S3 (for women) and Fig S4 (for men) presented the predictive union formation probabilities by employment situations across different policy scenarios. In general, the gap closing effects of higher labour market flexibility mainly reflected upward equalization, in which union formation probabilities increased in both permanent and non-permanent employment groups. On the other hand, the gap closing effects of more generous unemployment benefits mainly reflected downward equalization, where permanent workers' union formation probability had significantly reduced.

4.4 Robustness and additional analyses

We performed several additional analyses to examine the robustness of our main analyses in the previous section. First, we checked the issue of influential cases (outliers) in multilevel analysis (Schmidt-Catran et al., 2019) and evaluated whether the estimated policy moderating effects were overrepresenting specific countries' extreme labour market changes. To this end, Fig S5 compared our main analyses with the estimates using reduced samples, in which we excluded countries with the most extreme changes in specific labour market regulations. These outlier countries were Portugal for EPLR analyses, Lithuania for EPLT analyses, Greece for CBC analyses, and Italy for unemployment benefits analyses. Fig S5 showed that models using full samples and reduced samples produced very similar point estimates and CIs in most cases. However, noticeable differences were found in the CBC analyses, where models using reduced samples (i.e., excluding Greece) produced very wide CIs, rendering severe statistical uncertainty. Such results indicated that moderating effects of CBC found in the cFES models might overrepresent Greece's unique experience following an extreme CBC reduction during years 2012–2016 (more than 80 percentage points reduction).

Second, we compared the results between our cFES models and the mixed-effects models in Fig S6. In general, the two models found similar labour market moderating effects regarding the effect directions. Still, there were two incongruences worth mentioning. First, the absolute sizes of the moderating effects of EPLR and EPLT were larger in cFES models than in mixed-effects models. This pattern might be driven by relatively stable EPLs in some countries during years 2010-2019 in our data. Because the cFES models rely on within-

country changes in EPLs to estimate their moderating effects, the estimation results were sensitive and possibly inflated in the context of insufficient within-country variations. Such statistical uncertainties were reflected in the wide 95% CIs in the cFES models. Second, although the cFES models estimated positive and statistically significant moderating effects of higher unemployment benefits on the relationship between unstable employment and union formation, the mixed-effects models found nearly zero moderating effects of unemployment benefits. As discussed in the method section, the mixed-effects models could yield biased estimates if there were unobserved country-level heterogeneities influencing both the unemployment benefits and the effects of unstable employment statuses on union formation. The fact that we observed positive moderating effects of unemployment benefits only in the cFES models might indicate the existence of unobserved country-level heterogeneities that were not accounted for in the mixed-effects models, such as cultural values.

Finally, to examine whether the more generalized policy moderating effects found in our comparative cFES models hold in specific country contexts, we modelled the time dynamics of the effects of unstable employment situations on union formation in a subset of countries that had experienced substantial reforms in specific labour market regulations during our observation (see Supplementary Appendix 1 for details). In general, case studies in Supplementary Appendix provided additional supports to our main findings. First, we found that decreasing EPLR in Portugal may attenuate the negative effect of unstable employment on union formation (in line with Hypothesis 3a), although such a moderating effect applied only to men. Second, increasing EPLT in Estonia may trigger a more negative effect of unstable employment on union formation (in line with Hypothesis 4a), although such a pattern applied only to women. The gender nuances in the moderating effects of EPLs through different channels supported our Hypotheses 7 and 8, suggesting a gendering impact of labour market changes on individuals' union formation through interacting with gender norms of employment. Third, the effect of unstable employment on union formation became more negative after a significant increase in CBC rates in Finland (in line with Hypothesis 5a). Finally, the negative effect of unstable employment on union formation in Italy had diminished to zero following a remarkable increase in unemployment benefits provision in the country (in line with Hypothesis 6a).

5 Conclusion and Discussion

This study investigated the influences of individuals' unstable employment situations, including temporary employment and unemployment, on the likelihood of union formation. It

enriched the literature by highlighting the roles of labour market institutions in shaping the micro-level relationship between employment situations and partnership behaviours. Drawing on comparative panel data across 26 European countries and fixed effects multilevel regression methods, our findings provided crucial implications for work-family theories and labour market policy research. Table S8 provided an overview of empirical supports for our hypotheses. In the follows we discussed several key findings.

On the European average, we found that individuals' temporary employment and unemployment compared to permanent employment reduced their probability of forming a partnership union. This finding at the European level was in line with most studies conducted for specific countries (Bolano & Vignoli, 2021; de Lange et al., 2014; Landaud, 2021; Müller & Dräger, 2019; Oppenheimer, 2003; van Wijk et al., 2021; Vignoli et al., 2016), indicating that individuals in Europe have the tendency to postpone union and family formation under the situations of employment uncertainty (Blossfeld et al., 2005; Kreyenfeld et al., 2012; Oppenheimer, 1988). Although negative effects of unstable employment on union formation were found for both genders, men's union transition probabilities were reduced more than women's by being temporarily employed (men's 19.3% vs. women's 14.6% reduction in transition risks) or unemployed (men's 45.1% vs. women's 27% reduction in transition risks). Similar to the finding of a gender-specific relationship between employment instability and fertility (Alderotti et al., 2021), the relationship between employment instability and union formation were gendered to some extent, despite the converging trend of work-family trajectories in Europe (Lesnard et al., 2016).

Breaking down the development of such relationship within countries, our country fixed effects multilevel models showed that the influences of temporary employment and unemployment on union formation may change according to the ongoing labour market reforms in many European countries. In general, our empirical results are in line with previous findings that stronger labour market insider-outsider segregation and weaker social welfare provisions could trigger more negative effects of unstable employment on union formation (Barbieri et al., 2015; Blossfeld et al., 2005; Scherer, 2009). First, we found that stricter employment protection legislations could reinforce the negative effects of unstable employment situations, especially unemployment, on union formation. Moreover, the reinforcement effect may operate through gender-specific channels. For men, higher EPLR may lead to significantly more negative effects of unemployment on union formation. For women, the negative effect of unemployment on union formation was reinforced with the increase of EPLT. Such a gender nuance of EPL's moderating effects through different

channels implied differentials in social expectations behind gender economic roles. Because men are socially expected to have a mature career before starting a family (Oppenheimer, 2003), the lowered possibility of transitioning to or being hired by a permanent contract due to stricter EPLR is particularly harmful for temporarily employed or unemployed men. In contrast, it is rather "socially acceptable" for women to be employed in temporary job when starting a family because they are more often expected to be secondary earners in a dual earning household (Van Lancker, 2012). As a result, when EPLT becomes stricter, higher difficulties of temporary contract renewals and fewer chances of transition out of unemployment via temporary jobs might be more discouraging for temporarily employed or unemployed women.

Second, increases in CBC could reinforce the negative effects of men's temporary employment and unemployment as well as women's unemployment on union formation. The enlarged union formation gap echoes a recent finding about the role of CBC in escalating labour market insider-outsider dualism (Barton et al., 2021). However, we should not overinterpret the results because a robustness analysis showed that the estimated moderating effect of CBC in our multilevel models was substantially influenced by the CBC reform in Greece. Nonetheless, the patterns of non-positive moderating effects clearly deviated from the notion of an "inequality reducing" property of collective bargaining institutions (Hayter & Weinberg, 2011). To provide holistic policy suggestions, more studies are needed to evaluate collective bargaining's social influences beyond wage distributions, such as the influence on people's family lives.

Third, we found clear evidence that increasing generosity of unemployment benefits may buffer the negative effects of temporary employment and unemployment on union formation for both genders. Previous sociological research has emphasized that generous unemployment benefits could reduce long-term income and employment disadvantages resulted from unstable employment experiences (Esping-Andersen & Regini, 2000; Gangl, 2004, 2006). We extended this literature beyond the discussion of economic wellbeing and showed that unemployment-related welfare provisions can level out the employment-driven social inequalities in demographic behaviours (Scherer, 2009), including union formation.

In the aftermath of the 2008/2009 Great Recession, the European Commission has been promoting labour market reforms under the notion of "flexicurity," aiming to create higher employment flexibility and social security in a unified policy package (Eichhorst et al., 2017; Viebrock & Clasen, 2009). Policy suggestions that once prevailed in Europe in the 1990s such as deregulating EPLs, lowering CBC, and increasing unemployment benefits regain

popularity. However, there hasn't been sufficient studies discussing how these policies influence people's social and family lives. To this end, our evaluations on the impacts of "flexicurity" reforms on employment-partnering relations bear crucial policy implications. The positive message is that flexibilization policies (i.e., deregulating EPLR/EPLT and lowering CBC), in general, could level out inequalities in union formation (Fig 2 and Fig 3) without sacrificing union transition probabilities for both the permanent and non-permanent employment groups (Fig S3 and Fig S4). On the other hand, while social security policies (i.e., more unemployment benefits) could attenuate union formation inequalities across employment groups, such attenuation came from a scenario of downward equalization, where permanent workers' union transition probability significantly declined. Weighing pros and cons, our findings suggest that "flexicurity" reforms should focus more on eliminating labour market segregation in strict employment system and avoid overreliance on unemployment benefit provisions.

Before concluding this paper, we want to point out three unresolved issues and discuss possible directions for future research. First, while our country fixed effects multilevel models accounted for all country-level time-constant unobserved heterogeneities, the estimation results might still suffer from omitted variable biases due to unobserved heterogeneities at the individual level, such as one's work-family preferences (Hakim, 2000). Ideally, a two-step multilevel estimation procedure which combines a central-demeaned individual fixed effects model at the first level and a country fixed effects model at the higher levels can solve the problem. However, we refrained from applying such method to the EU-SILC dataset due to its short panel observation and insufficient outcome event transitions. If individual fixed effects models are applied at the fist level, the huge losses of country-wave estimation will make the second and the third level multilevel modelling inestimable. Bearing this in mind, we specified a discrete-time linear probability model at the micro level to estimate the short-term effects of temporary employment and unemployment on the probability of union formation in the following year. Relatedly, whether the short-term effects found in our analyses apply to the long-term relationship between employment trajectories and cumulative union formation probabilities remains an open question. To solve these issues, future research may consider using other panel datasets that cover longer partnership histories. Nevertheless, for cross-national comparative research on life course transitions among younger Europeans, the EU-SILC panel dataset remains the most useful data sources due to its large scope and prospective panel design.

Second, we might over-simplify the measurements of labour market regulations at the country level. Some researchers have pointed out the importance of considering the multidimensionality of labour market policy measures. For example, rather than using the original EPLR and EPLT indexes provided by OECD, which are weighted indexes comprising multiple items, Balz (2017) suggests using specific items of the indexes to capture the strictness of regulation in specific aspects (e.g., the definition of unfair dismissal). Regarding CBC measurements, research on industrial relations has shown that it's not only the CBC rate, but also the level of collective bargaining (Hayter & Weinberg, 2011) and the degree of bargaining centralization (Barton et al., 2021) that determine the degree of wage and employment coordination. As for measuring the comprehensiveness of unemployment benefits, the entitlement, coverage, and duration are also important aspects besides the generosity measured by the income replacement rates (Gangl, 2006). In summary, while this study has covered the most common measurements of labour market regulations in these three dimensions (Esping-Andersen & Regini, 2000), there is still room for improvement by considering the multidimensionality of specific policy measures.

Third, the current study has not yet discussed the complex influences of policy constellations on shaping people's work-family behaviours (Korpi et al., 2013). Our models are designed to quantify the moderating effects of each specific labour market regulation by holding other regulation indicators (and other macro control variables) constant. However, previous research has shown that different labour market institutions might complement each other in shaping the scale of social inequalities between labour market insiders and outsiders. For example, Barbieri and Cutuli (2016) and Högberg et al. (2019) found that it is the dualistic development of employment protection schemes, measured as the gap between EPLR and EPLT, that marginalizes the labour market outsiders and enlarges the insecurity gaps between the permanent employees and the temporary employees. Similarly, strict EPL combining with a strong collective bargaining institution might enhance labour market segregations and reinforce employment and income inequalities across employment status groups. Finally, unemployment benefits might more effectively buffer the unemployment wage scars in "a relatively flexible labour market that provides lower levels of employment protection" (Gangl, 2006: 1003), which might lead to an even weaker effect of unemployment on union formation.

In conclusion, our fruitful findings and the unresolved issues call for greater attention on the institutional influences of labour market regulations in the changing work-family dynamics in Europe. Building on and going beyond previous comparative research (Barbieri

et al., 2015; Blossfeld et al., 2005; Karabchuk, 2020; Scherer, 2009), this study is the first to quantify how labour regulations reforms moderate the micro-level relationship between employment instability and union formation. It sheds light on the literature by demonstrating that the societal-level transitions of work-family relationships in Europe have been, at least partially, driven by changes in labour market regulations in the past decade.

6 Reference

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7 Supplementary Materials

Table S1. Theoretical mechanisms and hypotheses of the policy moderating effects

Labour market regulations ↑	**Insecurity gap between temporary employment and permanent employment**	**Insecurity gap between unemployment and permanent employment**	**Hypotheses: moderating roles of labour market regulations**
EPL for dismissing regular workers (EPLR)	*Employment insecurity gap* ↑ • Higher costs of dismissal discourage the transition to permanent contract	*Employment insecurity gap* ↑ • Higher costs of dismissal discourage hiring • Stronger scar effects due to prolonged unemployment duration	*H3a: Stricter EPLR may reinforce the negative effect of unstable employment situations on union formation.* *H3b: The reinforcement effect of stricter EPLR is particularly strong in the negative relationship between unemployment and union formation.*
EPL for hiring temporary workers (EPLT)	*Employment insecurity gap* ↑ (↓) • Shorter temporary contract duration and lower possibility of temporary contract renewal • More comprehensive temporary employee protection	*Employment insecurity gap* ↑ • Higher costs of hiring temporary employees discourage reemployment in temporary positions	*H4a: Stricter EPLT may reinforce the negative effect of unstable employment situations on union formation.* *H4b: The reinforcement effect of stricter EPLT is particularly strong in the negative relationship between unemployment and union formation.*
Collective bargaining agreement coverage rate (CBC)	*Income insecurity gap* (↓) • Higher bargaining power over wages, benefits, and insurance *Employment insecurity gap* ↑ • Enhanced insider-outsider dualism	*Employment insecurity gap* ↑ • Enhanced insider-outsider dualism	*H5a: Higher CBC may reinforce the negative effect of unstable employment situations on union formation.* *H5b: The reinforcement effect of higher CBC is particularly strong in the negative relationship between unemployment and union formation.*
Generosity of unemployment benefits	*Income insecurity gap* ↓ • Income safety net after the end of temporary contract *Employment insecurity gap* ↓ • Increased subsequent job tenure and higher probability of permanent contract transition	*Income insecurity gap* ↓ • Income safety net *Employment insecurity gap* ↓ • Weaker scar effects by permitting workers to search for adequate reemployment	*H6: More generous unemployment benefits may attenuate the negative effect of unstable employment situations on union formation.*

Table S2. Descriptive analysis of micro variables by country, average over years

Female sample	Age (Mean)	Employment status				Educational level			Health status			Have children	No capacity to cover unexpected expense	Have some difficulty to make ends meet
		Perm.	Temp.	Unemp.	Self-empl.	Low	Middle	High	Good	Fair	Bad			
Austria	29.8	74.0%	11.3%	10.7%	4.0%	9.8%	57.0%	33.2%	86.7%	11.1%	2.2%	16.5%	28.5%	40.2%
Belgium	30.0	57.1%	21.5%	17.5%	3.9%	13.4%	35.2%	51.4%	86.7%	9.8%	3.5%	19.3%	33.3%	44.3%
Switzerland	25.9	60.6%	33.4%	3.5%	2.5%	21.1%	49.5%	29.4%	88.4%	10.4%	1.2%	3.6%	18.4%	24.3%
Czechia	29.7	63.3%	19.6%	11.1%	6.0%	6.7%	62.8%	30.4%	90.9%	7.5%	1.5%	20.4%	43.7%	65.5%
Germany	30.4	58.5%	29.7%	9.1%	2.7%	12.5%	54.2%	33.3%	83.6%	13.6%	2.9%	14.6%	44.4%	17.0%
Denmark	32.4	76.4%	13.1%	9.2%	1.3%	9.0%	38.1%	52.9%	82.2%	14.8%	3.0%	25.0%	34.2%	25.2%
Estonia	30.0	79.2%	7.0%	11.1%	2.7%	12.1%	47.2%	40.7%	81.9%	15.2%	2.9%	32.7%	49.8%	64.9%
Spain	29.9	31.5%	30.2%	33.5%	4.9%	28.8%	23.2%	48.0%	90.8%	8.0%	1.2%	10.1%	42.9%	64.1%
Finland	29.9	54.3%	26.7%	12.0%	7.0%	7.2%	49.9%	42.9%	83.3%	15.2%	1.4%	17.0%	46.7%	29.5%
France	30.0	50.5%	26.9%	19.6%	3.0%	11.3%	47.4%	41.4%	79.9%	16.5%	3.6%	22.7%	46.4%	67.9%
Greece	29.1	26.9%	20.4%	44.1%	8.6%	4.7%	46.9%	48.4%	96.1%	3.0%	0.9%	0.9%	51.3%	93.0%
Hungary	28.8	65.1%	14.4%	17.5%	3.0%	10.4%	55.0%	34.6%	88.8%	9.5%	1.7%	12.7%	67.8%	87.7%
Ireland	29.5	60.1%	18.4%	18.8%	2.7%	8.5%	41.0%	50.5%	93.0%	6.1%	0.9%	26.5%	58.1%	68.0%
Iceland	29.1	69.2%	17.6%	8.9%	4.3%	26.5%	37.7%	35.8%	86.5%	12.0%	1.4%	37.7%	54.2%	56.7%
Italy	30.8	40.4%	19.7%	27.4%	12.5%	16.1%	54.3%	29.6%	91.7%	6.5%	1.8%	7.3%	39.4%	76.0%
Lithuania	29.2	74.6%	4.6%	16.3%	4.5%	8.4%	39.8%	51.8%	82.0%	15.7%	2.3%	19.9%	50.2%	79.2%
Luxembourg	29.1	63.6%	20.9%	11.9%	3.6%	24.3%	39.9%	35.8%	81.8%	14.2%	4.0%	15.8%	30.1%	34.3%
Latvia	29.9	76.7%	5.2%	15.0%	3.0%	12.3%	47.6%	40.0%	74.8%	23.1%	2.1%	28.6%	66.7%	79.0%
Netherlands	31.6	63.2%	25.2%	5.9%	5.6%	8.1%	36.9%	55.0%	84.5%	12.9%	2.6%	16.2%	31.3%	27.0%
Norway	30.1	66.1%	23.8%	6.2%	3.8%	17.9%	27.8%	54.3%	86.2%	10.4%	3.4%	19.6%	31.5%	23.6%
Poland	28.0	35.0%	40.1%	19.3%	5.5%	5.7%	53.8%	40.5%	88.1%	10.0%	1.9%	14.4%	50.8%	71.2%
Portugal	29.3	39.2%	33.0%	23.1%	4.7%	25.6%	37.8%	36.6%	74.5%	22.6%	2.9%	15.3%	45.4%	78.0%
Sweden	29.2	60.4%	27.5%	10.3%	1.8%	6.1%	47.4%	46.5%	84.3%	12.6%	3.1%	18.9%	30.0%	20.4%
Slovenia	31.5	51.1%	20.6%	23.3%	5.0%	4.9%	51.1%	44.1%	79.5%	16.5%	4.0%	24.5%	48.2%	68.9%
Slovakia	27.8	61.0%	17.7%	18.2%	3.1%	3.5%	56.2%	40.4%	92.8%	6.2%	1.0%	5.1%	35.0%	76.7%
UK	27.8	74.0%	11.2%	10.1%	4.7%	9.8%	52.6%	37.5%	84.2%	12.8%	3.0%	26.8%	52.0%	57.3%

Table S2. (*Continued*)

Male sample	Age (Mean)	Employment status				Educational level			Health status			Have children	No capacity to cover unexpected expense	Have some difficulty to make ends meet
		Perm.	Temp.	Unemp.	Self-empl.	Low	Middle	High	Good	Fair	Bad			
Austria	29.3	59.8%	14.3%	18.9%	7.0%	18.4%	46.0%	35.6%	91.9%	6.4%	1.7%	0.3%	28.4%	42.7%
Belgium	26.8	60.2%	29.8%	5.8%	4.3%	22.5%	52.1%	25.4%	90.7%	8.4%	0.9%	0.0%	16.6%	24.1%
Switzerland	30.0	66.2%	13.4%	11.1%	9.4%	5.8%	76.8%	17.4%	91.1%	6.9%	2.0%	0.0%	39.5%	61.2%
Czechia	28.6	56.3%	31.1%	9.8%	2.9%	20.2%	56.5%	23.3%	88.1%	10.6%	1.4%	0.0%	33.6%	18.5%
Germany	30.5	71.7%	11.7%	12.2%	4.4%	20.1%	47.7%	32.2%	82.2%	14.1%	3.6%	0.3%	25.5%	22.9%
Denmark	28.5	66.9%	6.8%	21.5%	4.8%	25.9%	58.1%	16.0%	81.0%	16.2%	2.8%	0.0%	44.0%	64.6%
Estonia	29.7	30.2%	24.1%	37.0%	8.8%	44.5%	24.2%	31.3%	93.0%	6.0%	1.1%	0.1%	43.4%	66.7%
Spain	30.1	51.0%	15.3%	20.6%	13.2%	12.2%	63.7%	24.1%	83.1%	14.4%	2.5%	0.0%	31.9%	22.6%
Finland	28.1	41.7%	28.7%	24.5%	5.0%	18.3%	50.9%	30.8%	84.5%	13.3%	2.2%	0.3%	39.3%	63.0%
France	30.7	25.2%	17.9%	38.6%	18.3%	13.9%	56.2%	30.0%	96.1%	2.7%	1.2%	0.0%	50.2%	93.6%
Greece	28.5	61.0%	15.5%	19.7%	3.9%	13.7%	70.3%	16.0%	89.8%	8.3%	2.0%	0.0%	73.1%	88.6%
Hungary	28.5	42.7%	13.2%	36.7%	7.3%	19.2%	44.3%	36.5%	93.4%	5.8%	0.7%	0.1%	54.5%	70.2%
Ireland	27.8	65.2%	17.6%	11.2%	6.0%	41.1%	43.0%	15.8%	85.4%	13.1%	1.5%	0.0%	30.2%	36.6%
Iceland	30.5	39.1%	14.4%	29.7%	16.9%	27.3%	56.1%	16.6%	92.2%	5.8%	2.0%	0.0%	38.2%	74.9%
Italy	28.3	65.7%	5.7%	21.5%	7.1%	16.3%	57.2%	26.5%	82.5%	15.7%	1.8%	0.2%	51.7%	80.5%
Lithuania	28.0	62.1%	22.0%	11.9%	4.0%	28.8%	48.2%	22.9%	86.1%	11.0%	2.8%	0.3%	24.6%	29.2%
Luxembourg	28.4	63.0%	6.7%	24.6%	5.7%	26.7%	56.1%	17.2%	78.8%	18.6%	2.6%	0.1%	66.9%	81.0%
Latvia	31.3	63.6%	21.0%	5.7%	9.7%	15.7%	41.9%	42.4%	90.8%	8.3%	0.9%	0.0%	19.8%	18.6%
Netherlands	29.0	67.0%	18.6%	8.4%	6.1%	29.3%	40.4%	30.3%	84.2%	13.0%	2.8%	0.0%	22.9%	16.5%
Norway	27.5	31.3%	34.7%	20.9%	13.1%	12.9%	69.7%	17.3%	89.5%	8.4%	2.2%	0.0%	51.6%	75.0%
Poland	28.9	35.9%	29.0%	29.7%	5.3%	49.4%	33.5%	17.0%	76.8%	20.3%	2.8%	0.2%	44.3%	80.1%
Portugal	28.9	63.8%	19.7%	12.7%	3.8%	8.2%	66.1%	25.7%	88.1%	10.5%	1.4%	0.0%	20.4%	11.2%
Sweden	30.4	52.6%	18.1%	21.3%	8.1%	11.9%	67.8%	20.3%	84.5%	12.2%	3.3%	0.3%	44.6%	68.6%
Slovenia	27.8	56.8%	15.0%	20.5%	7.7%	4.8%	73.4%	21.8%	93.1%	5.6%	1.3%	0.0%	35.2%	76.9%
Slovakia	27.3	69.2%	9.2%	14.5%	7.1%	14.8%	51.7%	33.5%	88.6%	9.5%	1.9%	0.0%	41.4%	48.2%
UK	29.2	47.0%	18.9%	24.2%	10.0%	22.1%	54.5%	23.4%	89.3%	8.8%	1.9%	0.1%	42.7%	65.8%

Table S3. Correlations between countries' average levels of labour market regulations and mean union formation probabilities

	Female				
	(1) Pr(Union) of permanent workers	(2) Pr(Union) of Temporary workers	(3) Pr(Union) of unemployed	(2) − (1) Diff in Pr(Union) between temporary and permanent workers	(3) − (1) Diff in Pr(Union) between unemployed and permanent workers
EPLR	-0.109	0.013	-0.070	0.099	-0.006
EPLT	-0.037	0.006	-0.005	0.035	0.022
CBC rate	0.414*	0.367*	0.205*	0.092	-0.040
UB replacement rate	0.424*	0.337*	0.238*	0.049	-0.007
	Male				
	(1) Pr(Union) of permanent workers	(2) Pr(Union) of Temporary workers	(3) Pr(Union) of unemployed	(2) − (1) Diff in Pr(Union) between temporary and permanent workers	(3) − (1) Diff in Pr(Union) between unemployed and permanent workers
EPLR	-0.038	0.036	-0.083	0.074	-0.018
EPLT	-0.094	0.045	-0.156*	0.141	-0.024
CBC rate	0.414*	0.322*	0.224*	-0.045	-0.237*
UB replacement rate	0.388*	0.277*	0.206*	-0.068	-0.223*

Note: Significance levels: * $p < 0.05$

Table S4. Results from the country fixed effects multinomial logit models, relative risk ratio

	Women		Men	
	Cohabiting / Single	Married / Single	Cohabiting / Single	Married / Single
Employment status (Ref.=Permanent empl.)				
Temporary empl.	0.892*	0.760*	0.803*	0.803*
	(0.052)	(0.101)	(0.078)	(0.078)
Unemployment	0.686*	0.662*	0.489*	0.413*
	(0.067)	(0.046)	(0.102)	(0.089)
Self-employment	0.923	0.990	1.082	1.080
	(0.102)	(0.162)	(0.070)	(0.119)
Educational level (Ref.=Low (ISCED 0-2))				
Middle (ISCED 3-4)	0.928	0.988	1.213+	0.992
	(0.099)	(0.087)	(0.101)	(0.112)
High (ISCED 5-8)	1.109	1.243	1.526*	1.098
	(0.108)	(0.140)	(0.107)	(0.202)
Health status (Ref.=Good)				
Fair	0.877	0.884	0.772*	0.836+
	(0.084)	(0.112)	(0.090)	(0.104)
Bad	0.994	0.786	0.656*	0.433*
	(0.103)	(0.279)	(0.165)	(0.251)
Number of children (Ref.= no child)				
One or more children	1.473*	1.418*	27.652*	20.390*
	(0.099)	(0.136)	(0.627)	(0.562)
Ability to make ends meet (Ref.=Fairly easy)				
With some difficulty/ difficult	0.837*	0.969	0.874+	0.979
	(0.059)	(0.093)	(0.071)	(0.091)
Capacity to face unexpected expense				
Yes	1.087	1.049	1.142*	1.051
	(0.069)	(0.059)	(0.066)	(0.093)
Age	1.435*	1.479*	1.472*	1.794*
	(0.047)	(0.053)	(0.048)	(0.052)
Age2	0.994*	0.993*	0.994*	0.991*
	(0.001)	(0.001)	(0.001)	(0.001)
Period fixed effects	✓	✓	✓	✓
Country fixed effects	✓	✓	✓	✓
Pseudo R^2	0.088		0.101	
n (individuals)	60,834		75,602	
N (country-rounds)	215		215	
M (countries)	26		26	

Note: All models control for country and period fixed effects using the LSDV approach. Standard errors are clustered at the country level. Significance levels: + p<0.1, * p < 0.05.

Table S5. Results from country FES linear probability models, full table for women

	Model 1		Model 2		Model 3		Model 4		Model 5	
	β	*S.E.*	*β*	*S.E.*	*β*	*S.E.*	*β*	*S.E.*	*β*	*S.E.*
Employment status (Ref.=Permanent employment)										
Temporary employment	-0.006*	(0.001)	-0.006*	(0.001)	-0.005*	(0.002)	-0.006*	(0.001)	-0.005*	(0.001)
Unemployment	-0.010*	(0.001)	-0.010*	(0.001)	-0.008*	(0.001)	-0.011*	(0.001)	-0.010*	(0.001)
self-employment	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
Micro-level control variables	✓		✓		✓		✓		✓	
Period fixed effects	✓		✓		✓		✓		✓	
Country fixed effects	✓		✓		✓		✓		✓	
Country fixed slopes	✓		✓		✓		✓		✓	
Macro-level variables										
GDP per capita	-0.007	(0.004)	-0.007	(0.004)	-0.008	(0.004)	-0.007	(0.004)	-0.007	(0.004)
Unemployment rate (female)	-0.014*	(0.007)	-0.014*	(0.007)	-0.014*	(0.007)	-0.014*	(0.007)	-0.014*	(0.007)
Temporary employment rate (female)	-0.003	(0.006)	-0.003	(0.006)	-0.003	(0.006)	-0.003	(0.006)	-0.003	(0.006)
Economic globalization	-0.012+	(0.006)	-0.011+	(0.006)	-0.012+	(0.006)	-0.012+	(0.006)	-0.011+	(0.006)
Female labour force participation rate	-0.011	(0.010)	-0.012	(0.009)	-0.011	(0.010)	-0.011	(0.010)	-0.012	(0.010)
EPLR	-0.002	(0.003)	-0.005	(0.004)	-0.002	(0.003)	-0.002	(0.003)	-0.002	(0.003)
EPLT	-0.008	(0.007)	-0.008	(0.007)	-0.004	(0.008)	-0.008	(0.007)	-0.008	(0.007)
CBC	-0.003	(0.002)	-0.003	(0.002)	-0.003	(0.002)	-0.002	(0.003)	-0.003	(0.002)
UB generosity	-0.005*	(0.002)	-0.005*	(0.002)	-0.005*	(0.002)	-0.005*	(0.002)	-0.008*	(0.002)
Temp. empl. * EPLR			0.013	(0.008)						
Unempl. * EPLR			-0.001	(0.003)						
Temp. empl. * EPLT					-0.008	(0.010)				
Unempl. * EPLT					-0.018*	(0.007)				
Temp. empl. * CBC							0.003	(0.004)		
Unempl. * CBC							-0.005+	(0.003)		
Temp. empl. * UB generosity									0.004*	(0.001)
Unempl. * UB generosity									0.004*	(0.001)
n (individuals)	87,670		87,670		87,670		87,670		87,670	
N (country-rounds)	215		215		215		215		215	
M (countries)	26		26		26		26		26	

Note: Significance levels: + p<0.1, * p < 0.05. Standard errors are clustered at the country level.

Table S6. Results from country FES linear probability models, full table for men

	Model 1		Model 2		Model 3		Model 4		Model 5	
	β	*S.E.*	*β*	*S.E.*	*β*	*S.E.*	*β*	*S.E.*	*β*	*S.E.*
Employment status (Ref.=Permanent employment)										
Temporary employment	-0.006*	(0.001)	-0.006*	(0.001)	-0.008*	(0.002)	-0.007*	(0.001)	-0.005*	(0.001)
Unemployment	-0.015*	(0.001)	-0.015*	(0.001)	-0.014*	(0.001)	-0.015*	(0.001)	-0.014*	(0.001)
self-employment	0.001*	(0.000)	0.001*	(0.000)	0.001*	(0.000)	0.001*	(0.000)	0.001*	(0.000)
Micro-level control variables	✓		✓		✓		✓		✓	
Period fixed effects	✓		✓		✓		✓		✓	
Country fixed effects	✓		✓		✓		✓		✓	
Country fixed slopes	✓		✓		✓		✓		✓	
Macro-level variables										
GDP per capita	-0.007	(0.006)	-0.008	(0.006)	-0.007	(0.006)	-0.007	(0.006)	-0.007	(0.006)
Unemployment rate (female)	-0.010*	(0.002)	-0.010*	(0.002)	-0.010*	(0.002)	-0.010*	(0.002)	-0.010*	(0.002)
Temporary employment rate (female)	-0.010+	(0.005)	-0.010+	(0.005)	-0.010+	(0.005)	-0.010+	(0.005)	-0.010+	(0.005)
Economic globalization	-0.005	(0.005)	-0.006	(0.005)	-0.005	(0.005)	-0.005	(0.005)	-0.005	(0.005)
Female labour force participation rate	-0.008	(0.007)	-0.008	(0.007)	-0.009	(0.007)	-0.008	(0.007)	-0.009	(0.007)
EPLR	-0.003	(0.003)	0.002	(0.003)	-0.003	(0.003)	-0.003	(0.003)	-0.003	(0.003)
EPLT	-0.009	(0.005)	-0.009	(0.005)	-0.009	(0.008)	-0.008	(0.005)	-0.009	(0.005)
CBC	-0.006*	(0.003)	-0.006*	(0.003)	-0.006*	(0.003)	-0.002	(0.004)	-0.006*	(0.003)
UB generosity	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)	-0.002	(0.002)
Temp. empl. * EPLR			-0.004	(0.004)						
Unempl. * EPLR			-0.011*	(0.004)						
Temp. empl. * EPLT					0.008	(0.010)				
Unempl. * EPLT					-0.003	(0.007)				
Temp. empl. * CBC							-0.005*	(0.002)		
Unempl. * CBC							-0.005*	(0.002)		
Temp. empl. * UB generosity									0.004*	(0.001)
Unempl. * UB generosity									0.005*	(0.001)
n (individuals)	115,666		115,666		115,666		115,666		115,666	
N (country-rounds)	215		215		215		215		215	
M (countries)	26		26		26		26		26	

Note: Significance levels: + p<0.1, * p < 0.05. Standard errors are clustered at the country level.

Table S7. Sensitivity analysis: Results comparison of unemployment benefits' moderating effects across different unemployment duration.

	Model 1 UB @ 12th month	Model 2 UB @ 18th month	Model 3 UB @ 24th month
Female			
Temp. empl. * UB generosity	0.004*	0.004*	0.007*
	(0.001)	(0.001)	(0.002)
Unempl. * UB generosity	0.003*	0.004*	0.006*
	(0.001)	(0.001)	(0.001)
Male			
Temp. empl. * UB generosity	0.003*	0.004*	0.005*
	(0.001)	(0.001)	(0.002)
Unempl. * UB generosity	0.004*	0.005*	0.007*
	(0.000)	(0.001)	(0.001)

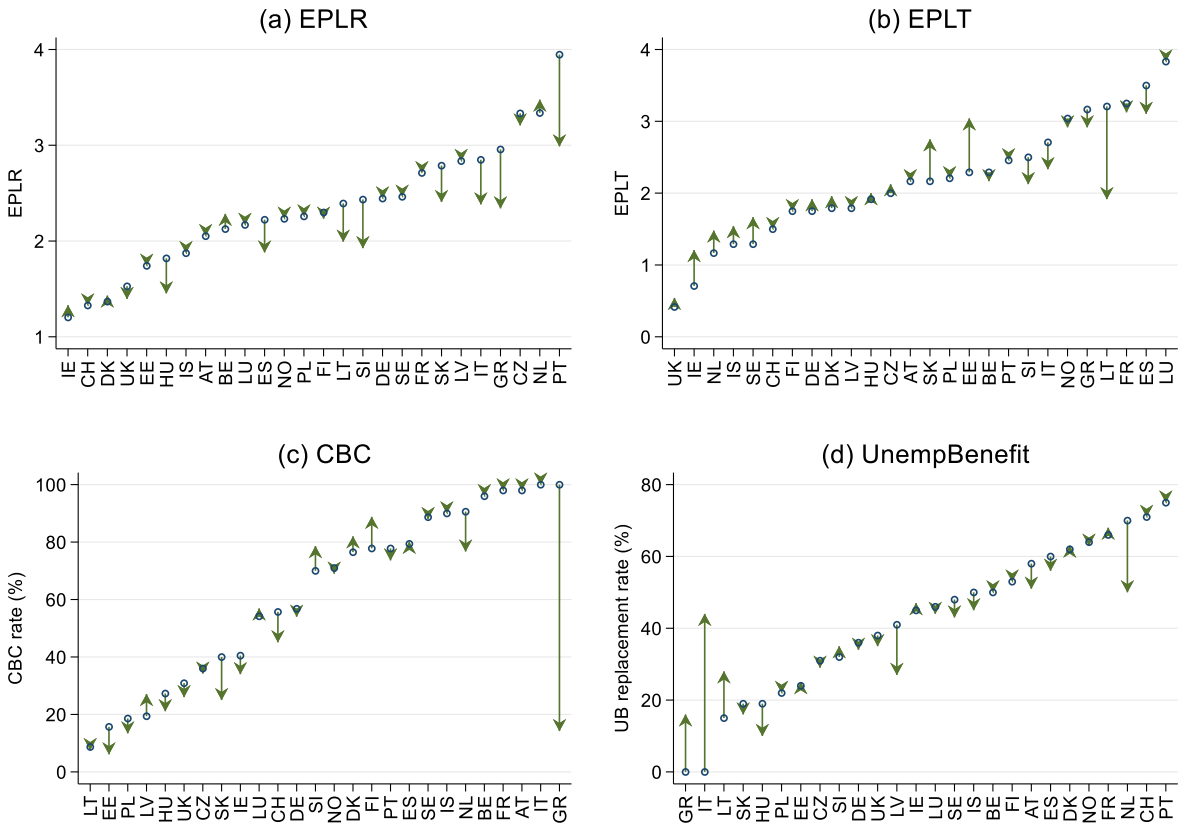
Note: Models presented in this table are the same as Model 5 in Table S5 and Model 5 in Table S6. Significance levels: + p<0.1, * p < 0.05. Standard errors are clustered at the country level.

Table S8. Overview of hypotheses and empirical supports

Hypotheses	Empirical supports		
	Female sample	Male sample	Gender difference
H1: Having an unstable employment situation such as temporary employment or unemployment has a negative effect on the probability of union formation among single individuals.	+	+	(H2)
H2: The negative effect of having an unstable employment situation on the probability of union formation is stronger for men than for women.			+
H3a: Stricter EPLR may reinforce the negative effect of unstable employment situations on the probability of union formation.	–	/	(H7)
H3b: The reinforcement effect of stricter EPLR is particularly strong in the negative relationship between unemployment and union formation.	–	+	
H4a: Stricter EPLT may reinforce the negative effect of unstable employment situations on the probability of union formation.	/	–	(H8)
H4b: The reinforcement effect of stricter EPLT is particularly strong in the negative relationship between unemployment and union formation.	+	–	
H5a: Higher CBC may reinforce the negative effect of unstable employment situations on the probability of union formation.	/	+	
H5b: The reinforcement effect of higher CBC is particularly strong in the negative relationship between unemployment and union formation.	+	–	
H6: More generous unemployment benefits may attenuate the negative effect of unstable employment situations on the probability of union formation.	+	+	
H7: Stricter EPLR may reinforce the negative effect of unstable employment situations on the probability of union formation especially for men.			+
H8: Stricter EPLT may reinforce the negative effect of unstable employment situations on the probability of union formation especially for women.			+

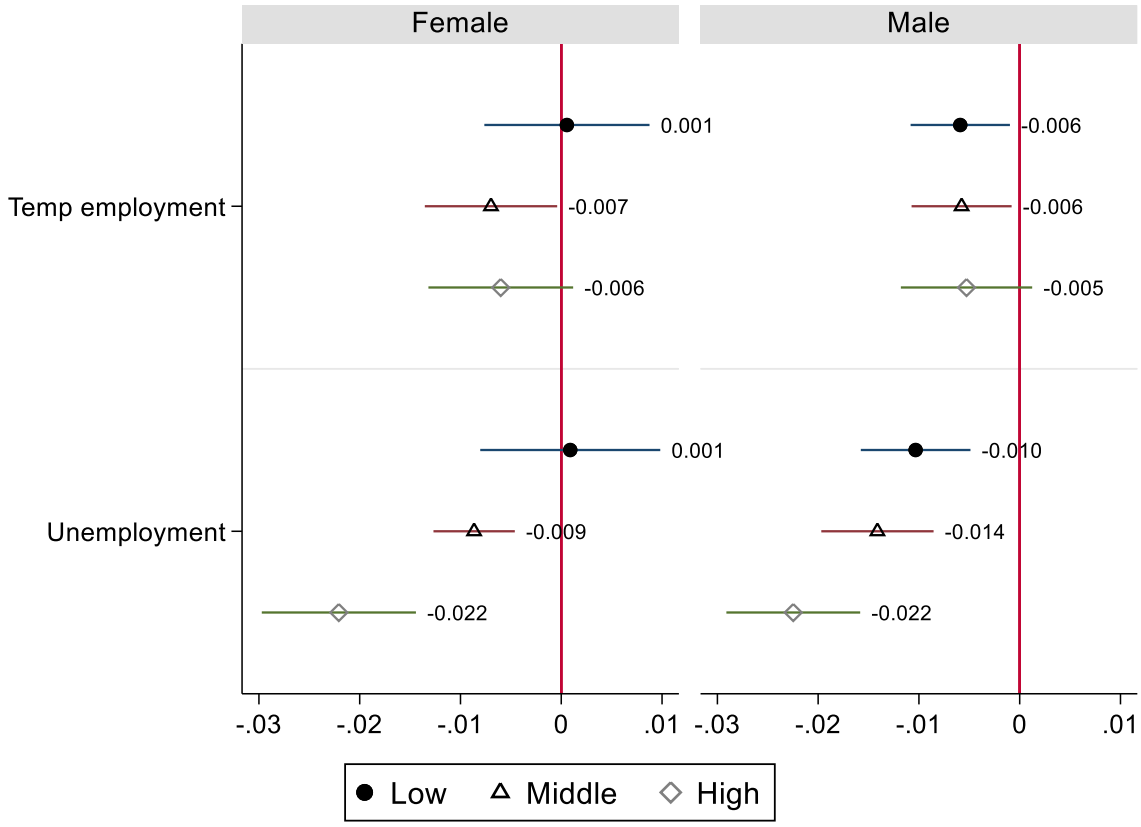
Note: + denotes empirical support, / denotes partial empirical support (only for the unemployed), – denotes no empirical support

Fig S1. Changes in labour market regulations across country



Note: The hollow dots present the initial values of regulation indicators in a specific country at the first observation (around 2010); the arrows indicate the directions and sizes of regulation changes toward the end of our observation (around 2018).

Fig S2. Effects of temporary employment and unemployment on union formation probability by educational levels



Note: Point estimates with 95% confidence intervals. The effects are calculated as probability differences with permanent employment as the reference groups. All models include control variables that are identical to those included in Table 3.

Fig S3. Predictive probability of union formation for women by employment status

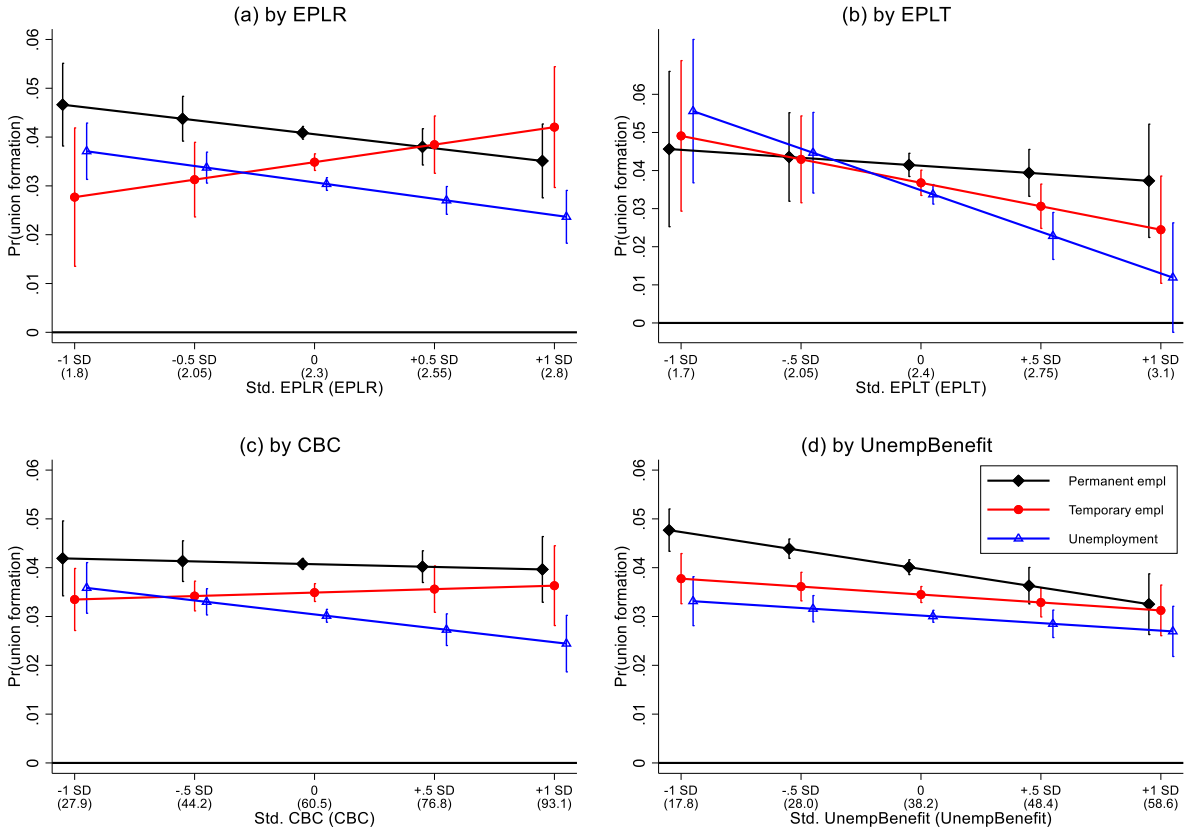


Fig S4. Predictive probability of union formation for men by employment status

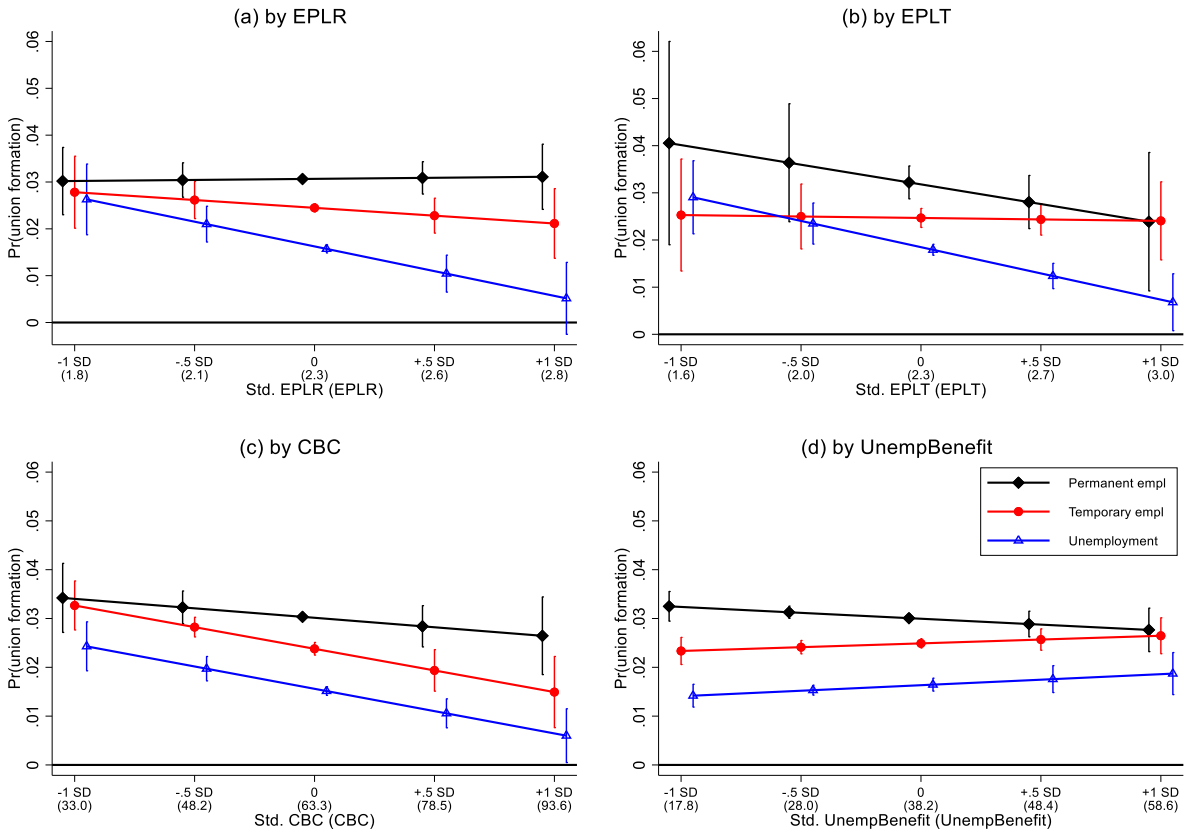
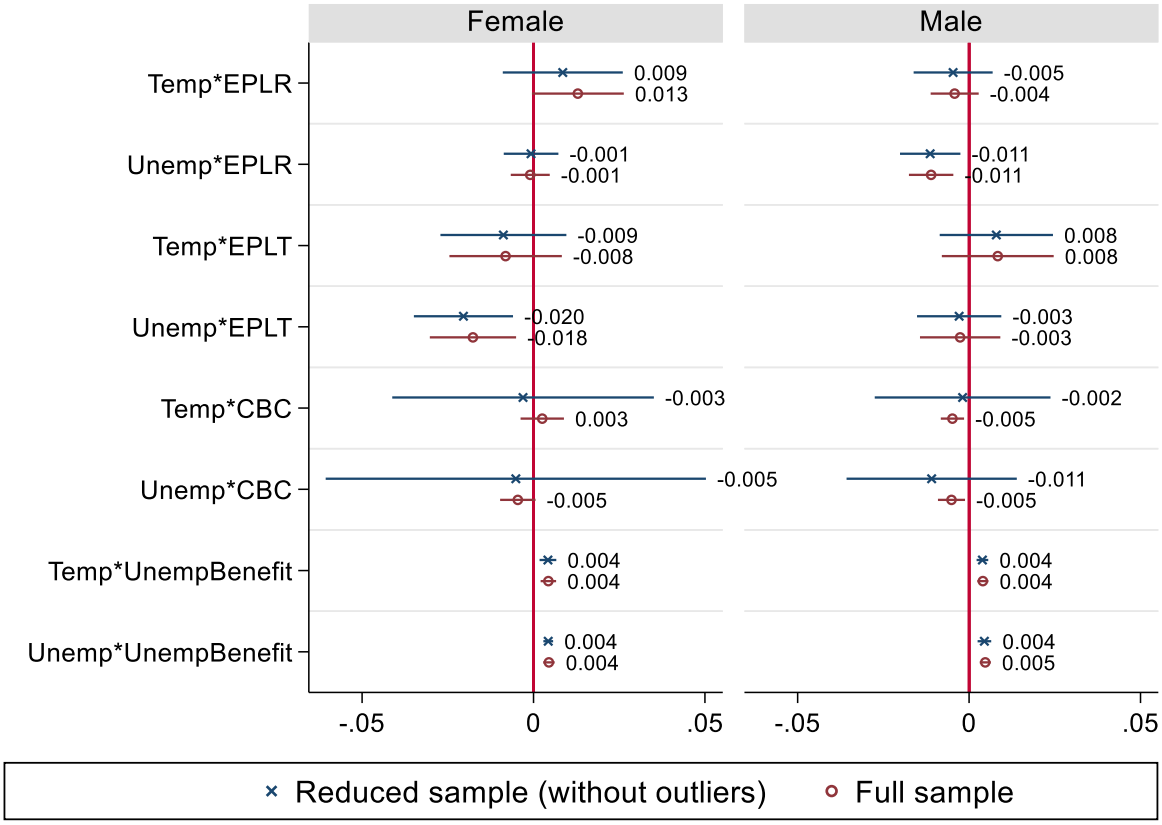
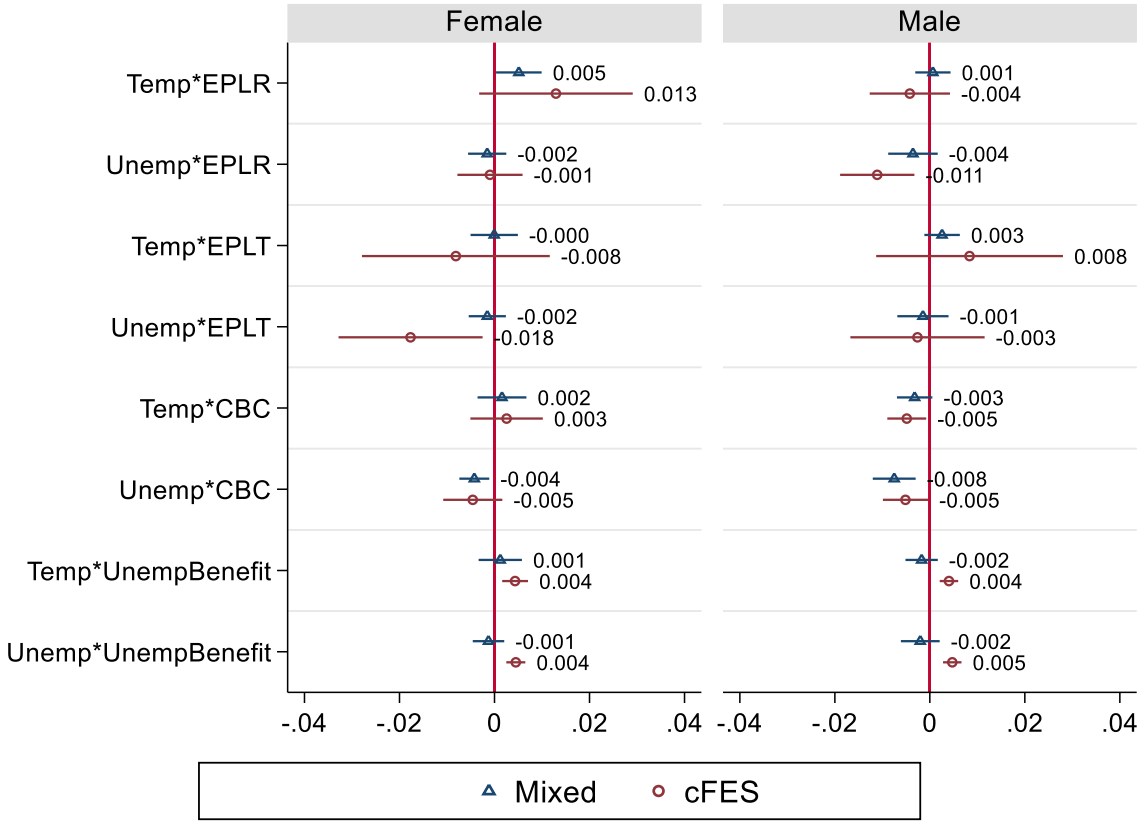


Fig S5. Robustness analysis: Estimated policy moderating effects for samples with and without outlier countries.



Note: Point estimates with 95% confidence intervals. All models include control variables included in Table 3. Outlier countries in the corresponding policy analyses are: (1) Portugal for EPLR analyses, (2) Lithuania for EPLT analyses, (3) Greece for CBC analyses, and (4) Italy for unemployment benefits analyses

Fig S6. Modeling results comparison between cFES models and mixed-effects models: the moderating effects of labour market regulations



Note: Point estimates with 95% confidence intervals. All models include control variables included in Table 3.

Supplementary Appendix 1: Case studies of labour market moderating effects

To check the credibility of our main findings, we performed additional case studies to examine whether the policy moderating effects generalized from cross-national comparative analyses can be applied to the experiences of specific countries (see Adsera (2011) for similar applications of this methodology in family demography). To this end, we identified four representative countries and estimated the time dynamics of the effects of unstable employment situations on union formation in these countries by adding interaction terms between employment situations and years in each country models. These models included all control variables included in Table 3.

To isolate the impact of policy changes in a specific dimension, the representative countries should not have more than one substantial labour regulation reforms during the observation period. Therefore, countries that experienced the most substantial reforms in specific labour market regulations were not necessarily the most ideal case to study. For example, while Greece had the largest reduction in CBC during our observation period, it was not the most suitable for studying the influences of CBC reforms because the country also experienced remarkable increase in unemployment benefits replacement rates during the observation period (see Fig 1 for details). Instead, Finland was a suitable case to study because while Finland's CBC rate had a remarkable increase, the other three labour market regulations remained largely unchanged in the country, making it possible to isolate the influences of CBC reforms.

Fig S7. Effects of temporary employment and unemployment on union formation in Portugal (EPLR decreased by 0.96 in 2012-2014)

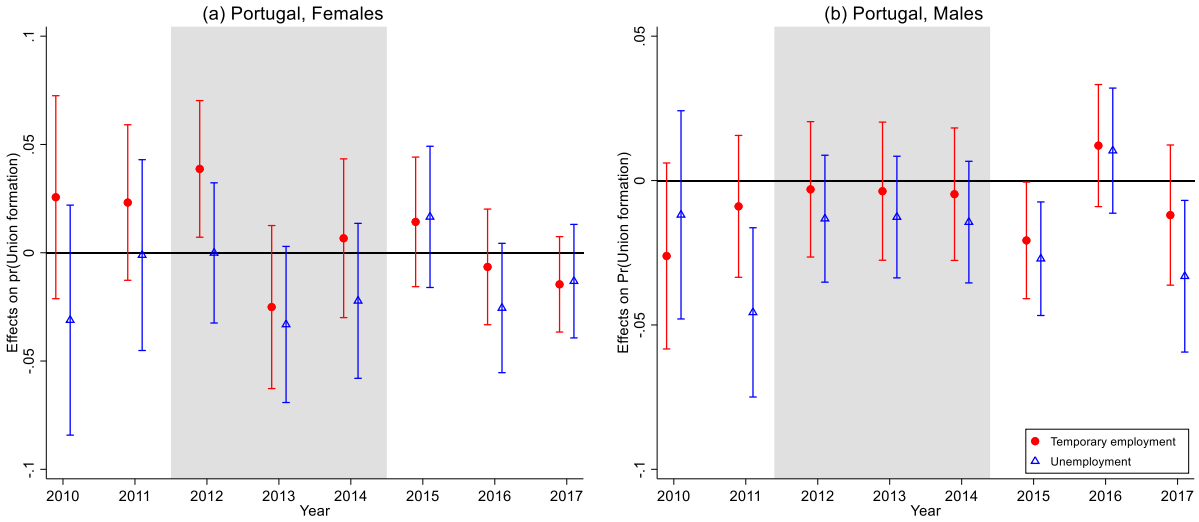
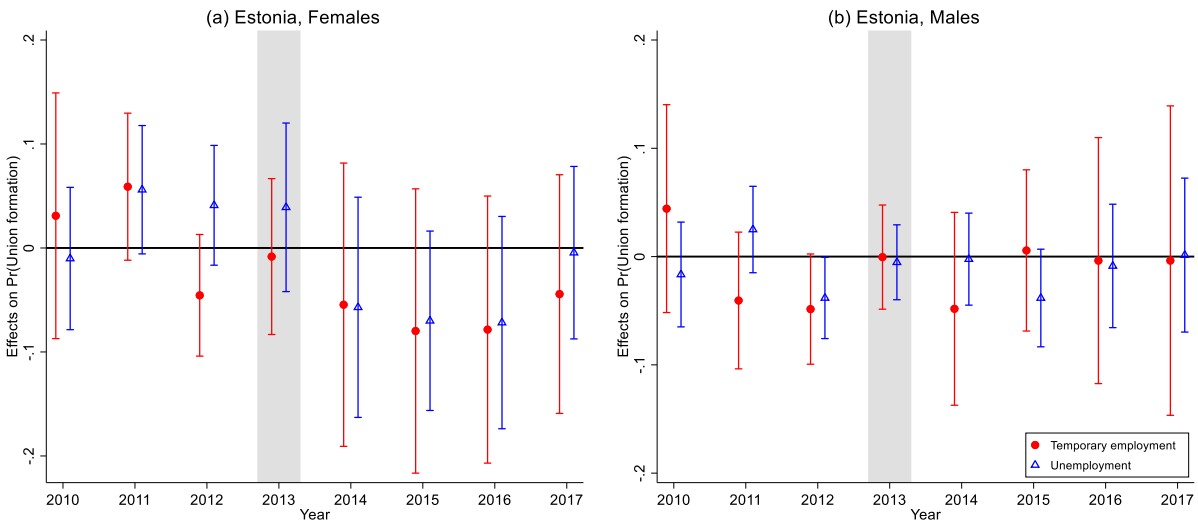


Fig S7 presents the time dynamics of the effects of temporary employment and unemployment compared to permanent employment in Portugal, where EPLR decreased from 3.95 in 2011 to 2.99 in 2014. According to our theoretical framework, such a decrease in EPLR might attenuate the negative effects of unstable employment situations on union formation (Hypothesis 3a), especially for men (Hypothesis 7). Fig S7's results for Portugal provided some evidence to these expectations. For men, we found that the negative effects of unstable employment on union formation became smaller during 2012–2014 comparing to the pre-reform years. For women, however, the effects of unstable employment situations on union formation became negative during the years of EPLR reduction—a pattern that contradicted Hypothesis 3a.

Fig S8. Effects of temporary employment and unemployment on union formation in Estonia (EPLT increased by 0.75 in 2012-2013)



To examine the moderating effects of EPLT changes, Fig S8 presented how micro-level effects of unstable employment on union formation were evolving in Estonia, where EPLT increased sharply from 2.29 in 2012 to 3.04 in 2013. Such an increase in EPLT is expected to cause a more negative effect of unstable employment situations on union formation (Hypothesis 4a), especially for women (Hypothesis 8). Results for Estonian women in Fig S8 provided some evidence to the theoretical expectations. After Estonia's sharp increase in EPLT in 2013, the negative effect of women's temporary employment on union transition had strengthened, and the once positive effect of women's unemployment turned negative. However, such a dynamic effect pattern following the EPLT reform was not observed for Estonian men.

As mentioned earlier, Finland was an ideal case to study the moderating effects of CBC reforms on the relationship between employment and union formation. Finland's CBC rate increased remarkably from 77.8% in 2010 to 91.9% in 2014. Such an increase in CBC is expected to trigger a more negative effect of unstable employment situations on union formation (Hypothesis 5a). This theoretical expectation seemed to be supported by results in Fig 9, in which a downward trend toward more negative effect of unstable employment was clearly found. Nevertheless, we should also notice that the most negative effect of unstable employment on union formation was observed before the reform (i.e., 2010). It was during the years of the CBC reform that the effect became less negative or turned positive before its post-reform plunge. We therefore suggest a cautious interpretation of CBC's moderation effect in Finland.

Fig S9. Effects of temporary employment and unemployment on union formation in Finland (CBC increased by 14.1 percentage points in 2011-2014)

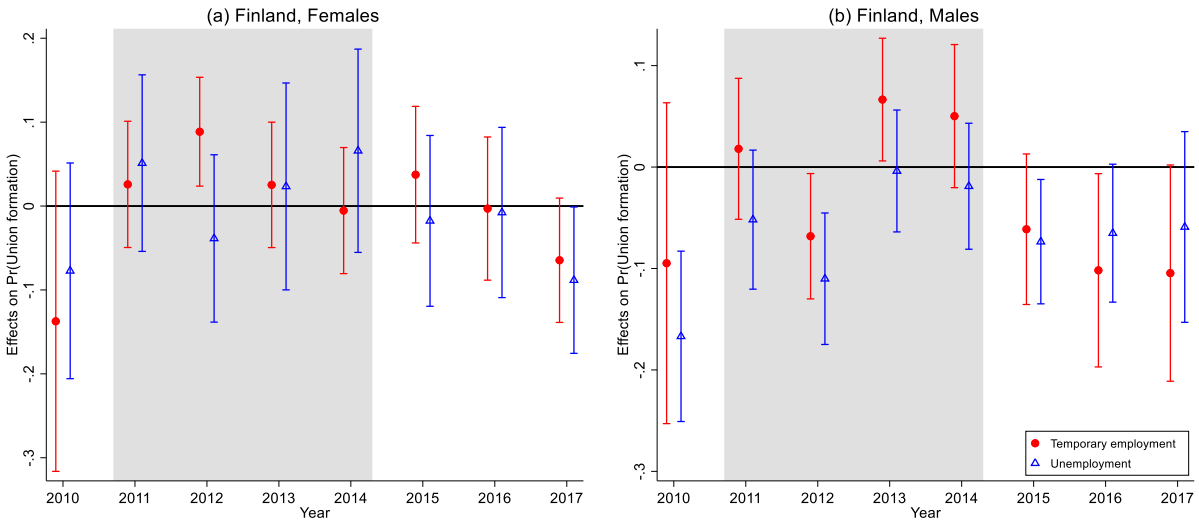
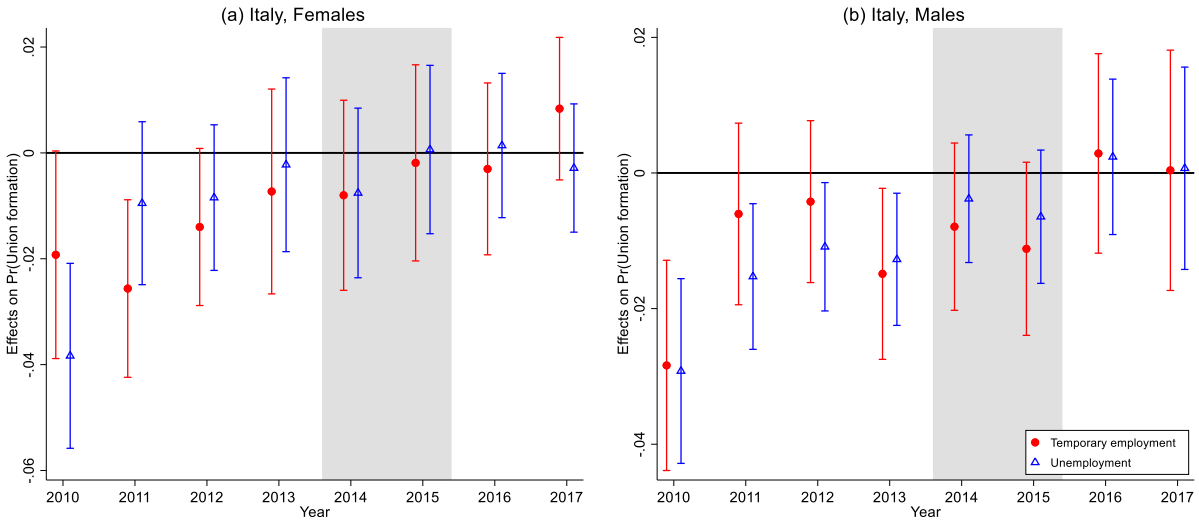


Fig S10. Effects of temporary employment and unemployment on union formation in Italy (UB replacement rate increased by 40 percentage points in 2014-2015)



Finally, Italy was selected to study how unemployment benefit reforms may moderate the effect of unstable employment on union formation. During the years 2014–2015, the income replacement rate of unemployment benefits at the 18th month of unemployment had significantly increased from 0 to 40 percent in Italy. In theory, such an increase in unemployment benefits might attenuate the negative influence of unstable employment on union formation (Hypothesis 6). Results in Fig S10 provided some evidence to the expectation, showing that the negative effects of unstable employment had reduced to nearly zero either during or after the unemployment benefits reform for Italian women and men.

In summary, case studies in this Supplementary Appendix provided additional supports to our theoretical hypotheses. However, due to small sample sizes for each country-rounds, the yearly effects of temporary employment and unemployment were estimated with high statistical uncertainty. Such uncertainty was reflected in the wide 95% CIs across all case studies. Rather than overinterpreting the findings, we suggest using these cases only as supplementary evidence to our main findings in the multilevel models.

Study II:

How women's employment instability affects birth transitions: The moderating role of family policies in 27 European countries

Status: Published in *European Sociological Review*

Citation: Hsu, C.-H. (2023). How women's employment instability affects birth transitions: The moderating role of family policies in 27 European countries. *European Sociological Review*, jcad037, 935–956. https://doi.org/10.1093/esr/jcad037

Acknowledgements: The author thanks Michael Gebel, Henriette Engelhardt, Sophia Fauser, and the anonymous reviewers for their insightful suggestions to improve the earlier version of this article. The author also thanks the participants in European Population Conference 2022 (EPC 2022) and in the DiSIA Seminar for their comments.

Abstract

Why women in some countries are more likely than others to postpone childbirth when facing employment instability? This study uses 2010–2019 EU-SILC panel data to explore whether the impacts of women's employment instability, including being unemployed or temporarily employed by fixed-term contracts, on the first- and second-birth transitions differ across 27 European countries and how governments' provisions of different family policies moderate such relationships. Results showed that while unemployment and temporary employment could generally delay women's first- and second-birth transition, such effects varied across European countries and depended on the levels of family policy provisions. Countries with more generous family cash benefits were associated with less negative and even positive effects of women's employment instability on birth transitions. On the other hand, the birth effects of women's employment instability did not vary significantly across countries according to the length of paid maternity/parental leaves. Most strikingly, countries with higher childcare coverage rates were associated with more negative effects of women's employment instability on birth transitions. These findings highlight the importance of family policy contexts in shaping women's childbirth responses to unstable employment circumstances.

1 Introduction

The relationship between women's employment and fertility behaviors has been a prominent research topic in social sciences. At the macro level, theories and empirical evidence are converging to suggest a positive relationship between women's stable employment conditions and fertility rates (Comolli, 2017; Goldscheider et al., 2015). However, whether such relationship manifests as well at the micro level remains inconclusive. Several theories and empirical studies reach contrasting conclusions regarding how women's childbirth transitions are influenced by employment instability. While an economic tradition of family research has long argued a negative impact of women's employment stability on fertility (Becker, 1991), such perspective has been challenged by recent studies, which show that women's stable employment is not always an obstacle to childbirth (Kreyenfeld et al., 2012). In fact, a meta-analysis (Alderotti et al., 2021) has shown that women's employment instability, including being unemployed or being temporarily employed by fixed-term contracts, is more detrimental to childbirth transitions than being stably employed by permanent contracts in most European countries. These recent findings reflect a shifting family economic foundation toward a more gender-neutralized pattern in the context of increasing economic uncertainty following globalization and labor market flexibilization (Blossfeld et al., 2005). As women's paid works become crucial sources of household income, their experiences of employment instability are more likely to discourage fertility intentions and childbirth transitions.[1]

Nevertheless, people's fertility responses to uncertain economic situations may differ across countries and population groups (Sobotka et al., 2011). Empirical studies in Europe showed that the impacts of employment instability on childbirth due to temporary employment or unemployment vary across institutional contexts (Adsera, 2011a, 2011b; Matysiak and Vignoli, 2013; Özcan et al., 2010). A popular empirical strategy to study the interplay between female employment, fertility behaviors, and family policies is using a comparative welfare state approach (Blossfeld et al., 2005; Esping-Andersen, 2009). Accordingly, researchers drew conclusions based on either the effect variations across a small number of countries (Matysiak and Vignoli, 2013; Özcan et al., 2010) or the variations across welfare regimes (Adsera, 2011b; Blossfeld et al., 2005). In general, women in Social Democratic (e.g., Sweden and Norway) or Liberal (e.g., the U.S.) welfare states are more likely to delay or forgone motherhood when they are temporarily employed or unemployed. However, some women, especially the lower-educated, in Familistic (e.g., Italy and Spain) or Conservative welfare states (e.g., Germany) are more likely to become mothers facing employment instability (see Blossfeld et al. (2005) and Kreyenfeld et al. (2012) for literature

reviews of these earlier comparative studies). While these studies provide valuable insights, their small-n comparative design cannot directly evaluate the degree to which the cross-national effect variations are explained by country-level differences in specific policy provisions. For policymakers and social scientists, it is crucial to understand whether people's childbirth responses to employment instability are shaped by family policy contexts.

To answer the unresolved question, this paper utilizes large-scale comparative microdata and applies multilevel analyses on the policy moderation effects. Its contributions to the literature are threefold. First, this paper provides a more comprehensive picture of the micro-level linkage between employment instability and birth transitions for women. Previous work usually focuses on the effect of a specific unstable employment status (e.g., being temporarily employed compared to permanently employed) and its impact on a specific birth transition (e.g., the first birth). This paper, on the other hand, considers the different economic implications of having a temporary job and being unemployed for women (Adsera, 2011b) and investigates their potentially heterogeneous effects across women's first- and second-birth transitions (Andersen and Özcan, 2021). Second, unlike most studies featuring single-country cases and overrepresenting Western-European countries, this paper investigates the consequences of unemployment and temporary employment on women's childbirth for 27 European countries across different welfare regimes. Its analyses enhance the generalizability of empirical findings by exploring the childbirth effects of women's employment instability both aggregately from a European perspective and separately for each country. Third, building on a comparative framework, this paper extends the literature by empirically testing the moderating role of family policies. Focusing on three mainstream family policies that directly affect women's work-family decision-making [2] —family benefits via cash transfers or tax breaks, paid leaves for mothers, and early childcare services—our findings add nuance to the ongoing debates over the most "effective" pronatalist family policies (Bergsvik et al., 2021; Billingsley and Ferrarini, 2014), showing that the complex interactions between micro-level employment statuses and macro-level policy measures could either mitigate or exacerbate the fertility inequality across employment subgroups in various ways.

2 Theory and Hypotheses

2.1 Employment instability and women's childbirth: Theory and evidence

According to New Home Economics (Becker, 1991), women's demand for children is contingent on the costs of children. The theory assumes that raising children is costly for parents in terms of monetary and non-monetary resources. With limited resources, the costs of

childbirth have to be weighed against the benefits gained from alternative activities, such as employment. In this economic model, women's employment instability can either depress or facilitate their childbirth transitions. On one hand, a stable employment status increases women's income, which compensates for the direct monetary costs of childrearing. This "income effect" leads to a negative relationship between women's employment instability and childbirth. On the other hand, the indirect opportunity costs of childbirth are lower for women of unstable employment status compared to permanent employees because the formers, especially the unemployed, usually have more time flexibility to take care of children. This "substitution effect" encourages women to become mothers earlier when they are facing employment instability.

Experiencing employment instability may also create a sense of economic uncertainty, which has been argued as a key mechanism affecting women's childbirth behaviors in sociological research (Kreyenfeld, 2010; Pailhé and Solaz, 2012). Perceiving uncertainty may on one hand discourage people's commitment to long-term relationships including parenthood (Blossfeld et al., 2005; Oppenheimer, 1988) and on the other hand produces psychosocial stress that impedes women's reproductive health (Gleason et al., 2020). Moreover, structural constraints accumulated in the past and present economic uncertainty lay the foundation for imaginaries of the future, through which the negative impact of passive narratives on fertility intentions might be reinforced (Lappegård et al., 2022).

In contrast, another sociological theory by Friedman and colleagues (1994) argues that the intrinsic socio-psychological values of children could counter the external uncertainty related to employment instability. Accordingly, women may strategically choose motherhood as an "alternative career" when they cannot establish a satisfying working career in permanent jobs (Kreyenfeld, 2010), leading to a positive relationship between employment instability and women's childbirth transitions.

During the historical period when the male-breadwinner system prevailed, earlier economic research usually assumed that the income effect of stable employment is less relevant to women's childbirth decisions and found a negative relationship between female employment and fertility outcomes (Kravdal, 1992). However, with the rise of the dual-earner model in developed countries, the income effect related to women's stable employment could become a dominant factor influencing women's fertility decisions (van Wijk et al., 2021). In the era of Globalization, people's perceived economic uncertainty due to temporary employment is also amplified because labor market flexibilization and deregulation not only

create more temporary positions but also make temporary employees more marginalized compared to regular workers (Blossfeld et al., 2005). Moreover, with the emergence of individualistic social norms during Europe's second demographic transition (Lesthaeghe, 2010), the intrinsic value of children and social recognition of motherhood are decreasing. Drawing on these discussions, the general impact of women's employment instability on childbirth in European countries after 2010 is expected as follows:

H1: *On European average, women's temporary employment or unemployment compared to permanent employment has a negative effect on women's childbirth transitions.*

2.2 The moderating role of family policies

There has been much debate over the impacts of family policies on women's fertility outcomes (Baizan et al., 2016; Bergsvik et al., 2021; Gauthier, 2007). In general, research suggests that mainstream family policies, including the provision of early childcare services, paid maternity and parental leaves for women, and family benefits through cash transfer or tax breaks, have at least short-term influences on women's birth timings and parity transitions. However, studies also show that their underlying mechanisms to enhance female childbirth are substantially different because they address people's concerns about work and family lives in distinct ways (Billingsley and Ferrarini, 2014; Notten et al., 2017). Building on two theoretical frameworks, this section illustrates that country-level differences in specific family policy provisions affect not only the economic incentives but also the normative conditions for women's birth decision-making. I argue that a country's reliance on specific policies may benefit specific employment groups, which may enlarge or close the fertility gaps between the permanently employed and the temporarily employed or unemployed women.

Focusing on the economic utility of family policies, scholars have distinguished between traditional income support and earner-career support policies (Bergsvik et al., 2021; Billingsley and Ferrarini, 2014), depending on whether they are enhancing female childbirth by relieving the direct costs (i.e., moderate the income effects) or the opportunity costs (i.e., moderate the substitution effects). Another framework emphasizes the policy impacts on social norms (Baizan et al., 2016; Lohmann and Zagel, 2016), arguing that the advocation of specific family policies can either familize or defamilize gender norms and childcare arrangements.

Family and child cash benefits via monthly allowances or tax breaks are categorized as traditional income policies, which subsidize the direct costs of childbearing (Kalwij, 2010; Riphahn and Wiynck, 2017). This design operates to increase women's fertility by decreasing

the income threshold to afford a child, thus reducing the relevance of income effects on women's fertility behavior. Therefore, a more generous family benefit may help to close the fertility gaps between the permanently employed, who are more economically secure, and the temporarily employed or unemployed women, who normally have lower incomes. From a sociological perspective, universal cash benefits provided to private household implies a familization of childcare responsibilities (Lohmann and Zagel, 2016). A generous family benefits program echoes the logic of the male-breadwinner gender norm and reinforces women's economic dependency. It creates financial incentives for and social expectations on women to stay marginally attached to the labor market for homecare (Baizan et al., 2016; Billingsley and Ferrarini, 2014). According to both theories, I expect:

H2: *The childbirth effects of women's temporary employment and unemployment compared to permanent employment are more positive in countries with more generous family cash benefits.*

Maternity and parental leaves policies are earner-carer support policies aiming to reduce the opportunity costs of childbirth (Billingsley and Ferrarini, 2014; Kalwij, 2010). According to family economic theory, women who interrupt their labor market participation for childbearing may face high risks of long-term unemployment, downward career mobility, and reduced wage returns. Against the background, the provision of job-protected leaves for mothers reduces their opportunity costs of losing a career. In addition, the wage-replacement benefits during the leaves period reduce the opportunity costs of losing monthly salaries.[3] Because these opportunity costs of childbirth are higher for women with an established working career, the economic perspective predicts that a long and well-paid parental leave scheme is particularly favorable for permanently employed women and may strengthen the negative effect of employment instability on women's childbirth. In contrast, a socio-psychological perspective predicts that temporarily employed or unemployed women are the major beneficiaries of a generous leave program because the childbirth-related economic concerns embedded in these unstable employment statuses are relieved in such policy context. Moreover, while paid parental leaves aim to support the earner-carer role of working mothers (Billingsley and Ferrarini, 2014), they also familize the care responsibilities to home caregivers. Given the fact that most women are the primary caregivers, an extended maternal leave scheme may create normative anchoring effects through which women's employment instability before and after childbirth is justified (Gangl and Ziefle, 2015). This social mechanism could neutralize the negative effect of employment instability on women's

childbirth. In summary, the role of paid leaves in moderating women's employment instability-childbirth relationship is mixed, depending on which theoretical mechanism is dominating. Accordingly, I propose two counterhypotheses:

H3a: *The childbirth effects of women's temporary employment and unemployment compared to permanent employment are more positive in countries with more generous paid leaves for mothers.*

H3b: *The childbirth effects of women's temporary employment and unemployment compared to permanent employment are more negative in countries with more generous paid leaves for mothers.*

Similar to leave policies, governments' provision or subsidization of early childcare services are earner-carer support policies aiming to reduce the opportunity costs of childbirth (Billingsley and Ferrarini, 2014; Kalwij, 2010). However, they use very different designs to achieve the goal. Instead of using leave benefits to offset the opportunity costs resulting from mothers' career breaks, childcare policies aim to completely avoid such costs by "outsourcing" parents' childcare responsibilities to the public or private sectors. This design facilitates women's combination of work and family and allows women with careers to continue working after childbirth. Since permanently employed women generally have higher involvement in paid work and higher wages, they will benefit more from the reduction in opportunity costs in a more comprehensive childcare system. The expansion of childcare services also "defamilize" the childcare norm, reducing the economic dependency of women on the male-breadwinners and the care dependencies of children on their mothers (Lohmann and Zagel, 2016). This normative change toward an egalitarian gender division of labor may increase the importance of the income effect on female fertility (Baizan et al., 2016; Kalwij, 2010), and thus enlarges fertility differentials between the permanently employed and the unstably employed women. Therefore, I expect:

H4: *The childbirth effects of women's temporary employment and unemployment compared to permanent employment are more negative in countries with higher coverage rates of early childcare services*

2.3 The interplay between employment and policies across parity transitions

Some studies have argued that women's first-birth behavior is influenced by family policies to a less extent than subsequent births (Baizan et al., 2016; Bergsvik et al., 2021). For example, the public childcare expansion in German stimulates women's fertility by increasing their probabilities of second- and third-birth transitions but not the first birth (Bauernschuster et al., 2016). The various policy effects across parity status may result from people's dynamic fertility adaptations to the parity-specific costs of childbirth in different institutional contexts. For women with established careers, the opportunity cost of having one child is already high. Therefore, these women's second-birth transition could be further depressed if childcare supports to substitute the opportunity costs of childbearing are limited (Bratti and Tatsiramos, 2012). Besides, although many family benefits packages are designed to support economically disadvantaged groups by subsidizing the direct costs of childbearing, they might eventually enlarge the fertility gap because the fertility-enhancing effects of these policies might be more prominent for higher-order births among higher-income families (Milligan, 2005; Riphahn and Wiynck, 2017). Bearing in mind these parity heterogeneities, this study separately examines the interplay between women's employment instability and family policies in the first- and second-birth transitions.

3 Data and Method

To test the research hypotheses, multilevel analyses using yearly data at both the micro- and the macro-level are required. Micro-level data are assembled from the 2010-2019 European Union Statistics on Income and Living Conditions (EU-SILC). The EU-SILC panel data in each wave compile comparable socio-economic statistics from nationally representative samples in European countries. Using a rotational panel data design, a new national-representative sample is drawn every year and is followed up for four years before being replaced by another rotation group. Between years 2010 and 2019, more than 500,000 women from 32 countries are interviewed. Macro-level data on family policies and other characteristics come from multiple sources including the OECD Family Database, the OECD tax-benefit model (TaxBEN), Eurostat, and ILOSTAT. Macro data are combined with EU-SILC data from all country-rounds between 2010 and 2019. Restricting the analyses to country-rounds where macro data are available results in a gross sample of 210 country-rounds nested in 27 countries. Bulgaria, Cyprus, Malta, Romania, and Russia are excluded from the analyses because yearly data for at least one macro variable are unavailable.

Supplementary Material S1 provides details about the data sources in each available country-rounds.

3.1 Micro-level data and variables

To utilize EU-SILC data's longitudinal traits, I select women who were first interviewed between the years 2010 and 2018 and were re-interviewed at least for another wave in the subsequent years. This sample selection secures the correct causal temporality for modeling the effect of her employment status in year *t* on her probability of a birth transition in year *t+1*. To include partners' information as controls, I restrict the investigation to heterosexual women who lived with their married or cohabited male partners during the interview.

The dependent variables are the first and the second birth events in year *t+1*, measured as time-varying binary variables (0=no event; 1=birth event). I construct two analytical subsamples for parity-specific analyses. All person-years from women who are at risk of a specific birth event are included in the subsample until the event occurred, union dissolution, or the date of panel exit. Following previous research (Greulich and Dasré, 2017; Nitsche et al., 2018), I use the number of coresident children reported in the EU-SILC household roster to specify a woman's parity status at her first entry. The occurrence of a birth event in the consecutive panel years can be identified using the newly-included child's status identifier—a newborn since the last interview. Following Greulich and Dasré's (2017) suggestion, I restrict the analyses to the first and the second birth transitions for women between ages 16 and 40 because using the number of coresident children in EU-SILC data to proximate women's parity status is downward biased for those who aged more than 40 or had more than 2 children. The final sample for the first birth includes 24,944 observations from 14,576 women, with a first-birth transition probability of 14.91% (3,719 birth events). For the second birth, 25,003 observations from 14,157 women are obtained, with a second-birth transition probability of 12.97% (3,243 birth events).

The key independent variable is women's employment status in year *t*. I use respondents' self-defined working status to differentiate between the employed and the non-employed women. Among the employed, the contract status of women's current job is further applied to distinguish between permanent employment by open-ended contracts, temporary employment by fixed-term contract, and self-employment. Among the non-employed, I distinguish between labor market inactive and unemployed women. For this research, the statuses of self-employment and inactivity are excluded from analyses because theoretical discussions covered in the previous section do not apply. To test the research hypotheses where unstable

employment is compared against stable employment, the key independent variable comprises three categories: 1=permanent employment, 2=temporary employment, and 3=unemployment.

All analyses control for a set of variables that could theoretically confound the relationship between female employment and childbirth (Mills et al., 2011). These variables include women's educational background (1=low (ISCED 0-2), 2=middle (ISCED 3-4), 3=high (ISCED 5-8)), women's self-rated health status (0=good/fair health, 1=bad health), and women's age and its squared term.

From a couple perspective, women's employment and childbirth are also influenced by their male partners' characteristics (Barbieri et al., 2015; Nitsche et al., 2018). To rule out these confounding factors, I control for the current union status (0=married, 1=non-marriage partnership) and the male partners' age (and its squared term), educational level (1=low (ISCED 0-2), 2=middle (ISCED 3-4), 3=high (ISCED 5-8)), and working status (1=working, 2=unemployed, and 3=inactive). All control variables are measured in year *t* to align with the key independent variable. Table 1 provides the descriptive statistics on micro-level variables.

Some micro-level variables have a small portion of missing data. To handle this issue in a multilevel framework, I apply multiple imputations with chained equations (MICE) to create 10 imputed datasets for each country. Multilevel analyses are performed using each imputed dataset. The results of coefficient and standard error estimates across 10 analyses are combined using Rubin's rules. Supplementary Material S2 provides details about the imputation models and diagnostics.

3.2 Macro-level data and variables

Time-varying indicators about specific family policy provisions and the institutional background at the country level are used to complement the EU-SILC data. The key macro variables of interest are the three family policy indicators that are hypothesized to moderate the employment instability-childbirth relationship. Rather than using policy expenditures as proxies (Kalwij, 2010), this study focuses on the contents of the policy measures to emphasize their roles in shaping people's childbirth responses (Billingsley and Ferrarini, 2014; Daly and Ferragina, 2018).

First, the generosity of family benefits through cash transfers or tax breaks is calculated from the OECD TaxBEN model, which incorporates detailed benefits and tax rules in the EU and OECD countries for income simulation. By setting the parameters regarding household size and income, the TaxBEN calculates the sum of family benefits received by the hypothetical family. Following the methodology of Gauthier (2007) and Thévenon (2011), I

measure the generosity of family benefit as its equivalent percentage of a full-time earner's average wages in a country (% AW). To highlight the wage-replacement effects of family benefits for women who interrupt paid work for childbirth, the hypothetical family is set as a single-earner 100% work-time family with a 2-year-old child.

Table 1. Descriptive statistics on micro-level variables

	First-birth sample		Second-birth sample	
	Mean; %	SD	Mean; %	SD
Dependent variables				
Birth probability	0.149	0.356	0.130	0.336
Key independent variable				
Women's employment status				
Permanent employment	70.3		70.3	
Temporary employment	18.3		14.2	
Unemployment	11.4		15.4	
Control variables				
Women's age	29.827	4.738	32.918	4.282
Women's educational level				
Low (ISCED 0-2)	7.2		12.5	
Middle (ISCED 3-4)	38.2		45.1	
High (ISCED 5-8)	53.8		42.1	
missing	0.8		0.3	
Women's health				
Good/fair health	95.2		94.7	
Bad health	1.2		1.9	
missing	3.6		3.4	
Marital status				
Married	44.9		73.1	
Non-marriage partnership	55.1		26.9	
missing	0.1		0.0	
Men's age	32.762	6.334	36.110	5.813
Men's educational level				
Low (ISCED 0-2)	12.2		18.6	
Middle (ISCED 3-4)	45.0		51.0	
High (ISCED 5-8)	39.0		28.1	
missing	3.8		2.3	
Men's working status				
Working	89.0		90.5	
Unemployed	5.5		6.7	
Inactive	3.2		2.1	
missing	2.3		0.8	
Observations	24,944		25,003	

Second, the full-rate-equivalent (FRE) paid leaves for mothers measure the total length of full-time paid leaves during which individuals' incomes are compensated at 100 percent average rates of salary (Thévenon, 2011). The indicator is widely used by policy researchers to capture the progressiveness of childcare leave provisions (Baizan et al., 2016; Bergsvik et al., 2021; Daly and Ferragina, 2018). It is calculated by multiplying the duration of leaves and the wage-replacement rates of benefits during the leaves. Following previous studies, both FRE maternity and parental leaves entitled to mothers are added up to a single indicator representing the total length of paid leaves in weeks. Time-series data on maternity and parental leaves since the year 2010 are collected from different releases of the OECD Family Database on a biannual basis. Missing values in the gap years (i.e., 2011, 2013, 2015, 2017) are interpolated using the country averages of the nearby years.

Third, the childcare coverage rate for children under three, collected from the OECD Family Database, captures the comprehensiveness of a country's formal childcare policies. The indicator measures the percentage of 0- to 2-year-old children enrolled in center-based childhood education and care services. It is worth noticing that this indicator refers to the total coverage rate from both public and private childcare participation. Therefore, some countries with limited public childcare provisions may have relatively high childcare coverage rates (e.g., the UK). Nevertheless, this indicator is usually referred to as the central component in capturing a country's policy orientation on care provisions (Billingsley and Ferrarini, 2014; Thévenon, 2011) and has been frequently applied to cross-national comparative studies (Baizan et al., 2016).

Besides the three moderators, the multilevel models include macro-level control variables that may confound the associations between women's employment and childbirth. The purchasing-power-adjusted GDP per capita is included to adjust for country differences in economic development, which may influence women's employment and fertility behaviors (Mills et al., 2011). Yearly data of GDP per capita, measured continuously in 1,000 Euro, come from Eurostat. To account for the procyclical nature of female employment and fertility (Sobotka et al., 2011), the models include period dummy variables (years 2010-2012, years 2013-2015, and years 2016-2018) and country-level unemployment rates for active workers aged 15-64 (continuous variable). Data on unemployment rates come from either Eurostat or ILOSTAT. Finally, to adjust for labor market institutions that affect the employment status-childbirth relationship (Karabchuk, 2020), I include an indicator measuring the strictness of employment protection against individual dismissals of regular workers (EPLR) and an indicator measuring the strictness of hiring temporary workers (EPLT). These data come from

the OECD Employment Protection Database's EPR_V3 and EPT_V3 indicators, which are composite indicators of 9 and 8 items scaling from 0 (unregulated) to 6 (fully regulated). Table 2 provides descriptive statistics on the macro-level variables for each country. All macro-level variables are measured in year *t*.

3.3 Modeling and estimation strategy

Three types of models are applied in this study for different purposes. First, to estimate the average effects of employment instability on women's childbirth across Europe, I estimate ordinary least squares regressions (OLS) with period and country fixed effects. Linear probability models (LPM) are applied for each birth transition (see Supplementary Material S3 for the application of LPM models in childbirth research). In each model, a woman *i*'s probability of a specific birth *y* in time *t+1* is defined by the following equation:

$$P\left(y_{(t+1)i} = 1 \middle| \boldsymbol{X}_{ti}\right) = \beta_0 + \boldsymbol{X}_{ti}\boldsymbol{\beta_p} + \boldsymbol{\beta_t} + \boldsymbol{\beta_c} + \varepsilon_i \quad (1)$$

where β_0 reflects the grand average of the birth probability. The vector $\boldsymbol{X}_{ti}$ includes *p* micro-level variables for individual *i* measured in time *t*, such as women's employment status. Their corresponding parameters are presented as the vector $\boldsymbol{\beta_p}$. I also include a set of period and country dummies in the model to account for the period fixed effects $\boldsymbol{\beta_t}$ and the country fixed effects $\boldsymbol{\beta_c}$. By specifying these two fixed effects, the model controls for the time-variant common factors (e.g., common economic shock) and the time-invariant country-specific factors (e.g., cultural regimes). Finally, the ε_i is the idiosyncratic error term for each individual. Given a correct model specification, the coefficient estimates $\boldsymbol{\beta_p}$ denote the European average effects of the micro-level variables on women's birth probabilities. To account for the nesting structure and potential heteroscedasticity, standard errors are clustered at the country level.

Secondly, to reveal the cross-national heterogeneity of the micro-level effects, I use the same model in Equation (1) but without country fixed effects to fit 27 country-specific OLS-LPM models for each country. The coefficient estimates $\boldsymbol{\beta_p}$ in these models denote the country average effects of the micro-level variables on women's birth probabilities.

Thirdly, to test the research hypotheses regarding how macro-level policy contexts moderate the micro-level effects of employment instability, I apply a three-level mixed-effects LPM model with cross-level interactions. The model can be written as follows:

$$P\left(y_{c(t+1)i}=1\middle|\boldsymbol{X}_{cti},\boldsymbol{Z}_{ct}\right)=\beta_0+\boldsymbol{\beta_t}+\boldsymbol{X}_{cti}\boldsymbol{\beta_p}+\boldsymbol{Z}_{ct}\boldsymbol{\beta_q}+\boldsymbol{X}_{cti}\boldsymbol{Z}_{ct}\boldsymbol{\beta_{pq}}$$
$$+v_c+u_{ct}+e_{cti}+\boldsymbol{U}_c\boldsymbol{X}_{cti} \quad (2)$$

where the left-hand side is individual *i*'s probability of a specific birth *y* in time *t+1* in country *c*. Different from the pooled model in Equation (1), the mixed-effects model on the right-hand side accounts for country variations in micro- and macro-level variables and allows such effects to vary across *c* countries. The "fixed part" of the model estimates the following terms: the grand average of the birth probability β_0, the period fixed effects $\boldsymbol{\beta_t}$. The effects of *p* micro-level variables $\boldsymbol{X}_{cit}$ are denoted by $\boldsymbol{\beta_p}$. The effects of *q* macro-level variables $\boldsymbol{Z}_{ct}$ are denoted by $\boldsymbol{\beta_q}$. The parameter estimates of $\boldsymbol{\beta_{pq}}$ for the cross-level interactions $\boldsymbol{X}_{cti}\boldsymbol{Z}_{ct}$ reflect the moderating effects of the country- and time-variant family policy indicators on the micro-level relationship between employment instability and childbirth. The "random part" of the model includes three variance components v_c (country level), u_{ct} (country-round level), and e_{cti} (individual level) to account for country and country-round variances of women's average birth probability (i.e., the random intercepts). It also includes two random slopes $\boldsymbol{U}_c$ at the country level for women's temporary employment and unemployment statuses to capture the unexplained contextual variations in their effects (Heisig and Schaeffer, 2019). I use the restricted maximum likelihood (REML) estimator for model estimation. These models are performed in the statistical software STATA (version 17) using the "mixed" command.

Table 2. Descriptive statistics on macro-level variables by country.

Country	ISO Code	Family benefits for one-child family (% AW) [a]		Length of FRE paid leaves for mothers (in weeks) [b]		Childcare coverage rate for children under 3 (%) [c]		GDP per capita (in 1,000 EUR)		Unemployment rate (%)		Employment protection legislation (EPL) – individual dismissals		N (number of country-round)	n (number of observations)
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Austria	AT	16.4	2.3	54.5	3.3	17.0	3.7	35.3	1.9	5.3	0.5	2.1	0.0	9	1,976
Belgium	BE	2.4	0.0	18.8	4.8	47.1	5.6	32.7	1.8	7.6	0.8	2.1	0.2	9	2,553
Czechia	CZ	20.8	3.2	54.8	4.0	4.5	2.1	23.8	2.3	5.3	1.8	3.2	0.1	9	2,346
Germany	DE	4.7	0.1	43.0	1.1	29.9	1.7	36.1	1.1	3.9	0.4	2.4	0.0	4	1,176
Denmark	DK	4.4	0.1	26.7	0.1	70.3	4.8	34.9	2.0	6.8	0.9	1.4	0.0	9	606
Estonia	EE	6.7	0.7	99.2	11.8	23.1	4.3	21.1	2.2	8.1	2.9	1.7	0.0	9	1,762
Greece	GR	1.6	0.6	22.0	2.0	17.6	10.3	19.4	0.5	22.9	3.1	2.4	0.1	9	2,846
Spain	ES	0.0	0.0	16.0	0.0	39.3	4.4	24.7	1.4	21.7	3.3	2.0	0.1	9	4,051
Finland	FI	16.0	0.5	42.3	1.5	31.2	3.3	30.9	1.3	8.3	0.6	2.3	0.0	9	1,762
France	FR	4.2	1.5	27.4	11.5	46.2	4.5	29.7	1.3	9.7	0.5	2.7	0.0	9	2,256
Croatia	HR	0.0	0.0	39.5	0.9	15.2	2.1	17.8	1.0	12.4	2.7	2.3	0.0	4	733
Hungary	HU	16.5	2.0	87.4	10.5	11.3	3.3	18.1	1.4	8.7	2.7	1.6	0.2	9	2,607
Ireland	IE	3.8	0.2	9.4	1.2	29.7	4.1	42.5	9.3	11.4	3.6	1.3	0.1	9	1,040
Italy	IT	2.7	1.2	24.6	0.7	25.5	4.1	27.1	1.1	10.9	1.5	2.7	0.2	9	4,064
Lithuania	LT	1.0	1.5	62.0	0.0	16.9	4.4	22.7	1.6	7.4	1.1	2.3	0.2	4	412
Luxembourg	LU	5.7	0.2	27.2	2.0	52.2	5.5	73.6	4.0	5.9	0.5	2.2	0.0	8	1,562
Latvia	LV	1.3	0.1	52.7	0.7	26.5	2.4	19.2	1.2	9.0	1.0	2.8	0.0	4	637
Netherlands	NL	1.6	0.1	18.8	2.3	51.4	5.5	36.1	1.6	5.6	1.1	3.4	0.1	9	1,658
Norway	NO	3.4	3.0	40.7	3.3	50.2	4.3	45.5	2.7	3.9	0.5	2.2	0.0	9	732
Poland	PL	0.0	0.0	47.0	6.6	6.3	3.0	18.4	1.7	8.0	2.3	2.3	0.0	9	4,750
Portugal	PT	1.6	0.6	20.7	0.4	44.9	5.5	21.6	1.3	11.6	3.0	3.2	0.3	9	3,486
Sweden	SE	3.1	0.2	41.4	5.6	53.7	4.2	34.4	1.2	7.5	0.7	2.5	0.0	9	954
Slovenia	SI	5.2	1.3	49.4	1.5	40.9	3.7	23.6	1.9	7.6	1.6	2.1	0.2	9	1,923
Slovakia	SK	25.6	0.3	50.4	1.6	4.4	1.3	20.1	0.6	13.6	0.7	2.5	0.2	5	888
Switzerland	CH	2.7	0.1	9.2	1.4	29.1	2.3	45.5	1.3	4.7	0.2	1.3	0.0	6	1,120
Iceland	IS	1.8	0.5	16.2	0.3	43.9	6.8	32.4	2.1	5.5	1.2	1.9	0.0	6	201
UnitKingdom	UK	3.5	0.7	14.8	4.1	30.3	2.7	28.8	1.0	7.2	1.0	1.5	0.1	7	1,846
All		6.0	6.8	35.9	22.7	30.5	16.5	29.6	11.5	9.7	5.6	2.3	0.6	210	49,947

Notes:

a. This statistic denotes the maximum benefits that can be received by a hypothetical single-earner household with one child aged 2 years, measured as the percentage of the average worker's wages.

b. Full-rate equivalent (FRE) method measures the length of full-time paid leaves during which individuals' income are compensated at 100 percent average rates of salary The length of FRE leaves equals the duration of maternal and parental leaves in weeks times the income replacement rates for each. The statistics only include leave payments by the states; employers' "top-ups" payments are not included.

c. This statistic measures the percentage of 0- to 2-year-old children enrolled in early childhood education and care services (ECEC).

4 Results

4.1 European and country-specific effects of employment instability on childbirth

Table 3 presents the first analysis of the European average effects of employment instability on women's first and second births. To evaluate the social significance and uncertainty of estimated effects, I follow Bernardi et al.'s (2017) approach to benchmark the point estimates and 90% confidence intervals against substantively meaningful valuess.[4] A 10% increase or decrease in the average birth transition probability is identified as the minimum relevant value ($\theta_{1st\ birth}$=±0.015; $\theta_{2nd\ birth}$=±0.013), while a 100% increase or decrease in the average birth transition probability serves the maximum plausible value ($\theta_{1st\ birth}$=±0.15; $\theta_{2nd\ birth}$=±0.13). In line with H1, Model 1 shows that temporary employment has a negative effect on women's first-birth transition. On the European average, being temporarily employed, compared to being permanently employed, decreases women's first-birth probability by –2.8 percentage points (*CI*=[–0.040, –0.017]). The negative effect is statistically and substantively significant, which amounts to a 19% decrease in the first-birth transition probability in our sample. On the other hand, the European average effect of unemployment on women's first birth is neither substantial nor statistically significant (β=–0.003, *CI*=[–0.018, 0.013]). These results echo the recent findings from a meta-analysis of 34 European studies (Alderotti et al., 2021), which showed that women's temporary employment has a more negative effect than unemployment on European women's first-birth transition. However, comparing in terms of odds ratio (OR) [5], the estimated effect of temporary employment on women's first birth (*OR*=0.79) is more negative than that in the meta-analysis (*OR*=0.90, from Alderotti et al., 2021: Table 9).

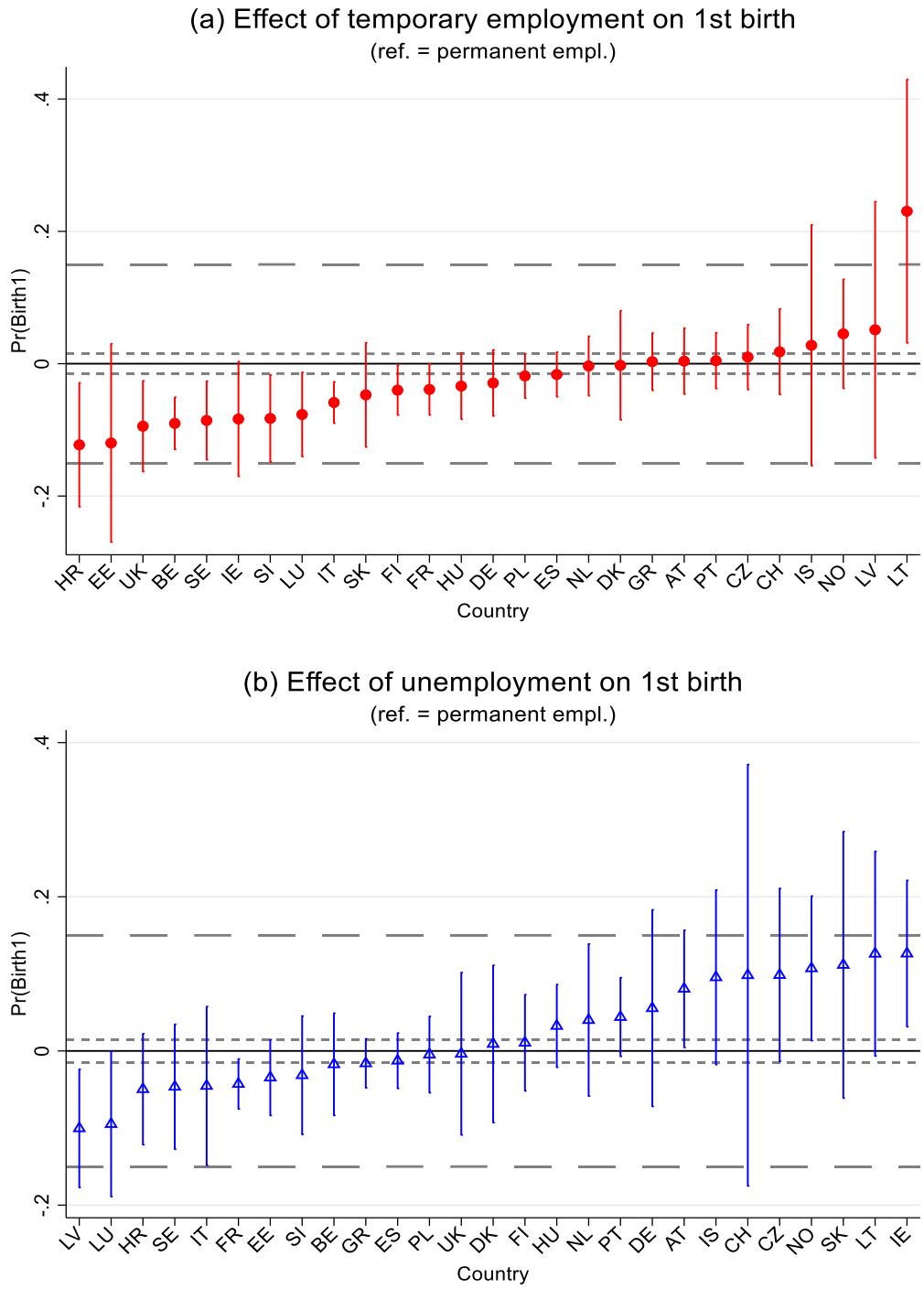
Among women with one child, Model 2 shows that temporary employment compared to permanent employment decreases the second-birth probability by –0.9 percentage points (*CI*=[–0.023, 0.006]). Being unemployed decreases women's second-birth probability also by –0.9 percentage points (*CI*=[–0.019, 0.001]). While both effects are not statistically smaller than zero according to the 5% one-tailed significance test, their lower CIs overlap with the substantively meaningful values. Therefore, I suggest a cautious interpretation of the minor negative effects of employment instability on women's second birth while acknowledging the uncertainty of these estimates.

Table 3. Pooled ordinary least squares linear probability models of women's first- and second-birth probabilities.

	Model 1 First-birth transition (n=24,944)			Model 2 Second-birth transition (n=25,003)		
	β	*90% CIs*		*β*	*90% CIs*	
Employment status (Ref.=Permanent employment)						
Temporary employment	-0.028	[-0.040,	-0.017]	-0.009	[-0.023,	0.006]
Unemployment	-0.003	[-0.018,	0.013]	-0.009	[-0.019,	0.001]
Control variables						
Women's age	0.043	[0.029,	0.057]	0.038	[0.028,	0.047]
Women's age2	-0.001	[-0.001,	-0.001]	-0.001	[-0.001,	-0.001]
Women's education (Ref.=Low, ISCED 0-2)						
Middle (ISCED 3-4)	0.010	[-0.007,	0.027]	0.012	[-0.006,	0.030]
High (ISCED 5-8)	0.028	[0.007,	0.049]	0.051	[0.032,	0.070]
Women's health (Ref.=Good/fair health)						
Bad health	-0.059	[-0.093,	-0.024]	-0.050	[-0.074,	-0.025]
Marital status (Ref.=Married)						
Non-marriage partnership	-0.098	[-0.116,	-0.081]	-0.011	[-0.020,	-0.001]
Men's age	-0.003	[-0.004,	-0.002]	-0.004	[-0.005,	-0.003]
Men's education (Ref.=Low, ISCED 0-2)						
Middle (ISCED 3-4)	-0.013	[-0.028,	0.003]	0.002	[-0.011,	0.016]
High (ISCED 5-8)	-0.012	[-0.029,	0.006]	0.035	[0.019,	0.050]
Men's working status (Ref.=Working)						
Unemployed	-0.015	[-0.028,	-0.002]	-0.005	[-0.018,	0.008]
Inactive	-0.059	[-0.078,	-0.040]	-0.021	[-0.042,	0.000]
Country fixed effects	✓			✓		
Period fixed effects	✓			✓		

Notes: Standard errors are clustered by country.

Figure 1. Country-specific effects of women's temporary employment and unemployment on the first-birth probability.



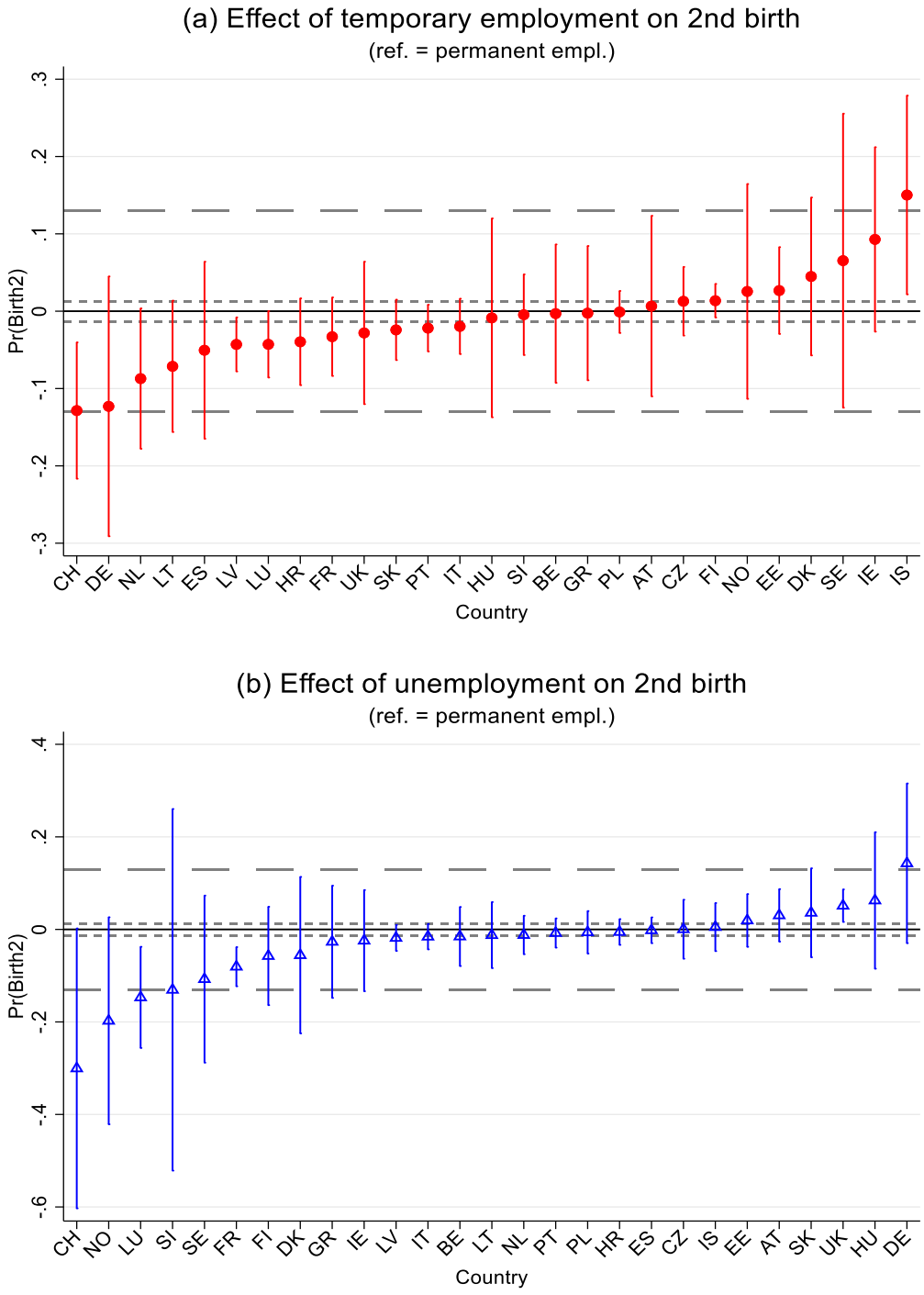
Notes: Marginal effects estimates with 90% confidence intervals are based on country-specific OLS-LPM models. In each panel, the dotted lines present the 10% average first-birth probability deviations from 0 (±0.015), which I use to benchmark the minimum relevant values of a negative or positive estimate. The dash lines present the one average first-birth probability deviations from 0 (±0.15), which I use to benchmark the maximum plausible values of a negative or positive estimate.

The second analysis further explores cross-national heterogeneity in the employment instability-childbirth nexus. Figure 1 presents the country-specific OLS-LPM results on women's first-birth transition. Figure 1-a shows that cross-national variations in the effect of temporary employment are remarkable. On one hand, negative effect estimates of temporary employment on first birth are observed in more than half of the European countries (18 out of 27), among which I identify the estimates for France, Finland, Italy, Luxembourg, Slovenia, Sweden, Belgium, the UK, and Croatia as substantively important and statistically plausible. The most negative effect is observed in Croatia, where temporarily employed women have a –12.3 percentage points (*CI*=[–0.216, –0.029]) lower probability of the first-birth transition than the permanently employed. The other substantively negative effects observed in Italy (Barbieri et al., 2015; Vignoli et al., 2020), France (Pailhé and Solaz, 2012), Finland (Sutela, 2012), and Sweden (Lundström and Andersson, 2012) are largely in line with previous research. On the other hand, being temporarily employed might be linked to higher first-birth probabilities in some countries. However, all positive effect estimates are either lacking statistical confidence or implausibly large (i.e., Lithuania). The effect of unemployment on women's first birth is also heterogeneous (Figure 1b), ranging from the most negative effect in Latvia (β=–0.100, *CI*=[–0.177, –0.024]) to the most positive effect in Ireland (β=0.126, *CI*=[0.031, 0.221]). However, wide confidence intervals are observed in many countries whose effect sizes are substantive, indicating rather high statistical uncertainties in these estimates. Nevertheless, the cross-national divergent effects of female unemployment versus permanent employment on the first-birth transition are largely in line with previous country-specific studies, such as the negative effect in France or the positive effect in Germany (González and Jurado-Guerrero, 2006).

Figure 2-a presents country-specific effects of women's temporary employment on second birth. The most negative effect is observed in Switzerland, where temporarily employed women have –12.8 percentage points (*CI*=[–0.217, –0.040]) lower probability of second-birth transition than the permanently employed. While the effect point estimates are substantively negative in 13 countries and substantively positive in six countries (excluding the implausibly large positive effect in Iceland), their confidence intervals mostly contain zero and thus cannot confidently rule out the null hypothesis of a zero effect. Similarly, Figure 2-b shows that although women's unemployment might have substantively negative effects on second birth in several European countries, the rather wide confidence intervals or implausibly large values indicate high uncertainty in these estimates. Despite these statistical uncertainties, Figure 1 and Figure 2 still provide crucial evidence that the influence of

women's employment instability on birth transitions could go in both directions (i.e., birth enhancing or depressing effects) and differ considerably across countries. To tackle the moderating role of family policies behind these variations, the following section applies multilevel regressions to test Hypotheses 2-4.

Figure 2. Country-specific effects of women's temporary employment and unemployment (vs. permanent employment) on the second-birth probability.



Notes: Marginal effects estimates with 90% confidence intervals are based on country-specific OLS-LPM models. In each panel, the dotted lines present the 10% average second-birth probability deviations from 0 (±0.013), which I use to benchmark the minimum relevant values of a negative or positive estimate. The dash lines present the one average second-birth probability deviations from 0 (±0.13), which I use to benchmark the maximum plausible values of a negative or positive estimate.

second-birth transition than the permanently employed. While the effect point estimates are substantively negative in 13 countries and substantively positive in six countries (excluding the implausibly large positive effect in Iceland), their confidence intervals mostly contain zero and thus cannot confidently rule out the null hypothesis of a zero effect. Similarly, Figure 2-b shows that although women's unemployment might have substantively negative effects on second birth in several European countries, the rather wide confidence intervals or implausibly large values indicate high uncertainty in these estimates. Despite these statistical uncertainties, Figure 1 and Figure 2 still provide crucial evidence that the influence of women's employment instability on birth transitions could go in both directions (i.e., birth enhancing or depressing effects) and differ considerably across countries. To tackle the moderating role of family policies behind these variations, the following section applies multilevel regressions to test Hypotheses 2-4.

4.2 The moderating role of family policies

Table 4 presents the results of multilevel mixed-effects models on women's first-birth transition. Model 1 includes micro and macro control variables as well as country and country-round random intercepts. Country random slopes for women's employment status are also specified. Model 1 reconfirms Table 3's findings: on the European average, women's temporary employment compared to permanent employment has a negative effect on first-birth transition (β=–0.028, *CI*=[–0.039, –0.017]), while the effect of unemployment is neither substantive nor statistically significant (β=0.003, *CI*=[–0.013, 0.018]).

Models 2 to 4 include cross-level interactions between women's employment status and the three family policy indicators to estimate how micro-level effects of women's employment instability differ across policy contexts. First, results from Model 2 indicate that the effects of women's temporary employment and unemployment on first birth are more positive in countries with more generous family cash benefits. The direction of the moderating effects is in line with H2, although only the moderating effect on the unemployment-first birth relationship is statistically larger than zero.

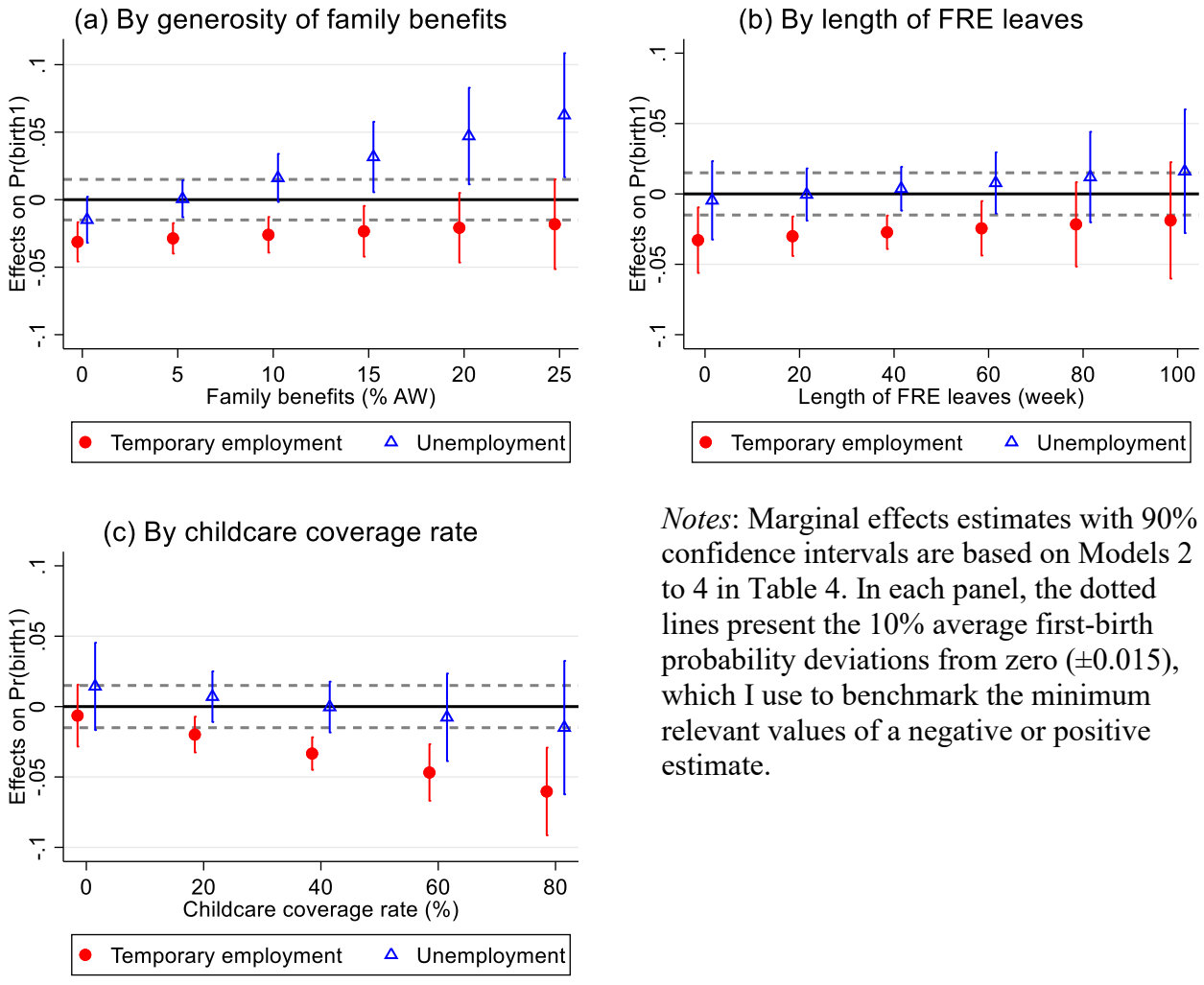
Table 4. Multilevel mixed-effects linear probability models of women's first-birth probability

	Model 1			Model 2			Model 3			Model 4		
	β	*90% CIs*		*β*	*90% CIs*		*β*	*90% CIs*		*β*	*90% CIs*	
Employment status (Ref.=Permanent employment)												
Temporary employment	-0.028	[-0.039,	-0.017]	-0.031	[-0.046,	-0.017]	-0.033	[-0.056,	-0.010]	-0.006	[-0.028,	0.016]
Unemployment	0.003	[-0.013,	0.018]	-0.015	[-0.032,	0.002]	-0.005	[-0.032,	0.023]	0.014	[-0.017,	0.045]
Micro-level control variables	✓			✓			✓			✓		
Period fixed effects	✓			✓			✓			✓		
Macro-level variables												
GDP per capita	-0.001	[-0.002,	0.001]	-0.001	[-0.002,	0.001]	-0.001	[-0.002,	0.001]	-0.001	[-0.002,	0.001]
Unemployment rate	-0.001	[-0.003,	0.001]	-0.001	[-0.003,	0.001]	-0.001	[-0.003,	0.001]	-0.001	[-0.003,	0.001]
EPLR	0.015	[-0.004,	0.034]	0.015	[-0.004,	0.034]	0.015	[-0.004,	0.034]	0.015	[-0.003,	0.034]
EPLT	-0.008	[-0.023,	0.008]	-0.008	[-0.023,	0.008]	-0.008	[-0.023,	0.008]	-0.008	[-0.023,	0.008]
Family benefits (10% AW)	-0.008	[-0.026,	0.010]	-0.011	[-0.029,	0.008]	-0.008	[-0.026,	0.010]	-0.008	[-0.026,	0.010]
Length FRE leaves (10 weeks)	0.003	[-0.003,	0.009]	0.003	[-0.003,	0.009]	0.003	[-0.003,	0.008]	0.003	[-0.003,	0.009]
Childcare coverage rates (10%)	0.005	[-0.002,	0.013]	0.005	[-0.002,	0.013]	0.006	[-0.002,	0.013]	0.007	[0.000,	0.014]
Cross-level interactions												
Temp. empl. * Family benefits				0.005	[-0.011,	0.021]						
Unempl. * Family benefits				0.031	[0.009,	0.053]						
Temp. empl. * Length FRE leaves							0.001	[-0.005,	0.007]			
Unempl. * Length FRE leaves							0.002	[-0.004,	0.009]			
Temp. empl. * Childcare coverage										-0.007	[-0.013,	-0.001]
Unempl. * Childcare coverage										-0.004	[-0.013,	0.005]
Constant	-0.332	[-0.488,	-0.177]	-0.332	[-0.488,	-0.176]	-0.333	[-0.489,	-0.178]	-0.340	[-0.495,	-0.184]
Variance components (random part)												
Country variance (U_c^2(Temp. empl.))	0.013	(0.011)		0.013	(0.011)		0.014	(0.011)		0.008	(0.016)	
Country variance (U_c^2(Unempl.))	0.021	(0.013)		0.013	(0.016)		0.021	(0.014)		0.023	(0.013)	
Country variance (v_c^2)	0.030	(0.007)		0.031	(0.007)		0.030	(0.007)		0.030	(0.007)	
Country-round variance (u_{ct}^2)	0.022	(0.004)		0.022	(0.004)		0.022	(0.004)		0.022	(0.004)	
Individual variance (e_{cti}^2)	0.350	(0.002)		0.350	(0.002)		0.350	(0.002)		0.350	(0.002)	
n (observations)	24,944			24,944			24,944			24,944		
N (country-rounds)	210			210			210			210		
M (countries)	27			27			27			27		

Notes: Standard errors of the variance components instead of confidence intervals are presented in the parentheses.

Second, Model 3 indicates that countries with longer paid leaves for mothers tend to have slightly more positive effects of temporary employment and unemployment on women's first-birth probability. However, both moderating effects are substantively negligible and statistically insignificant. Third, Model 4 suggests that more negative effects of employment instability on women's first-birth transition are observed in countries with high childcare coverage rates. These results are in line with H4, although only the moderating effect on the temporary employment-first birth relationship is statistically negative.

Figure 3. Effects of women's temporary employment and unemployment (vs. permanent employment) on the first-birth probability by level of family policy indicators.



Notes: Marginal effects estimates with 90% confidence intervals are based on Models 2 to 4 in Table 4. In each panel, the dotted lines present the 10% average first-birth probability deviations from zero (±0.015), which I use to benchmark the minimum relevant values of a negative or positive estimate.

To better illustrate these findings, Figure 3 plots the effects of temporary employment and unemployment on the first-birth probability (y-axis) against the respective policy indicators (x-axis). In Figure 3-a, the steep blue line indicates that more generous family benefits may alleviate the negative effect of women's unemployment on the first-birth

transition. In contrast to the substantively negative effect of unemployment found in countries with zero family benefit (e.g., Spain 2015), a substantively positive effect of women's unemployment on first-birth transition is found in countries with family benefits up to 25% AW (e.g., Slovakia 2015). Figure 3-b shows that the effects of women's temporary employment and unemployment on first birth depend less on the length of FRE leaves. Finally, Figure 3-c shows that women's employment instability, particularly being temporarily employed, has more negative effects in countries with higher childcare coverage rates. While temporary employment decreases women's first-birth probability only by –2 percentage points in countries with 20% childcare coverage rates (e.g., Austria 2016), it substantially decreases women's first-birth probability by –4.7 percentage points in countries with 60% childcare coverage rates (e.g., the Netherlands 2017).

Table 5 presents the results of multilevel mixed-effects models on women's second-birth transition. In line with Table 3's results, Model 1 shows that women's temporary employment (β=–0.008, *CI*=[–0.022, 0.006]) and unemployment (β=–0.008, *CI*=[–0.022, 0.006]) compared to permanent employment *on average* has negative yet insubstantial effects on second-birth transition.

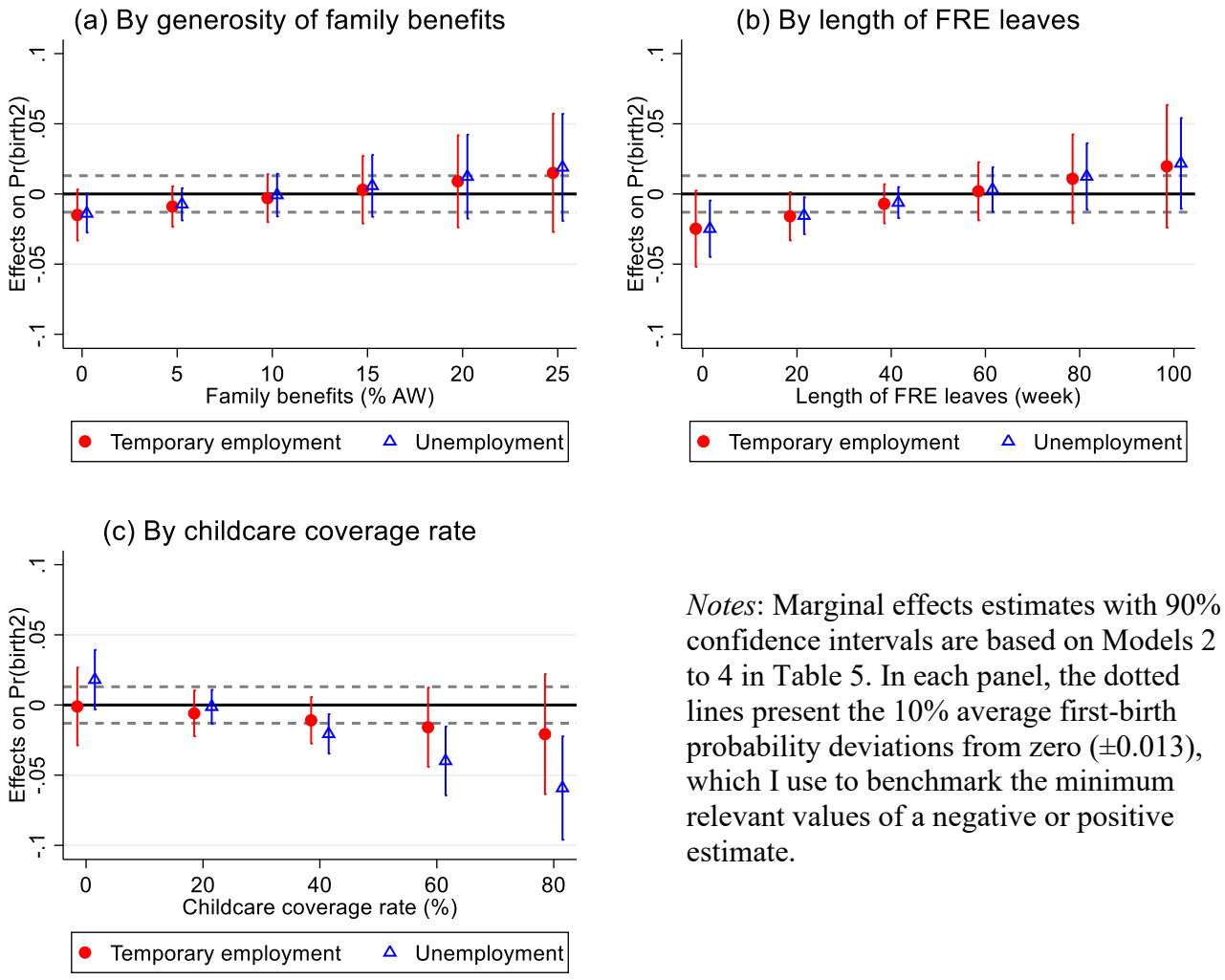
Models 2 to 4 in Table 5 further examine the moderating roles of family policies on women's second birth. First, Model 2 suggests that the effect of women's temporary employment and unemployment on second birth might be more positive in countries with more generous family benefits schemes. While the estimated effects are in line with the predictions in H2, the relatively wide confidence intervals indicate a higher degree of statistical uncertainty. Second, Model 3 shows that countries with longer paid leaves for mothers tend to observe a more positive effect of employment instability on women's second-birth probability. Although these effect sizes seem to be small and statistically insignificant, their moderating effects could become substantial with a large increase in leave provisions. Third, Model 4 suggests that higher childcare coverage rates associate with a more negative effect of women's employment instability, particularly due to unemployment, on the second-birth transition (in line with H4).

Table 5. Multilevel mixed-effects linear probability models of women's second-birth probability

	Model 1		Model 2		Model 3		Model 4	
	β	90% CIs	β	90% CIs	β	*90% CIs*	*β*	*90% CIs*
Employment status (Ref.=Permanent employment)								
Temporary employment	-0.008	[-0.022, 0.006]	-0.015	[-0.033, 0.003]	-0.033	[-0.056, -0.010]	-0.006	[-0.028, 0.016]
Unemployment	-0.008	[-0.019, 0.003]	-0.014	[-0.028, 0.000]	-0.005	[-0.032, 0.023]	0.014	[-0.017, 0.045]
Micro-level control variables	✓		✓		✓		✓	
Period fixed effects	✓		✓		✓		✓	
Macro-level variables								
GDP per capita	0.002	[0.000, 0.003]	0.002	[0.000, 0.003]	-0.001	[-0.002, 0.001]	-0.001	[-0.002, 0.001]
Unemployment rate	-0.004	[-0.006, -0.002]	-0.004	[-0.006, -0.002]	-0.001	[-0.003, 0.001]	-0.001	[-0.003, 0.001]
EPLR	0.020	[-0.003, 0.042]	0.020	[-0.003, 0.042]	0.015	[-0.004, 0.034]	0.015	[-0.003, 0.034]
EPLT	-0.017	[-0.035, 0.002]	-0.016	[-0.035, 0.002]	-0.008	[-0.023, 0.008]	-0.008	[-0.023, 0.008]
Family benefits (10% AW)	-0.013	[-0.034, 0.009]	-0.015	[-0.037, 0.006]	-0.008	[-0.026, 0.010]	-0.008	[-0.026, 0.010]
Length FRE leaves (10 weeks)	-0.007	[-0.013, 0.000]	-0.007	[-0.014, 0.000]	0.003	[-0.003, 0.008]	0.003	[-0.003, 0.009]
Childcare coverage rates (10%)	-0.003	[-0.012, 0.005]	-0.004	[-0.012, 0.005]	0.006	[-0.002, 0.013]	0.007	[0.000, 0.014]
Cross-level interactions								
Temp. empl. * Family benefits			0.012	[-0.008, 0.032]				
Unempl. * Family benefits			0.013	[-0.004, 0.031]				
Temp. empl. * Length FRE leaves					0.001	[-0.005, 0.007]		
Unempl. * Length FRE leaves					0.002	[-0.004, 0.009]		
Temp. empl. * Childcare coverage							-0.007	[-0.013, -0.001]
Unempl. * Childcare coverage							-0.004	[-0.013, 0.005]
Constant	-0.212	[-0.397, -0.027]	-0.208	[-0.394, -0.022]	-0.333	[-0.489, -0.178]	-0.340	[-0.495, -0.184]
Variance components (random part)								
Country variance (〖U_c〗^2(Temp. empl.))	0.023	(0.012)	0.024	(0.012)	0.014	(0.011)	0.008	(0.016)
Country variance (〖U_c〗^2(Unempl.))	0.007	(0.019)	0.009	(0.014)	0.021	(0.014)	0.023	(0.013)
Country variance (〖v_c〗^2)	0.046	(0.008)	0.047	(0.008)	0.030	(0.007)	0.030	(0.007)
Country-round variance (〖u_ct〗^2)	0.017	(0.004)	0.017	(0.004)	0.022	(0.004)	0.022	(0.004)
Individual variance (〖e_cti〗^2)	0.327	(0.001)	0.327	(0.001)	0.350	(0.002)	0.350	(0.002)
n (observations)	24,944		24,944		24,944		24,944	
N (country-rounds)	210		210		210		210	
M (countries)	27		27		27		27	

Notes: Standard errors of the variance components instead of confidence intervals are presented in the parentheses.

Figure 4. Effects of women's temporary employment and unemployment (vs. permanent employment) on the second-birth probability by level of family policy indicators.



Notes: Marginal effects estimates with 90% confidence intervals are based on Models 2 to 4 in Table 5. In each panel, the dotted lines present the 10% average first-birth probability deviations from zero (±0.013), which I use to benchmark the minimum relevant values of a negative or positive estimate.

Figure 4 illustrates the moderating effects of the three family policies on women's second-birth transition. Figure 4a shows that while women's temporary employment and unemployment might have substantively negative effects on the second-birth transition in countries with no family benefit (e.g., Poland 2015), such negative effects diminish as the level of family benefits increase. In countries with 10% AW family benefits (e.g., Austria 2018), both effects diminish to zero. Similarly, the effects of employment instability become more positive in countries with longer paid leaves for mothers. Figure 4b shows that being temporarily employed or unemployed may substantially decrease women's second-birth probability by 1.6 percentage points in countries with 20 weeks of FRE leaves (e.g., the Netherlands 2014); but such negative effects vanish in countries with 60 weeks of FRE leaves. In countries with very long FRE leaves (e.g., Estonia, averaged around 100 weeks), a

positive linkage between women's employment instability and second-birth probability is found after conditioning on other variables. Finally, Figure 4-c suggests a strong negative moderating effect of childcare provisions on the effect of women's unemployment on second birth. In countries with very low childcare coverage rates (e.g., Czechia), unemployment compared to permanent employment may substantially increase women's second-birth probability. However, in countries where childcare coverage rates are higher than 40% (e.g., France, averaged around 46%), a negative relationship between women's unemployment and second-birth transition becomes dominating.

Besides these main findings, an additional analysis using couple-dyadic data (see Supplementary Material S4) shows that country differences in family policy contexts could also moderate the influences of within-couple employment patterns on birth transitions. Specifically, women's own employment instability regardless of their partners' employment situation would be more detrimental to birth transitions in countries where family policies are geared to support earner-carer combination and defamilization of women's homecare roles (e.g., in Belgium and Luxembourg). On the other hand, in countries where family policies emphasize traditional income support and a high degree of childcare familization (e.g., in Czechia and Slovakia), women's employment instability combined with men's permanent employment might even accelerate birth transitions

5 Discussion

This paper examines how women's employment instability affects women's first and the second birth transitions in Europe. Previous studies on this topic are mainly confined to single-country analyses, which raise concerns about the generalizability of empirical findings. Besides, existing knowledge about how macro-level contexts moderate the strength and direction of such micro-level effect is limited. To fill the gap, this paper proposes a theoretical framework and empirically tests whether the impacts of women's temporary employment and unemployment on their first- and second-birth transitions vary across 27 European countries, and if so, how such cross-national variations are explained by the country-level differences in family policy provisions.

Using multilevel analyses on cross-nationally harmonized data, my first key finding is that women's employment instability, *on the European average*, had a negative effect on the first-birth transition. However, such a statement mainly applied to the negative relationship between women's temporary employment and the first birth. In contrast, no robust evidence

was found regarding the negative effect of women's unemployment on first-birth transition. These findings are in line with a recent meta-analysis of European studies (Alderotti et al., 2021), and the estimated effect sizes are comparable. Regarding the second birth, I found that women's temporary employment and unemployment could negatively affect European women's second-birth transition to some extent. However, these effects were rather small and statistically insignificant. In this regard, previous findings in Alderotti et al.'s (2021) meta-analysis and Adsera's (2011a) comparative study that temporary employment compared to permanent employment significantly delays women's second birth transition are short of robust support from our data. A possible explanation to the inconsistency is that our study covers substantially more countries across Europe than previous research. Most crucially, it is the first comparative study on the micro-level relationship between employment instability and fertility that includes multiple counties in Central Eastern Europe (i.e., CEE, including Poland, Czechia, Hungary, Slovakia, Slovenia, Croatia) and Baltic States (Estonia, Latvia, Lithuania). In a supplementary analysis (see Supplementary Material S5), I found that the average effects of women's temporary employment and unemployment on second-birth transition both became substantively negative once the CEE and Baltic countries were excluded from the estimation sample, while such effects were averagely near zero in CEE and Baltic countries. Such findings indicate that this paper's enlarged analytical scope not only enriches the empirical literature in Europe, which has been underrepresenting the experiences of CEE and Baltic countries (Alderotti et al., 2021), but may also change the effect size of employment instability on fertility when concluding an aggregate *European average effect*.

Taking a closer look into the employment instability-childbirth linkage in Europe, my second analysis revealed that the direction and magnitude of such relationship diverged across European countries. For example, women's temporary employment could substantively decrease the first-birth transition probability in France, Finland, Italy, Luxembourg, Slovenia, Sweden, Belgium, the UK, and Croatia. In contrast, such effects might be positive in Switzerland, Iceland, Norway, Latvia, and Lithuania, despite higher statistical uncertainty in the estimates. The cross-national divergent patterns were also found in the relationships between women's unemployment and the second birth, between women's temporary employment and the second birth, and between women's unemployment and the second birth. In line with the suggestions from previous studies (Adsera, 2011a; Alderotti et al., 2021; Matysiak and Vignoli, 2013), I argued that the country-level welfare differences could be a key factor shaping the observed cross-national effect heterogeneity. Building upon but going beyond the empirical approach of previous comparative welfare states research (Blossfeld et

al., 2005; Esping-Andersen, 2009), this study applied multilevel regressions and showed specifically that the effects of women's employment instability on childbirth transitions could be moderated by country variations in family policy provisions.

To this end, my key findings regarding the moderating roles of family policies on women's first birth are threefold. First, I found that the effect of women's unemployment on first-birth transition was more positive in countries with more generous family cash benefits (in line with H2). In the context of generous family cash benefits (such as Czechia and Slovakia), unemployed women could have higher probabilities of motherhood transition in the following years compared to permanently employed women. Second, the effects of women's temporary employment and unemployment on the first-birth transition were rather insensitive to country differences in the length of paid leaves. This finding might result from the joint operation of opposite mechanisms implied in the counter hypotheses H3a and H3b, which offset the moderating effects of each other. Specifically, longer paid leaves may on one hand strengthen the negative effects of employment instability on childbirth because the opportunity costs of childbirth for women with a permanent job are largely relieved. On the other hand, a comprehensive leave policy may buffer the socio-psychological uncertainty related to unstable employment and create a social norm that familizes women's home childcare responsibilities, thereby neutralizing the negative effect of employment instability on women's childbirth. Because the effect-enhancing and the effect-reduction mechanisms are like to offset each other's influences, it is not surprising that I only found a negligible moderating effect of paid leaves on the relationship between women's employment instability and first birth. Thirdly, more comprehensive early childcare services at the country level could enlarge the negative effect of temporary employment on women's motherhood transition (in line with H4). This finding has important policy implications because previous studies usually highlighted the fertility-enhancing and the conflict-reducing effects of childcare policies but underemphasized their potential role in reinforcing the structural disadvantages of certain groups, such as women who encounter employment instability.

Key findings on the moderating roles of family policies on women's second-birth transition are similar. First, countries with more generous family benefits tended to observe more positive effects of women's temporary employment and unemployment on the second-birth transition. Second, countries with longer paid leaves for mothers were associated with less negative and even positive effects of temporary employment and unemployment on second birth. This finding is somewhat different from the patterns observed in the first birth, where I found nearly zero moderating effects of leave policies. A potential explanation is that

familization of homecare responsibilities is high in countries with very long paid leaves schemes (Lohmann and Zagel, 2016), which creates a social norm that discourages women's combination of regular paid work and childrearing (Gangl and Ziefle, 2015). Because mothers of two children generally bear much higher childcare responsibilities than mothers of one child, it is likely that in such context mothers with established careers in permanent jobs are more reluctant to progress to higher-order births compared to mothers with unstable employment statuses. Third, a more negative effect of unemployment on women's second birth was found in the context of higher childcare coverage rates (in line with H4). Again, this finding suggests that in addition to discussing the "bright sides" of a comprehensive childcare system, policymakers should also pay attention to the potentially enlarged social stratification in fertility across employment groups.

Overall, the above findings about the impacts of women's employment instability on childbirth and the moderating role of family policies are largely consistent with the theoretical expectations. Nevertheless, several limitations should be noted before concluding. First, this study focused only on the objective aspect of employment instability by referring to women's employment status as the key explanatory variable of childbirth. While this design is in line with the mainstream literature (see Alderotti et al., 2021), some studies have argued that individuals' subjective feelings of employment uncertainty may have unique impacts on childbirth, which are independent of the impacts of the objective instability of employment status (Kreyenfeld, 2010; van Wijk et al., 2021). Because the EU-SILC data did not have subjective measurements of employment instability or uncertainty, a parallel analysis using these variables was not available for this study. Second, this study explored policy-specific moderating effects of family benefits, paid maternity/parental leaves, and childcare policies respectively. While using policy-specific evaluations provides clear-cut results for hypotheses testing (Baizan et al., 2016; Kalwij, 2010), this methodology fails to account for the holistic constellations of welfare policies (Billingsley and Ferrarini, 2014; Thévenon, 2011). Future research may extend our approach by utilizing composite indicators to capture the latent factors behind different policy constellations and test their moderating effects on the relationship between women's employment instability and childbirth. Third, while this study clearly illustrated that the effects of women's employment instability on childbirth were contingent on the "levels" of family policy provisions, causal interpretations of the moderating effects of family policies should be cautious. This is because the mixed-effects multilevel models cannot reliably partial out unobserved country-level heterogeneities that might confound the micro-level relationship between women's employment instability and

childbirth and the micro-macro interactions between such relationship and policies. Future research might consider using quasi-experimental designs to examine whether within-country policy "changes" may act as a factor of stratification by changing women's childbirth responses to employment instability (Bergsvik et al., 2021). From a methodological point of view, country-specific quasi-experimental designs may complement the cross-national comparative approach very well to establish both internal and external validities of empirical findings.

Despite these limitations, this study is the first to use multilevel analyses and comparative microdata from most European countries to examine the effects of women's employment instability on childbirth and the moderating roles of family policies on such relationships. Its findings contribute to the knowledge about whether institutional innovations, such as family policy provisions, may attenuate the social inequality in people's family behaviors or may reinforce such inequality in an unintended way (Blossfeld et al., 2005; Esping-Andersen, 2009). Most importantly, it highlights that different family policies may create distinct incentives or constraints across employment status groups, leading to their divergent fertility outcomes.

Notes

1 Following previous research, I consider uncertainty arises in a condition where "outcomes are not homogeneous enough to be estimated through probability calculus, or they are purely unknown" (Vignoli et al., 2020: 27). *Economic uncertainty* thus arises when individuals cannot expect or feel secure about their future economic outcomes in several aspects, such as employment careers, financial situations, and their ability to handle adverse economic situations (Buh, 2023). While the concept of uncertainty is inherently subjective, the operationalization of economic uncertainty in the empirical literature involves both subjective and objective measurements (Vignoli et al., 2020). On the other hand, following Alderotti et al. (2021), I define *employment instability* as an individual risk factor related to unstable, insecure employment experiences. Empirically, the concept is mostly operationalized using objective measurements, such as employment status, contract types, job characteristics, or the intersection of these factors (Buh, 2023). Accordingly, this study discusses the childbirth influences of employment instability, with a specific focus on women's

objective employment situations, in the broader literature linking economic uncertainty and fertility.

2 To this end, I do not discuss a wide range of policies that are without a specific demographic target, such as labor market policies, education policies, and social or health security policies, although such policies could affect women's work-family decisions (Bergsvik et al., 2021; Blossfeld et al., 2005; Esping-Andersen, 2009). With a focus on women, I also leave aside paternity or parental leaves reserved for fathers because the influences of paternity quota on mothers' work and fertility decisions are mainly indirect, contingent on how fathers respond to their increased efforts at homecare (Bergsvik et al., 2021).

3 In theory, women's entitlement to paid leaves does not guarantee job protection. In practice, European countries' leave programs generally cover both dimensions; employed women who received wage-replacement benefits during the leave period are also entitled to job protection. Still, the length of leave entitlement and the wage replacement rates of the benefits differ largely across countries. This paper focuses on the length and generosity of paid maternity and parental leaves for mothers, assuming job protection for employed mothers during the leave period.

4 When the 90% confidence interval contains only values that are more negative than the benchmark of a substantively negative effect, it indicates that the *p*-value is less than 0.05 for a one-tailed test of the null hypothesis that the effect is equal to or higher (i.e., weaker) than the substantively negative value.

5 See Supplementary Material S3 for the method translating predictive probabilities to odds ratios.

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7 Supplementary Materials

Supplementary Material S1	Data sources in each available country round
Supplementary Material S2	Missing data and imputation method
Supplementary Material S3	Using LMPs to model childbirth transition probabilities
Supplementary Material S4	Additional analysis using couple employment dyad
Supplementary Material S5	Additional analysis on CEE/Baltic countries

Supplementary Material S1 Data sources in each available country round

Data of this study come from multiple sources. All micro-level data come from the EU-SILC panel data files (release 1 in 2021, doi: https://doi.org/10.2907/EUSILC2004-2019V.2) provided by the Leibniz Institute for the Social Sciences (GESIS). I follow the Stata.do setups (ver_2021_04 update) provided by the GESIS Microdata Information System (MISSY) to prepare the comparative micro variables (https://www.gesis.org/en/missy/materials/EU-SILC/setups). To realize the full potential of the EU-SILC rotational panel data, I follow Berger and Schaffner's (2016) methodology to combine subsamples from multiple rotation groups that jointly comprises the full sample in each country-round.

Data sources of macro-level variables are listed as follows:

Family benefits

The data are calculated using the OECD Tax-benefit web calculator (https://www.oecd.org/els/soc/benefits-and-wages/tax-benefit-web-calculator/#d.en.500997) based on the OECD tax-benefit model (TaxBEN). To highlight the wage-replacement effects of family benefits for mothers who temporarily exit the labor market for childcare, the indicator used in this study is calculated by setting the hypothetical family as having a single-earner with 100% work time and a 2-year-old child. In a sensitivity analysis (not shown), I also run models using a family benefits indicator calculated for a two-earner family with 165% work time (100% + 65%) and a 2-year-old child. Results show that the directions of the moderating effects found in Table 4 and Table 5 are very similar regardless of the chosen hypothetical family parameters.

FRE paid leaves for mothers

The data come from the OECD Family Database's (OECD_FDB) "PF2.1 Key characteristics of parental leave systems" (https://www.oecd.org/els/soc/PF2_1_Parental_leave_systems.pdf). The full name of the indicator is "Total paid leave available to mothers, full-rate equivalent in weeks." The data are released and assembled in this study biannually in 2010, 2012, 2014, 2016, 2018, and 2020. Missing values in the gap years (i.e., 2011, 2013, 2015, 2017, and 2019) are interpolated using the country averages of the previous and the next years.

Childcare coverage rate (for children under 3 years old)

The data come from the OECD Family Database's "PF3.2 Enrolment in childcare and pre-school" (https://www.oecd.org/els/soc/PF3_2_Enrolment_childcare_preschool.pdf). The full

name of the indicator is "Enrolment rates in early childhood education and care services, 0- to 2-year-olds."

GDP per capita

The data come from Eurostat's online database (https://ec.europa.eu/eurostat/data/database). The full name of the indicator is "Purchasing power adjusted GDP per capita [SDG_10_10]."

Unemployment rate

For most countries covered by this paper, data on country-level unemployment rates come from the Eurostat's online database (https://ec.europa.eu/eurostat/data/database). The full name of the indicator is "Unemployment rate - annual data [TIPSUN20]." Data on the unemployment rates in Norway, Switzerland, Iceland, and the UK are not covered by the Eurostat database. For these four countries, I assemble such data directly from the ILOSTAT data explorer (https://www.ilo.org/shinyapps/bulkexplorer58/?lang=en&segment=indicator&id=UNE_2EAP_SEX_AGE_RT_A), which is the source of the Eurostat's data.

EPLR and EPLT

Data on both variables come from the OECD Employment Protection Database (OECD_EPD) (https://www.oecd.org/employment/emp/oecdindicatorsofemploymentprotection.htm). The full name of the EPLR indicator is "Strictness of employment protection – individual dismissals (regular contracts)." I use the more comprehensive Version 3 EPLR indicator, which incorporates 9 data items. The full name of the EPLT indicator is "Strictness of employment protection – temporary employment." Likewise, I use the more comprehensive Version 3 EPLT indicator, which incorporates 8 data items.

Supplementary Material S2 Missing data and imputation method

Some micro-level variables in this study have missing data. The largest proportion of missing data is observed in the variable of men's educational level in the first-birth subsample, which includes 3.8 percent of respondents without such information. To handle the missing data issue in micro variables, this study applies multiple imputation by chained equations (MICE). Compared to the standard "listwise deletion" method, the MICE has an advantage of relying on a much weaker missing data assumption. Specifically, it assumes that missing data are missing at random (MAR), which assumes that the probability of missing data in a targeted variable depends on the other observed variables but does not depend on the value of the missing data in the targeted variable itself. With this assumption, the MICE method utilizes the observed information in the incomplete cases to predict the missing values in the targeted variable and uses the predicted values for further imputation iterations.

Table S2.1 Descriptive diagnostics of the imputation results, imputation model #5 of the first-birth subsample

	Observed	Imputed	Completed		Observed	Imputed	Completed
Women's education				Men's education			
Low (ISCED 0-2)	7.3%	10.1%	7.3%	Low (ISCED 0-2)	12.7%	11.3%	12.7%
Middle (ISCED 3-4)	38.5%	31.7%	38.5%	Middle (ISCED 3-4)	46.8%	43.5%	46.6%
High (ISCED 5-8)	54.2%	58.2%	54.3%	High (ISCED 5-8)	40.5%	45.1%	40.7%
N	24,736	208	24,944	*N*	24,009	935	24,944
Women's health				Men's working status			
Good/fair health	98.8%	99.0%	98.8%	At work	91.0%	89.8%	91.0%
Bad health	1.2%	1.0%	1.2%	Unemployed	5.6%	3.9%	5.6%
N	24,052	892	24,944	Inactive	3.3%	6.3%	3.4%
Marital status				*N*	24,373	571	24,944
Married	44.9%	42.9%	44.9%				
Partnership	55.1%	57.1%	55.1%				
N	24,923	21	24,944				

Following (White et al., 2011), I use an imputation model includes all micro-level variables used in the analyses (see Table 1). In addition, I include the EU-SILC sample weight as an auxiliary variable in the imputation model. I use the mi commands in the software Stata 17 to perform the MICE. Binary and categorical variables (e.g., women's health; marital status) are imputed by multinomial logistic regression. Ordinal and continuous variables (e.g., women's educational level; men's age) are imputed by the predictive mean matching (PMM) method drawing form the ten nearest neighbors (White et al., 2011). To capture the multilevel structure, the imputation procedure is performed separately for each country. The number of

imputations is set to ten, and the iterations for the burn-in period is also set to ten. By applying Rubin's rules, the estimation results from the ten MICE imputed datasets are combined to calculate the coefficients and standard errors estimates (van Buuren, 2010).

Table S2.2 Complete case analysis on the pooled ordinary least squares linear probability models of women's first- and second-birth probabilities.

	First-birth transition (n=22,854)			Second-birth transition (n=23,488)		
	β	*S.E.*	*p-value*	*β*	*S.E.*	*p-value*
Employment status (Ref.=Permanent employment)						
Temporary employment	-0.026	(0.007)	0.001	-0.009	(0.009)	0.301
Unemployment	-0.001	(0.010)	0.947	-0.007	(0.006)	0.213
Control variables						
Women's age	0.044	(0.008)	< 0.001	0.041	(0.006)	< 0.001
Women's age2	-0.001	(0.000)	< 0.001	-0.001	(0.000)	< 0.001
Women's education (Ref.=Low, ISCED 0-2)						
Middle (ISCED 3-4)	0.009	(0.011)	0.432	0.012	(0.011)	0.294
High (ISCED 5-8)	0.027	(0.013)	0.047	0.050	(0.012)	0.000
Women's health (Ref.=Good/fair health)						
Bad health	-0.065	(0.022)	0.006	-0.051	(0.014)	0.001
Marital status (Ref.=Married)						
Non-marriage partnership	-0.098	(0.011)	< 0.001	-0.011	(0.005)	0.038
Men's age	-0.003	(0.001)	< 0.001	-0.004	(0.001)	< 0.001
Men's education (Ref.=Low, ISCED 0-2)						
Middle (ISCED 3-4)	-0.011	(0.010)	0.286	0.002	(0.008)	0.794
High (ISCED 5-8)	-0.012	(0.011)	0.314	0.037	(0.009)	< 0.001
Men's working status (Ref.=Working)						
Unemployed	-0.015	(0.009)	0.091	-0.006	(0.008)	0.446
Inactive	-0.058	(0.012)	< 0.001	-0.017	(0.013)	0.192
Country fixed effects	✓			✓		
Period fixed effects	✓			✓		

Note: Standard errors are clustered by countries.

To evaluate the statistical fitness of the imputation, I compare the distributions of the imputed and the observed values. Table S2.1 shows the descriptive diagnostics of one of the imputation datasets. The distributions of the imputed and the observed data are not systematically different, thereby creating almost identical distributions in the completed datasets. This result indicates a generally good fit of the imputation model (Eddings and Marchenko, 2012).

To check whether the estimation results of the effects of temporary employment and unemployment on childbirth is systematically influenced by the multiple imputation method, I perform complete case analyses that use only the observed values in the datasets. Estimation results are shown in Table S2.2. In general, the estimated effects of women's temporary employment and unemployment on the first- and the second-birth probabilities and the statistical significances of such effects are very similar to the main findings in Table 3. This similarity suggests high fitness of the applied imputation procedure.

Supplementary Material S3 Using LMPs to model childbirth transition probabilities

Although using LPM to model birth probabilities is a less common strategy than using logit regressions [but see recent applications in Cygan-Rehm (2016) and Hofmann et al. (2017)], this method is preferable in the present setting for three reasons. Firstly, compared to the counterintuitive interpretation of logit models' coefficients in terms of "logits" or "odds", the interpretation of LPM's coefficient estimates in terms of the effects on birth "probabilities" is straightforward and suitable for hypothesis testing (Breen et al., 2018). Secondly, multilevel logit regressions have serious convergence issues in the empirical setting of a low prevalent outcome event and a small group size at the higher level (Bryan and Jenkins, 2016). The estimation is further complicated in a design that uses multiple imputation to handle missing data. If the imputed sample sizes or variables differ across datasets, the rescaled coefficient estimates across different logit models are not comparable (Breen et al., 2018), making the computation of the average estimates using Rubin's rule problematic. Thirdly, the simulation results from Bryan and Jenkins (2016) suggest that to provide a reliable estimation, a multi-country comparative study fitting multilevel logit models requires at least 30 countries at the higher level. In contrast, having at least 25 countries would suffice for analyses using multilevel LPM.

Nevertheless, previous studies usually applied logit regressions or discrete-time event history analyses with a logit link to estimate the effect of employment instability on birth transitions. Therefore, most studies reported odds or odds ratios as the effect size unit. To compare the LPM's effect estimates with those reported in previous studies, I need to translate the model predicted conditional probabilities of birth transitions to odds ratios. For example, if the predictive birth transition probabilities are p_1 for the unemployed and p_2 for the permanently employed, the odds ratio of temporarily employed women having a birth transition in the following year against permanently employed women is $(p_1/(1-p_1\ ))/(p_2/(1-p_2))$.

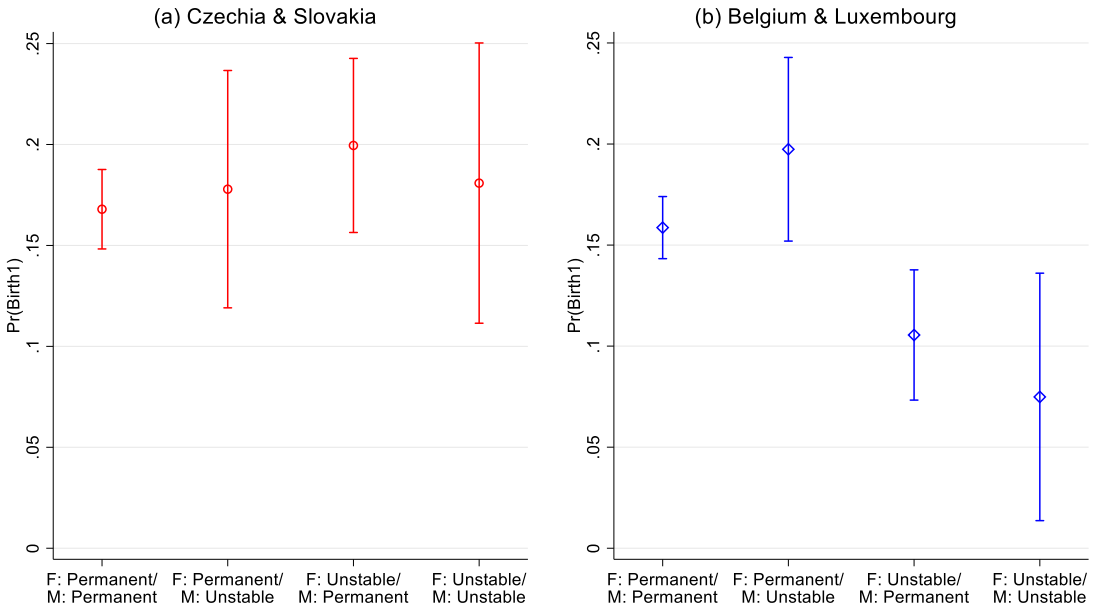
Supplementary Material S4 Additional analyses using couple employment dyad

Multilevel models in the main text estimate the policy moderating effects on the effects of women's employment instability on childbirth transitions, in which male partners' working status is controlled for as a confounder. This parsimonious model specification is not without a flaw because it fails to capture the within-couple gender nuances in the relationship between employment instability and fertility (Bueno and García-Román, 2021). For example, a study in Italy found that women's stable employment combined with men's unstable employment strongly depressed couple's parenthood transition possibly because this couple employment pattern violated the traditional male-breadwinning norms that prevailed in the society (Vignoli et al., 2012). Such gender nuance can be integrated into this paper's micro-macro theoretical framework. Specifically, women's own employment instability regardless of their partners' employment situation would be more detrimental to parity progressions in countries where family policies are geared to support earner-carer combination and defamilize women's homecare roles. On the other hand, in countries where family policies emphasize traditional income support and a high degree of childcare familization, women's employment instability combined with men's permanent employment might even accelerate birth transitions because such a gender-asymmetric employment pattern within couples fits the conventional male-breadwinning norm.

Unfortunately, testing these hypotheses directly in the proposed multilevel models is not plausible because the EU-SILC panel data did not collect key independent variables regarding contract types and subjectively evaluated employment status for "not-selected respondents" in seven countries, causing complete missingness on the variable regarding male partner's employment stability in these countries (i.e., Denmark, Finland, Iceland, the Netherlands, Norway, Sweden, and Slovenia). Nevertheless, the hypotheses can be examined indirectly by comparing childbirth impacts of couple employment patterns between countries where family policies feature the opposite ends of the continuum between income support-familization and earner-carer support-defamilization. For this purpose, I categorize couple employment patterns into four groups: (1) both permanent employment, (2) female permanent employment and male unstable employment (either temporary employment or unemployment), (3) female unstable employment and male permanent employment, and (4) both unstable employment. For country comparison, I choose Czechia and Slovakia to compare against Belgium and Luxembourg. The former group represents countries of strong income support and familization policies, in which high family cash benefits (CZ: 20.8 %AW; SK: 25.6 %AW) are combined with longer FRE leaves (CZ: 54.8 weeks; SK: 50.4 weeks) and very low

childcare coverage rates (CZ: 4.5%; SK: 5.4%). The latter group represents countries of strong earner-carer support and defamilization policies, where high levels of childcare coverage (BE: 47.1%; LU: 52.2%) come along with shorter FRE leaves (BE: 18.8 weeks; LU: 27.2 weeks) and limited family cash benefits (BE: 2.4 %AW; LU: 5.7 %AW).

Figure S4.1 Additional analysis: Model predictive first-birth probability by couple employment patterns, Czechia & Slovakia vs. Belgium & Luxembourg.

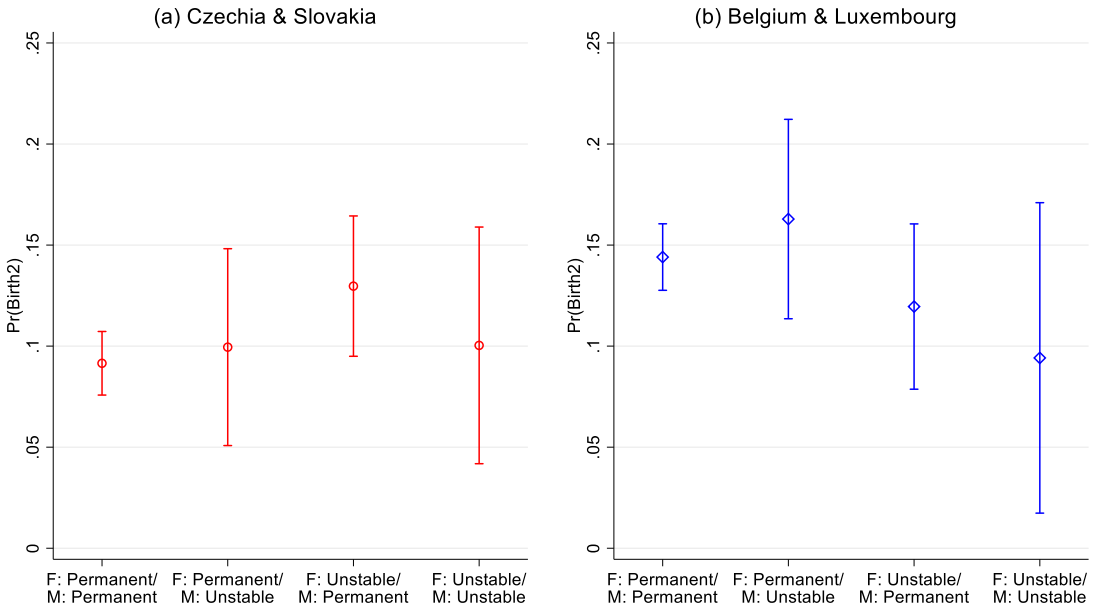


Note: Marginal predictive probabilities with 90% confidence intervals are based on country-specific OLS-LPM models. "F" denotes female employment status, and "M" denotes male employment status. "Permanent" denotes permanent employment in year *t*, and "Unstable" denotes either temporary employment or unemployment in year *t*. All models control for women's and men's age, education, health status, marital status, and period fixed effects.

By regressing women's birth transitions on the new variable regarding couple employment patterns, I predict the group-specific first- and second-birth probabilities for couples in these two country groups. Consistent with the theoretical expectation, modeling results in Figure S4.1 show that female employment instability combined with male partner's permanent employment has a higher first-birth transition probability than couples where both partners are permanently employed in Czechia and Slovakia. In contrast, in Belgium and Luxembourg, women's employment instability links to much lower first-birth transition probabilities regardless of male partner's employment situations. Similar patterns and cross-country differences are also found for the second birth transition (see Figure S4.2). In general, the additional case study not only confirms the main findings from our multilevel models but also provides new insights by showing that policy contexts may interact with couple-level

gendered employment norms to determine the relative impacts of women's employment stability on birth transitions.

Figure S4.2 Additional analysis: Model predictive second-birth probability by couple employment patterns, Czechia & Slovakia vs. Belgium & Luxembourg.



Note: Marginal predictive probabilities with 90% confidence intervals are based on country-specific OLS-LPM models. "F" denotes female employment status, and "M" denotes male employment status. "Permanent" denotes permanent employment in year *t*, and "Unstable" denotes either temporary employment or unemployment in year *t*. All models control for women's and men's age, education, health status, marital status, and period fixed effects.

Supplementary Material S5 Additional analysis for CEE/Baltic countries

Table S5.1 Pooled ordinary least squares linear probability models of women's first-birth transition probability, Non-CEE/Baltic countries versus CEE/Baltic countries.

	Model 1 Non-CEE/Baltic countries			Model 2 CEE/Baltic countries		
	β	*90% CIs*		*β*	*90% CIs*	
Employment status (Ref.=Permanent employment)						
Temporary employment	-0.027	[-0.042,	-0.012]	-0.014	[-0.032,	0.005]
Unemployment	-0.014	[-0.037,	0.008]	0.008	[-0.025,	0.041]
Control variables						
Women's age	0.047	[0.033,	0.061]	0.027	[-0.007,	0.061]
Women's age2	-0.001	[-0.001,	-0.001]	-0.001	[-0.001,	0.000]
Women's education (Ref.=Low, ISCED 0-2)						
Middle (ISCED 3-4)	0.000	[-0.016,	0.017]	0.034	[-0.027,	0.095]
High (ISCED 5-8)	0.027	[0.000,	0.054]	0.049	[-0.014,	0.112]
Women's health (Ref.=Good/fair health)						
Bad health	-0.058	[-0.091,	-0.025]	-0.045	[-0.171,	0.081]
Marital status (Ref.=Married)						
Non-marriage partnership	-0.082	[-0.105,	-0.059]	-0.108	[-0.143,	-0.074]
Men's age	-0.003	[-0.004,	-0.002]	-0.003	[-0.005,	0.000]
Men's education (Ref.=Low, ISCED 0-2)						
Middle (ISCED 3-4)	-0.015	[-0.033,	0.003]	-0.027	[-0.061,	0.008]
High (ISCED 5-8)	-0.017	[-0.038,	0.003]	-0.008	[-0.031,	0.014]
Men's working status (Ref.=Working)						
Unemployed	-0.009	[-0.026,	0.007]	-0.025	[-0.067,	0.017]
Inactive	-0.041	[-0.062,	-0.020]	-0.078	[-0.141,	-0.014]
Country fixed effects	✓			✓		
Period fixed effects	✓			✓		
n (Observations)	18,368			6,576		
M (Countries)	18			9		

Notes: Standard errors are clustered by country. CEE/Baltic countries include Poland, Czechia, Hungary, Slovakia, Slovenia, Croatia, Estonia, Latvia, and Lithuania. Non-CEE/Baltic countries include Austria, Belgium, Germany, Denmark, Greece, Spain, Finland, France, Ireland, Iceland, Italy, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland, and the UK.

Table S5.2 Pooled ordinary least squares linear probability models of women's second-birth transition probability, Non-CEE/Baltic countries versus CEE/Baltic countries.

	Model 1 Non-CEE/Baltic countries		Model 2 CEE/Baltic countries	
	β	*90% CIs*	*β*	*90% CIs*
Employment status (Ref.=Permanent employment)				
Temporary employment	-0.022	[-0.039, -0.005]	0.006	[-0.009, 0.020]
Unemployment	-0.030	[-0.052, -0.008]	0.001	[-0.026, 0.027]
Control variables				
Women's age	0.043	[0.027, 0.059]	0.031	[0.012, 0.050]
Women's age2	-0.001	[-0.001, -0.001]	-0.001	[-0.001, 0.000]
Women's education (Ref.=Low, ISCED 0-2)				
Middle (ISCED 3-4)	0.009	[-0.011, 0.029]	0.024	[0.006, 0.042]
High (ISCED 5-8)	0.054	[0.026, 0.083]	0.060	[0.045, 0.074]
Women's health (Ref.=Good/fair health)				
Bad health	-0.062	[-0.099, -0.025]	-0.031	[-0.079, 0.018]
Marital status (Ref.=Married)				
Non-marriage partnership	-0.003	[-0.020, 0.014]	0.002	[-0.017, 0.020]
Men's age	-0.004	[-0.006, -0.003]	-0.004	[-0.005, -0.003]
Men's education (Ref.=Low, ISCED 0-2)				
Middle (ISCED 3-4)	0.005	[-0.013, 0.022]	0.009	[-0.019, 0.036]
High (ISCED 5-8)	0.053	[0.036, 0.071]	0.028	[-0.003, 0.060]
Men's working status (Ref.=Working)				
Unemployed	-0.012	[-0.026, 0.002]	0.010	[-0.007, 0.026]
Inactive	-0.026	[-0.058, 0.005]	-0.013	[-0.036, 0.011]
Country fixed effects	✓		✓	
Period fixed effects	✓		✓	
n (Observations)	15,521		9,482	
M (Countries)	18		9	

Notes: Standard errors are clustered by country. CEE/Baltic countries include Poland, Czechia, Hungary, Slovakia, Slovenia, Croatia, Estonia, Latvia, and Lithuania. Non-CEE/Baltic countries include Austria, Belgium, Germany, Denmark, Greece, Spain, Finland, France, Ireland, Iceland, Italy, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland, and the UK.

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Study III:

Work and fertility in Taiwan: How do women's and men's career sequences associate with fertility outcomes?

Status: Published in *Longitudinal and Life Course Studies*

Citation: Hsu, C. (2022). Work and fertility in Taiwan: How do women's and men's career sequences associate with fertility outcomes?, *Longitudinal and Life Course Studies*, *13*(3), 380–411. https://doi.org/10.1332/175795921X16379265590317

Acknowledgements: Data for this research are provided by the Survey Research Data Archive, Academia Sinica, Taiwan. The author thanks Michael Gebel, Jonathan Latner, Sophia Fauser, Sonja Scheuring, Maye Samy and Luis Ortiz for their insightful comments on the earlier version of this paper.

Abstract

There has been much debate over the micro-level relationship between employment situations and fertility in Europe and Northern America. However, related research in East Asia is scant, although countries in this region have some of the lowest fertility rates in the world. Moreover, most studies analyze the employment-fertility relationship from a static perspective and only for women, which underemphasizes life-course dynamics and gender heterogeneity of employment careers and their fertility implications. Drawing on retrospective data from the 2017 Taiwan Social Change Survey (TSCS), this study explores women's and men's career trajectories between ages 18 and 40 in Taiwan using sequence cluster analyses. It also examines how career variations associate with different timing and quantum of birth. Empirical results show that economically inactive women experience faster motherhood transitions and have more children by age 40 than women with stable full-time careers. For men, having an unstable career associates with slower fatherhood transitions and a lower number of children. For both genders, self-employed people are the earliest in parenthood transitions and have the highest number of children by midlife. Our findings demonstrate sharp gender contrasts in employment careers and their diversified fertility implications in low-fertility Taiwan.

1 Introduction

The demographic transition in East Asia has been fueled by families' shifting economic foundations (Raymo et al., 2015). Central to this discussion is the micro-level relationship between men's and women's employment conditions and their fertility. Despite the rapid modernization and industrialization in East Asia, social expectations on men's and women's work-family roles remain rigidly stratified following the Confucianism family model, where male-breadwinners and female-homemakers are still the norms (Bumpass et al., 2009; Cheng, 2020). Given such context, increased employment opportunities for women and the deteriorated career stability for men might contribute to the significant postponement and reduction of fertility (McDonald, 2009). A few East-Asian studies have empirically examined the impacts of employment situations on fertility in Japan and South Korea. In general, men who are unemployed or employed in non-standard positions are more likely to delay fatherhood transition, stay childless, or have fewer children (Piotrowski et al., 2018; Raymo and Shibata, 2017). In contrast, women who are highly attached to the labor market are often linked to delayed family formation and lower marital fertility (Brinton and Oh, 2019; Jones, 2007; Raymo and Shibata, 2017).

In a broader literature context beyond Asia, many studies in Europe have discussed how different forms of employment instability, which primarily manifests as being unemployed or non-standard employed, affect people's birth timing and quantum (Alderotti et al., 2021). Most researchers used event history models or discrete-time logit/probit regressions to examine whether the transition hazards or the likelihood of a specific birth differ across states of employment (Adsera, 2011b; Blossfeld and Mills, 2005; Kreyenfeld, 2010; Pailhé and Solaz, 2012; Piotrowski et al., 2018; Raymo and Shibata, 2017; Vignoli et al., 2016). While these studies provide rich insights to test the instantaneous causal relationship between employment and childbirth, their focus on the snapshot of employment "states" or "transitions" in cross-sectional time points tend to overlook how people's careers are unfolding in real life (Abbott, 2016; Aisenbrey and Fasang, 2017). Also, the isolated investigation on each birth transition would not allow an examination of how people's holistic employment careers are associated with their complete fertility histories.

According to family theorists, individuals' work and fertility trajectories are unfolding in an interdependent process over time, indicating that the timing, duration, and sequencing of employment states in discrete time points should be examined as a whole package to understand its long-term implications on people's fertility histories (Buhr and Huinink, 2014; Huinink and Feldhaus, 2009; Huinink and Kohli, 2014). However, these theoretical insights have rarely been

tested using holistic approaches until recently (Busetta et al., 2019; Ciganda, 2015; Özcan et al., 2010; Pailhé and Solaz, 2012).

Drawing on the strengths of multiple methods, this study contributes to the emerging literature of investigating work-family relationships from a life course perspective (Huinink and Kohli, 2014). The study is the first to typologize women's and men's major career tracks in Taiwan using sequence analyses and to investigate career differentials in the timing and quantum of fertility until midlife. Its findings for ultra-low-fertility Taiwan complement previous East-Asian work-family research by demonstrating the gendered career patterns and their fertility implications in multiple aspects (Brinton, 2001; Jones, 2019; McDonald, 2009; Yu, 2009).

2 Background

2.1 Theoretical relationship between employment and fertility

The micro-level relationship between individuals' employment and fertility outcomes is a prominent research topic among economists, sociologists, and demographers. Previous studies have shown that such a relationship could be bi-directional, namely, people's employment situations may affect their fertility behaviors and vice versa (Matysiak, 2011; Matysiak and Vignoli, 2008). With an aim to understand the economic and sociological factors behind Taiwan's low fertility phenomenon, this study pins down to the discussions on how people's employment situations affect fertility.

An economic perspective from the *New Home Economics* (Becker, 1991) argues that people's fertility is contingent on the costs and benefits of children. It assumes that raising children is "costly" for parents in terms of pecuniary and non-pecuniary resources, such as time and energy. Since income is decided primarily by one's employment status, this theory predicts that stable employment may enhance the demand for children (i.e., the positive income effect) because stably employed individuals can afford more children under the same costs comparing to those without a stable job. On the other hand, stable employment and its extended utilities, including higher economic and social status, could raise the price of time and the opportunity costs of children, thereby reducing one's childbirth demand (i.e., the negative substitution effect). Whether employment affects fertility positively or negatively depends on which effect is dominating. Given a traditional gender division of labor, where men are the primary income provider of a household, the New Home Economics theory predicts gender-asymmetric effects of employment on fertility (Becker, 1991). That is, the

positive income effect of employment usually dominates men's fertility decisions, leading to a positive relationship between employment stability and male fertility. Among women, fertility decisions are affected more by the substitution effect of employment, leading to a negative relationship between female employment and fertility outcomes.

Sociologists tackle the issue from another perspective, emphasizing the impacts of employment instability on fertility and how they interact with the gendered social norms. On the one hand, the theory of *career-marriage dynamics* (Oppenheimer, 1988) argues that unstable employment leads to uncertain career prospects, which impedes individual's chance of matching an ideal partner in the marriage market. In addition, highly differentiated gender roles may foster gender differences in entering marriage or becoming parents when coping with career uncertainty. As a result, unemployment or unstable employment status makes a man economically unattractive (Oppenheimer et al., 1997), which delays his family formation (Oppenheimer et al., 1997; Vignoli et al., 2016). On the other hand, Friedman and colleagues (1994) propose the *uncertainty reduction theory*, which emphasizes the socio-psychological benefits of parenthood and argues that having children could serve as a strategy to counter the external uncertainty in employment conditions. In contrast to Oppenheimer's focus on men's career instability, the uncertainty reduction theory focuses on women and argues that women who confront unfavorable employment prospects may choose motherhood as an alternative career to secure their self-confidence and social status, particularly in societies that appraise the intrinsic value of family and parenthood.

While these theories explain the work-fertility linkage through different mechanisms, they have similar predictions regarding the fertility impacts of employment stability, especially in a context where familistic gender norms are dominating. Given the gendered role expectation in familistic countries, both Becker's (1991) and Oppenheimer's (1988, 1997) theories predict that stable employment enhances men's fatherhood transition and fertility. On the other hand, Becker's (1991) and Friedman's (1994) theories indicate that women's fertility behaviors are negatively associated with employment stability.

2.2 Empirical research on the employment-fertility relationship

Empirical evidence on the micro-level relationship between employment stability and fertility is inconclusive and varies across countries (Blossfeld and Mills, 2005; Matysiak and Vignoli, 2008). In conservative or familistic countries such as Germany, Italy, and Japan, findings for men generally support the theoretical predictions: stable employment, comparing to unstable employment, enhances men's fertility (Blossfeld and Mills, 2005; Hilgeman and Butts, 2009;

Piotrowski et al., 2018; Raymo and Shibata, 2017). For women in conservative or familistic countries, stable employment has fertility-depressing effects when it is compared against unemployment (Matysiak and Vignoli, 2008, 2013), while it has fertility-enhancing effects when it is compared against non-standard time-limited employment (Alderotti et al., 2021). However, most previous studies only investigate the cross-sectional employment-fertility relationship at a specific point of lifetime. Such a static perspective cannot fully capture the life-course dynamics of employment careers and their long-term associations with multiple fertility outcomes (Abbott, 2016; Aisenbrey and Fasang, 2017; Bernardi et al., 2019).

Life-course theories argue that individuals unfold their life courses according to experiences accumulated in the past, choices and constraints encountered in the present, and life prospects anticipated for the future (Abbott, 2016; Elder et al., 2003; Mayer, 2009). According to Bernardi et al. (2019), a life course is conceptualized as a multidimensional behavioral process marked by sequences of events and social transitions that individuals enact over time.

Over the lifetime, some people have stable employment experiences in full-time standard positions or self-employment, while some may have interrupted careers at some ages or switching between different career tracks; still others may work continuously in precarious jobs or stay inactive to the labor market. Each employment trajectory involves different timing and sequencing of employment experiences. Given such complexity, it is rather ambiguous to classify one's employment pattern as "stable" or "unstable" based only on one or several discrete-time employment states or transitions (Biemann et al., 2012; Devillanova et al., 2019; Fuller and Stecy-Hildebrandt, 2015). For example, using sequence analyses, researchers show that a seemingly uncertain employment state in the short term may lead to diverse career pathways in the long run (Brzinsky-Fay, 2010; Fauser, 2020; Fuller and Stecy-Hildebrandt, 2015; McVicar et al., 2019; Reichenberg and Berglund, 2019): some people follow the "stepping-stone" pathway where earlier temporary employment, part-time employment, or unemployment leads to stable, full-time employment in the long run, while other workers in non-standard employment positions are "trapped" in a labor market dead-end.

Fertility histories are also structured in a sequential timetable in modern societies (Huinink and Feldhaus, 2009; Huinink and Kohli, 2014). Childbirth decisions are not made in isolation. The timing, spacing, and the number of births over the life course are contingent on past fertility experiences (Buhr and Huinink, 2014; Huinink and Feldhaus, 2009). More importantly, fertility life courses have interdependent relationships with other life domains,

particularly with one's work and employment careers (Aisenbrey and Fasang, 2017; Krüger and Levy, 2001; Pollock, 2007; Vignoli et al., 2020). In this regard, people's fertility histories are shaped not only by "sequential institutionalization," but also by "simultaneous institutionalization," in which fertility and employment life courses are unfolding simultaneously (Huinink and Kohli, 2014; Krüger and Levy, 2001).

Drawing on the life-course perspective, I define people's "career" as a sequence of inter-dependent employment states evolving over time (Biemann et al., 2012; Pollock, 2007; Simonson et al., 2011). Following previous research on the objective relationship between employment uncertainty/instability and fertility (Kreyenfeld et al., 2012), I define an "unstable" career as having a sequence of multiple incidences or long duration in unemployment or non-standard employment states (Kalleberg, 2009), which contrasts a "stable" employment career featuring continuous employment in standard full-time jobs.

An unstable employment career is considered detrimental to people's parenthood transition (Blossfeld and Mills, 2005; Kreyenfeld et al., 2012). Using multi-channel sequence analyses, several studies showed that a disrupted or low-prestige employment career has a life-course affinity with delayed family formation and parenthood transition (Aisenbrey and Fasang, 2017; Simonson et al., 2011; Sirniö et al., 2017). However, the complex associations between careers and fertility outcomes are "gendered" (Krüger and Levy, 2001), particularly in conservative and familistic countries (Blossfeld and Mills, 2005). Studying the career pathways to childlessness, research in Italy found that most childless women had a stable rather than an interrupted or inactive employment career (Mynarska et al., 2015; Tocchioni, 2018), while childless men's career pathways were more diversified (Tocchioni, 2018). An uninterrupted employment career increased men's likelihood of fatherhood but decreased women's likelihood of motherhood in the Netherlands (Keizer et al., 2008). Among Italian couples, husbands' persistent joblessness also played a more decisive role in inhibiting wives' intentions to have further childbirth (Busetta et al., 2019).

Several studies considered the impacts of employment stability not only on one specific birth transition but also on the total number of children people ultimately have (i.e., the quantum effect). In Germany, Auer and Danzer (2016) found that entering the labor market with a fixed-term contract delayed women's age at first birth and reduced their total number of children within ten years since graduation, while no significant effect in these two aspects was found for men. Focusing on the duration of unemployment, Pailhé and Solaz (2012) found that long-term unemployment negatively affected men's but not women's complete fertility (i.e., the number of children by age 40) in France. By examining people's

employment sequences, Ciganda (2015) found that having an unstable career delayed men's fatherhood transition and reduced the number of children for both men and women in France. While the gendered patterns found are inconclusive, all these studies point to the need for a holistic investigation into the gendered employment-fertility relationship because the impacts of employment stability may extend far beyond the first parenthood transition.

Aside from the dichotomy between the typically stable and unstable careers, another prominent career type in familistic countries is self-employment. Empirical studies show that self-employment has distinct implications on fertility across different countries (Adsera, 2011a; Begall and Mills, 2013; Del Boca et al., 2005; Köppen et al., 2017; Matysiak and Mynarska, 2020; Noseleit, 2014; Sinyavskaya and Billingsley, 2015; Tocchioni, 2018). Comparing to workers of stable full-time employment, self-employees might on the one hand enjoy higher flexibility needed to reconcile work with family, while on the other hand suffer from higher employment uncertainty because their jobs are not protected by contracts. Self-employment also provides career alternatives for many people who have difficulty finding dependent employment jobs, especially in familistic welfare regimes like Southern Europe during an economic downturn (Adsera, 2011a). Therefore, researchers have suggested that self-employment could enhance women's fertility when institutional support for combining work and childcare is weak (Matysiak and Mynarska, 2020). Also, in a context where people's selection into self-employment involves more rational incentives, such as to secure and mobilize family resources, this career choice may serve as an ideal package to combine work with family (Anthias and Mehta, 2003).

2.3 The Taiwanese context

Taiwan is well known for its currently ultra-low fertility rates and late adulthood transitions in the demographic literature (Cheng, 2020; Goldstein et al., 2009; Jones, 2019; Nauck et al., 2017). During the post-WWII industrialization, Taiwan's period total fertility rate (PTFR) has dropped from seven children in 1951 to the replacement level of 2.1 children in 1983. Following the Globalization trend in the 1990s, the PTFR has further declined to below the level of 1.3 children since 2003. Meanwhile, the social and economic systems have changed fundamentally, particularly in two aspects: (1) the dramatic increase in female labor force participation in paid jobs (Gietel-Basten, 2019; Yu, 2009), and (2) the emergence of precarious and uncertain employment relationships (Chen et al., 2003; Hsiao, 2013; Kalleberg and Hewison, 2013). Given such a context where the Second Demographic Transition meets Globalization (Mills and Blossfeld, 2013), it is theoretically crucial to investigate whether and how Taiwanese

women and men's fertility behaviors are associated with their employment careers. Surprisingly, empirical research in Taiwan on this micro-level relationship is scant.

Taiwan, together with Japan and South Korea in East Asia, are usually ranked among the countries with the most inadequate conditions for combining work with family (Frejka et al., 2010; Gauthier, 2016; Jones, 2007; McDonald, 2009). This is especially true for Taiwanese women because childcare and housework tasks are conventionally considered as mothers' responsibilities (Cheng, 2020; Cheng & Hsu, 2020). Moreover, work-family reconciliation is weakly supported by public policies (Gauthier, 2016; Tsai, 2012). A two-year unpaid parental leave was introduced in 2002 in the *Act of Gender Equality in Employment*. In 2009, the *Amendment of the Employment Insurance Act* further added a six-month childcare cash benefit for parental leave takers. However, taking parental leaves is not common among Taiwanese until very recently. From 2009 to 2018, the percentage of eligible female workers receiving childcare benefits during their leaves increased from 24.3% to 77.3%, while the male uptake rate remained below 9% in 2018 (Ministry of Labour, 2020; author's calculation). Meanwhile, the enrollment rate in public-supported childcare facilities is extremely low in Taiwan, especially for infants and toddlers below age three. From 2005 to 2018, the enrollment rate in early education and childcare for children below age three increased from 0.5% to 11.5% (Ministry of Education, 2020; Ministry of Health and Welfare, 2020; author's calculation). Given the context, the "mismatch" between women's rising demand for work-family reconciliation and the stagnated policy development of public childcare and parental leaves is argued to withhold people's childbirth in Taiwan (Gauthier, 2016).

An earlier study has found that "current employment away from home has a significant effect on children ever born for Taiwanese women, depressing fertility by an average of 0.25 children" (Speare Jr. et al., 1973: 332). These results might reflect Taiwanese women's tendency to avoid the conflicts between work and childrearing by delaying motherhood or by spacing each parity transition at greater intervals. Such findings were supported by another study using data from a 1980 survey (Stokes and Hsieh, 1983), which found that married women who were always employed had the lowest number of children ever born. Using data from a 1989 survey, Wu and Chuang (2018) found that longer job tenure and higher labor market attachment before the first birth may delay married women's first birth transition.

While these studies provided valuable insights, their findings were relatively outdated and did not capture the employment-fertility relationship in Taiwan after 1989. They also did not discuss the negative impact of unstable employment on men's fertility, which has been a crucial fertility-depressing factor in other East-Asian countries like Japan (Piotrowski et al.,

2018; Raymo and Shibata, 2017). Most importantly, previous studies in Taiwan failed to examine the dynamic development of people's employment careers and fertility outcomes from a life-course perspective. The present paper adds to prior studies by using sequence analyses to explore Taiwanese women and men's major career trajectories before midlife and to examine how these careers are related to different timing and quantum of fertility by age 40.

2.4 Hypotheses

By incorporating the Taiwanese case into the theoretical framework discussed above, I formulate several hypotheses on the relative timing of parenthood transitions and the quantum of fertility across different career types. Specifically, I predict:

> *Hypotheses 1a & 1b: Taiwanese women who have a stable employment career in standard full-time jobs, compared to women of unstable careers, are associated with a slower motherhood transition (H1a) and a lower number of children by midlife (H1b).*
>
> *Hypotheses 2a & 2b: Taiwanese men who have a stable employment career in standard full-time jobs, compared to men of unstable careers, are associated with an earlier fatherhood transition (H2a) and a higher number of children by midlife (H2b).*

Regarding the fertility implications of self-employment for women, I expect:

> *Hypotheses 3a & 3b: Taiwanese women who have a self-employed career, compared to women in the standard full-time track, are associated with an earlier motherhood transition (H3a) and a higher number of children by midlife (H3b).*

This prediction reflects the difficulties for career-oriented women to combine work with family in a standard employment position because childcare supports from public policies and husbands' domestic help are generally lacking (Cheng and Hsu, 2020; Gauthier, 2016).

For men, many male self-employees in Taiwan are either the patrilineal descendants of family firms or first-generation entrepreneurs starting their own business with the help of family resources. In such context, self-employed men might have higher economic status than the majority of firm-employed men. They might also have superiority in mobilizing non-monetary family resources for childcare (Lu, 2001). Finally, due to the lack of employment protection laws in Taiwan until recently, dependent employees in the private sector do not necessarily have higher job stability than self-employees (Yu and Su, 2009). Therefore, I expect:

Hypotheses 4a & 4b: Taiwanese men who have a self-employed career, compared to men in the standard full-time track, are associated with an earlier fatherhood transition (H4a) and a higher number of children by midlife (H4b).

3 Method

3.1 Data

This study uses data from the 2017 Taiwan Social Change Survey (TSCS 2017, Fu, 2019). The TSCS is a cross-sectional survey project tracking the long-term trends of social changes in Taiwan. Since its first wave completed in 1985, the TSCS has accumulated over 60 surveys over the past 30 years. It applies survey modules comparable to many international survey projects, such as the ISSP and the EASS. The 2017 TSCS data comprise a nationally representative sample of 1,917 Taiwanese adults aged 18 to 70. It includes retrospective information on individuals' education, work, partnership, and fertility histories. To construct individuals' employment and family biographies between ages 18 and 40, I restrict the analytical sample to those aged above 40 by 2017. After excluding 87 people without complete records in education, employment, or fertility histories, the final sample comprises 507 women and 585 men born between 1946 and 1977.

3.2 Analytical strategy, variables, and measurements

To explore the major career trajectories and their linkage to the timing and the quantum of fertility, I propose an analytical framework combining multiple methods including sequence analysis, survival analysis, and multivariate regressions. Firstly, I use sequence and cluster analyses to identify typical employment careers for Taiwanese women and men. Individuals' yearly employment and education histories across 23 years from age 18 until age 40 are reconstructed as holistic career sequences. For women, I consider five distinct states of activities in each time point: (1) in education, (2) self-employment and family workers (i.e., work in family business), (3) non-standard employment, including part-time workers, temporary/fixed-term contractors, and dispatched workers,[1] (4) full-time standard employment, and (5) non-employment.[2] For men, I consider an additional state of (6) in

[1] It is worth noticing that employment subcategories defined as "non-standard" or "precarious" in the Taiwanese context may differ from those in Western countries (Hsiao et al., 2015). The inclusion of subcategories in our non-standard employment state follows Hsiao's (2013) contextual definition.

[2] Due to data limitation, I cannot directly identify whether a non-employment state in a retrospective year is resulted from one's involuntary unemployment or from his/her voluntary labor market inactivity. Both states in

military services because military services for up to three years are mandatory for male citizens in Taiwan. Using these states, I create career sequences for each individual and use the Hamming Distance algorithm (HAM) to calculate the pairwise distances matrix between sequences. Comparing to the commonly used Optimal Matching algorithm, HAM is more sensitive to dissimilarities in the timing and positioning of states and transitions (Aisenbrey & Fasang, 2010; Studer & Ritschard, 2016). Placing more emphasis on timing is theoretically justified because life course research has shown that the timing of school-to-work transitions and early-career work development is particularly important in shaping individuals' family lives in both Europe and East Asia (Buchmann & Kriesi, 2011; Yeung & Alipio, 2013).[3]

After obtaining the distances matrix, I deploy the partitioning around medoids (PAM) procedure for clustering (Kaufman & Rousseeuw, 2009). This method aims to obtain the best partitioning of a dataset into a predefined number of *k* groups. Through an iterative "swapping" procedure, PAM seeks to minimize the weighted sum of distances between every sequence and the medoids—the "best representative" sequences of each group (see Kaufman & Rousseeuw (2009) for technical details). Comparing to the popular Ward hierarchical clustering method, the PAM method has a better global-level clustering performance and generally renders higher between-cluster dissimilarities (Studer, 2013). However, a drawback of the conventional PAM method is that its clustering results are sensitive to the initial choice of medoids, which are not always optimal. To overcome this limitation, I follow Studer's (2013) suggestions to initialize the PAM algorithm using the result of the Ward procedure (i.e., the PAM+Ward procedure).[4] Because previous studies for Taiwan did not offer any reference *number* of career types, I follow the rule of thumb in empirical sequence research: determining the number of clusters based on statistical quality measures and theoretical

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the focal analyses are categorized as non-employment. In a measurement sensitivity test, I create a proxy state of inactivity and reassign employment years into this category when individuals stay non-employed for consecutive three years. Sensitivity analyses using this proxy state in the sequences show similar clustering results in terms of their substantive social meanings. Since using the ad hoc proxy state does not add empirical values to my career typology, I adhere to the original state measurement of non-employment.

[3] In a sensitivity analysis presented in the supplementary material S1, I use the Optimal Matching of spells (OMspell) algorithm with an expansion cost e = 0.5 to calculate the distances matrix. Comparing to HAM, OMspell is more sensitive to the duration and the sequencing of spells (Studer & Ritschard, 2016). It thus serves as the benchmark algorithm to test whether shifting the theoretical focus from timing to the duration and sequencing of states will significantly change the clustering results. From a substantive sense, the clustering results from OMspell are similar to those from HAM. However, the clustering performance of OMspell, measured by several sequence partitioning indices, are inferior to HAM (see Table A2 for the comparison of global-level and cluster-specific ASWs between these two solutions).

[4] A sensitivity analysis (not shown, available on request) shows that using the conventional Ward hierarchical clustering yields similar results in terms of the substantive attributes of the identified clusters. However, from a statistical point of view, the clustering results of the PAM+Ward procedure obviously outperform the Ward method in the partitioning quality measures. Table A2's note compares the performances of statistical quality measures across different methods.

meaningfulness (i.e., the construct validity) of different cluster solutions (Aisenbrey and Fasang, 2010; Fuller and Stecy-Hildebrandt, 2015). Using this strategy, I identify four clusters for women and three clusters for men as optimal. A battery of partitioning quality indicators across different clustering solutions are presented in Figure A1 (Piccarreta & Struffolino, 2019; Studer, 2013), including the Average Silhouette Width (ASW), the Point Biserial Correlation (PBC), and the Hubert's C (HC). Taken together, I argue that women's four-cluster and men's five-cluster solutions using the HAM algorithm in a PAM+Ward procedure have high validity representing the major career typology in Taiwan.

To explore the career differentials in fertility timing, I calculate the cumulative hazards of the first three parenthood transitions using the Nelson–Aalen estimators by career. The hazard (rate) of transition is identified as the conditional probability of a birth event occurring at time t_i, given that there has been no such an event before t_i. In discrete time, the hazard function is given by $r(t_i) = \Pr(T = t_i | \, T \geq t_i) = \frac{f(t_i)}{S(t_{i-1})}$, which is the probability function of time duration from the initial state to the birth event divided by the survivor function up to the time point just before time t_i. Presenting cumulative transition hazards using the Nelson–Aalen estimator is informative in describing the (timing) pace of fertility because the cumulative form of transition hazards implies the duration of waiting time for the occurrence of a birth transition (Mills, 2010).

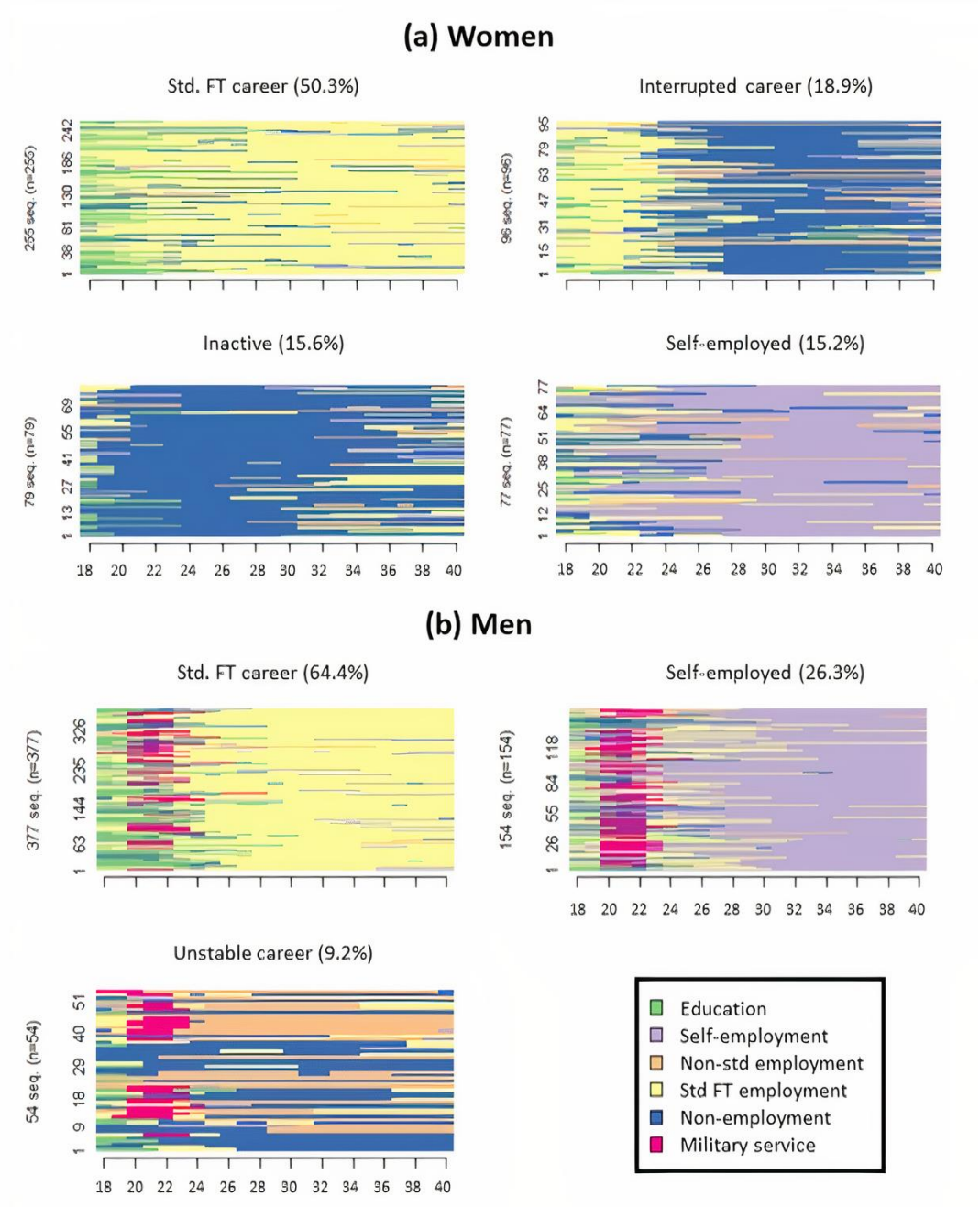
To further investigate whether one's fertility quantum is affected by having a different career type, I specify a count model of a person i's number of children ever born y_i by age 40 using the following equation:

$$y_i = \boldsymbol{X}_i \, \boldsymbol{\beta} + \boldsymbol{Z}_i \, \boldsymbol{\varphi} + \varepsilon_i \qquad (1)$$

where $\boldsymbol{X}_i$ denotes the vector of career dummies specified from the sequence cluster analyses. $\boldsymbol{Z}_i$ is a vector of other covariates used as control variables. ε_i denotes the unobserved individual error term (idiosyncratic errors). The parameters $\boldsymbol{\beta}$ thus present the estimated fertility quantum effects of having a specific career type comparing to the reference career, conditioning on the control variables. Following Auer and Danzer (2016), I use Poisson regressions to estimate the regression coefficients specified in Equation (1) for female and male samples separately. For statistical inferences, I present bootstrapped standard errors with 200 repetitions to account for the possible violation of normal distribution assumptions for residuals in a relatively small sample (Efron & Tibshirani, 1986; Guan, 2003).[5]

[5] A sensitivity test using the robust standard errors (not shown, available on request) shows very similar results for statistical inferences.

Figure 1: Clusters of employment careers from age 18 to age 40 for women and men



Regression models control for several socio-demographic covariates. Individuals are categorized into three *birth cohort* categories: cohorts 1946–1957, cohorts 1958–1967, and cohorts 1968–1977. The *parental highest educational level* measures if at least one of an individual's parents received tertiary education (ISCED levels 5–8). *Ethnic minority* measures if a person was born in an ethnic minority family, defined as having at least one parent of Taiwanese-Aboriginal or non-Taiwanese backgrounds. *Family economic background* is measured as a subjective evaluation of one's household financial situation at age 15 relative to other families' using a five-point liker scale, ranging from "much better" to "much worse."

For 7 people who have missing data in this variable due to item non-response, I assign them with the median value 3 (which denotes a "fair" family economic background). Finally, in the robustness analysis in Table A3, I additionally control for individuals' *highest educational level* by age 40 in three categories: primary education (ISCED 0–2), secondary education (ISCED 3–4), and tertiary education (ISCED 5–8). Table A1 in the Appendix presents descriptive statistics of these variables for each subsample.

Sequence and cluster analyses in the first part are performed using the software R (version 4.0.2) and the R package TraMineR (Gabadinho et al., 2011). Survival analysis and multivariate regressions are performed using the software STATA (version 14.2).

4 Results

4.1 Women's and men's career typologies in Taiwan

Figure 1 graphically presents the sequence-clustering results of major career trajectories for Taiwanese women and men. Figures A2 and A3 in the Appendix present the Silhouette widths of sequences by cluster for women and men. Within career clusters, year durations in each state are presented in Table 1. For women, the most prevalent pattern is working mostly in a *standard full-time career* (50.3% of women). Women in this career track spend a relatively long time in education (1.86 years) after turning 18 years old. This marks the relatively high educational level of this group—on average tertiary degree—comparing to other women. After graduation, these women spend on average 18.07 years in standard full-time employment positions until midlife. There are only short career interruptions up to 1.84 years among these women, and they don't frequently switch to other employment tracks. The second cluster, comprising 18.9% of women, is best described as *interrupted careers*.[6] The majority of these women start their careers in standard full-time positions for about 7 years. After age 25, most of these women quit employment entirely or switch to more flexible self- or non-standard employment tracks. The emergence of this interrupted career pattern in East Asia is likely due to women's career adjustment upon family formation in order to reconcile work-family role conflicts (Raymo et al., 2015; Yu, 2009). The third pattern is called *(economically) inactive*, comprising 15.6% women who have been non-employed for 17.77 years out of the first 23 years after age 18. The fourth female career pattern, the *self-*

[6] According to Figure A2, the average Silhouette width of this cluster is 0.19, which indicates a very weak structure and a low within-cluster homogeneity (Studer, 2013). Against the background, one should be cautious not to overinterpret the fertility results related to this interrupted career cluster.

employed, is featured by an extended time duration in self- or family-employment positions before midlife (on average 16.3 years).

For men, my results indicate a three-cluster solution. The most prevalent male career pattern is having a *standard full-time career* (64.4%). Like what I found for women, men in the standard full-time track have longer years in education (2.49 years) comparing to other men. The second pattern, which is also found for women, is being *self-employed* (26.3%) for most of the early career. The third pattern for men, best described as *unstable careers* (9.2%), is featured by the combination of long-term non-employment, long-term non-standard employment, or frequent switching between standard and precarious career tracks. Comparing to men in the prior two clusters, men of unstable careers spend more time in either the state of non-standard employment (8.07 years) or non-employment (10 years) after age 18.

Table 1: Year duration in each state by sex and career types, ages 18–40

	In education	Self- or family-employment	Non-standard employment	Standard FT employment	Non-employment	Military service	Total years	N of cases
Women								
Standard FT career	1.86	0.63	0.60	18.07	1.84	–	23	255
Interrupted career	0.78	1.19	1.58	6.99	12.46	–	23	96
Inactive	0.67	0.75	0.94	2.87	17.77	–	23	79
Self-employed	0.49	16.30	0.75	3.03	2.43	–	23	77
Men								
Standard FT career	2.49	0.77	0.21	17.12	1.31	1.09	23	377
Self-employed	0.84	15.23	0.20	3.69	1.34	1.70	23	154
Unstable career	0.78	0.54	8.07	2.26	10.00	1.35	23	54

The clustering results not only show career heterogeneity among Taiwanese women and men but also indicate career hierarchies in terms of employment stability. Following previous research (Biemann et al., 2012; Fauser, 2020; Fuller and Stecy-Hildebrandt, 2015), I define the standard full-time career as the most "stable" employment career for both women and men, not only because they enjoy better employment and financial protections compared to non-standard workers, but also because their employment might be less influenced by external business cycle compared to self-employees. For men, having an unstable career denotes the least employment stability because being trapped in the states of non-employment or non-standard employment signal these men's incapability of establishing a secured employment career (Fuller & Stecy-Hildebrandt, 2015; McVicar et al., 2019). For women, it is relatively ambiguous to argue whether having an inactive career is more unstable than an interrupted career because the former might simply reflect some women's family-oriented life preferences (Hakim, 2000). Yet, from a life course perspective, economically inactive women

obviously have less labor force attachment than women of interrupted careers. Therefore, I assume that inactive women have the least employment stability among Taiwanese women.

4.2 Descriptive analyses of the employment–fertility relationships

Table 2 presents descriptive statistics of the average incidence, timing, and quantum of fertility for Taiwanese women and men across career types. The percentage of standard full-time employed women having at least one birth by age 40 (84.7%) is about 10 percentage points lower than women of other careers, indicating that women of uninterrupted full-time careers are more likely to remain childless by midlife. Moreover, they are also less likely to have the second (70.2%) and the third births (26.3%). Given the later age at first birth and the lower incidence of each birth transition among standard full-time women, they have a relatively low number of children (1.87 children) by age 40 comparing to women of other careers. In contrast, economically inactive women have the highest incidence rates of experiencing all three birth transitions, leading to their highest number of children by age 40 among women (3 children).

Table 2: Average fertility outcomes by sex and career types, ages 18–40

	Incidence rate of childbirth (% of entire cluster)			Age at childbirth (given a birth event)			N of children by age 40
	1st birth	2nd birth	3rd birth	1st birth	2nd birth	3rd birth	
Women							
Standard FT career	84.7%	70.2%	26.3%	26.76	28.90	29.16	1.87
Interrupted career	93.8%	91.7%	54.2%	24.90	27.48	29.42	2.47
Inactive	94.9%	92.4%	69.6%	21.71	24.45	26.82	3.00
Self-employed	93.5%	87.0%	53.2%	23.15	25.33	27.59	2.61
Men							
Standard FT career	86.7%	67.4%	27.9%	29.51	31.56	32.96	1.94
Self-employed	92.9%	82.5%	47.4%	27.44	28.88	31.36	2.44
Unstable career	70.4%	59.3%	25.9%	27.42	29.36	32.40	1.69

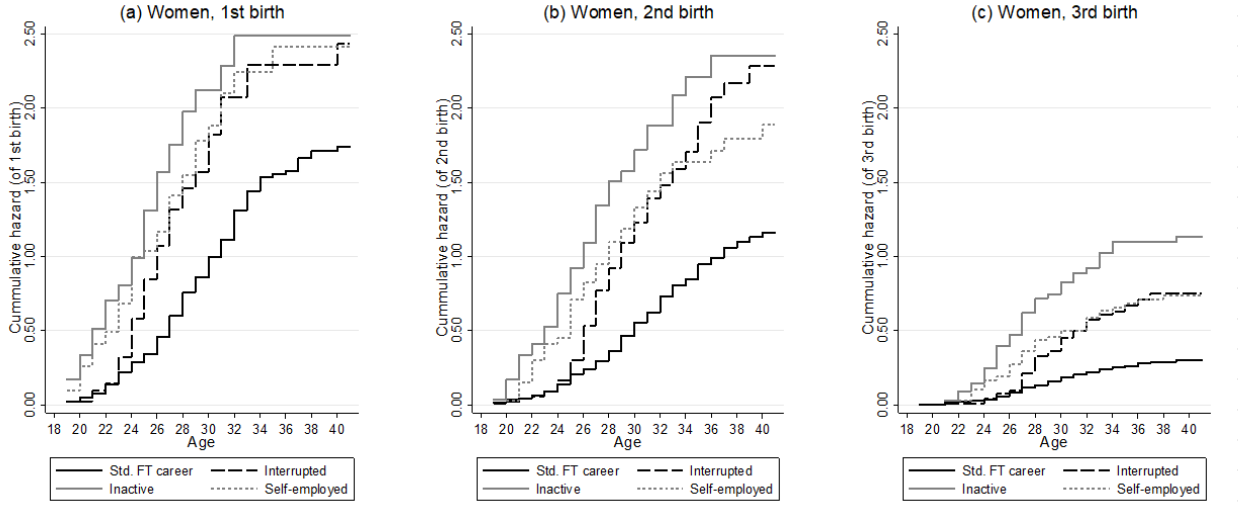
Note: Birth-specific incidence rates are calculated as the numbers of the specific births divided by the entire cluster sample sizes. Ages at childbirth are calculated as the mean ages of the specific births among those who experienced the birth events.

For men, Table 2 shows that those who have unstable careers are more likely to stay single by age 40 (about 30% do not have the first birth). Men with unstable careers are also the least likely to have the second (59.3%) and the third births (25.9%). Interestingly, the incidence rates of each birth transition are higher among self-employed men than standard full-time male employees. The aggregate result is that self-employed men have on average 0.75 more children than unstable-career men and 0.5 more children than standard full-time career men by midlife.

4.3 Employment careers and fertility timing

To further investigate whether and how people's timing of childbirth differs across career groups over the life course, I use non-parametric Nelson–Aalen estimators to estimate the cumulative hazards of birth transitions for the first three birth events. Figure 2 presents women's results and the log-rank tests for the equality of the survivor functions across groups. Large career differentials in the hazards of (first) motherhood transitions are observed in Figure 2-a according to the log-rank test. Both inactive and self-employed women experience higher transition hazards to motherhood in their early careers comparing to the other two groups. Despite their slower pace to motherhood at the beginning, women with interrupted careers gradually catch up with the former two groups after age 25 and eventually have the same level of cumulative first-birth hazards as the prior two groups after the mid-30s. In sharp contrast, standard full-time women not only lag behind other women in terms of motherhood transition during the early lives but also cannot catch up with their pace before midlife.

Figure 2: Nelson–Aalen cumulative hazard estimates and log-rank tests of group differences across women's career types by birth transitions.



Log-rank test for equality of survivor functions

	Events observed	Events expected
Std. FT	208	276.93
Interrupted	87	70.55
Inactive	61	32.43
Self-empl.	68	44.10
Total	424	424
chi2(2)		68.33
Pr>chi2		0.000

Log-rank test for equality of survivor functions

	Events observed	Events expected
Std. FT career	Std. FT	255.02
Interrupted	Interruptive	67.69
Inactive	Inactive	35.10
Self employment	Self-empl.	45.19
	Total	403
chi2(2)		90.69
Pr>chi2		0.000

Log-rank test for equality of survivor functions

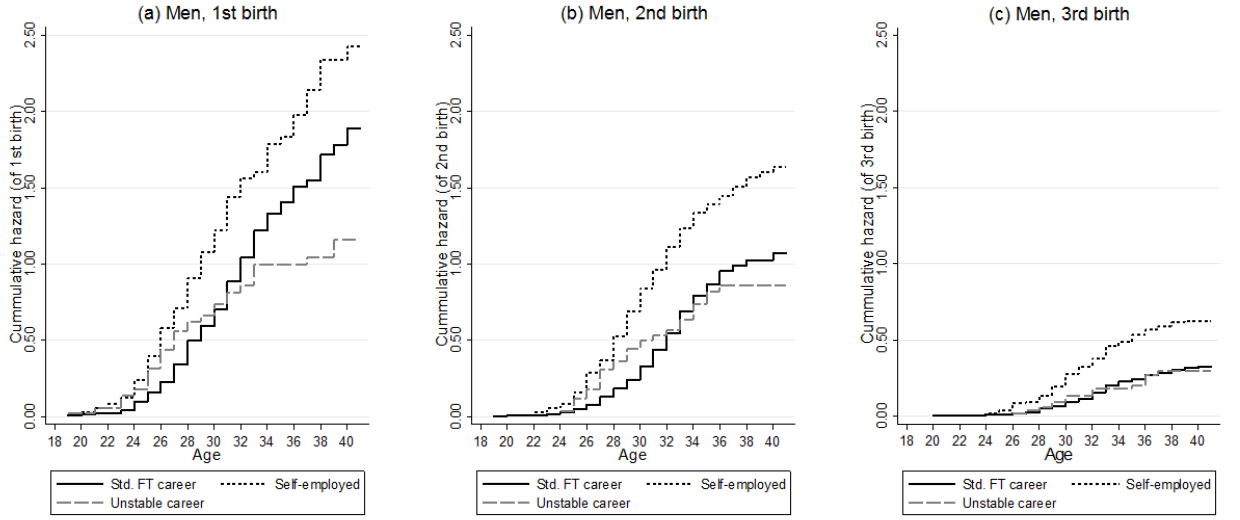
	Events observed	Events expected
Std. FT	66	120.83
Interrupted	52	39.84
Inactive	55	24.07
Self-empl.	41	29.26
Total	214	214
chi2(2)		76.44
Pr>chi2		0.000

In summary, these findings support Hypotheses 1a and 3a, showing that Taiwanese women who have a stable career in standard full-time jobs are associated with a slower

motherhood transition than women with unstable careers (i.e., inactive women) and self-employed careers.

Additional analyses in Figures 2-b and 2-c show that the gap between inactive and standard full-time women in childbirth timing extends beyond the first birth. Inactive women lead women of all career groups in the second and the third birth transitions, while standard full-time women constantly lag behind. The pace to second birth is similar between inactive and self-employed women in early ages. However, the second-birth transition hazard has flattened among self-employed women after age 30, which has enlarged the cumulative hazard gap between self-employed and inactive women by age 40. Similar patterns of career differentials in the pace of transition are also observed regarding women's third birth.

Figure 3: Nelson–Aalen cumulative hazard estimates and log-rank tests of group differences across men's career types by birth transitions.



Log-rank test for equality of survivor functions

	Events observed	Events expected
Std. FT	327	355.73
Self-empl.	143	100.47
Unstable	38	51.79
Total	508	508

chi2(2) 27.03
Pr>chi2 0.000

Log-rank test for equality of survivor functions

	Events observed	Events expected
Std. FT	254	293
Self-empl.	127	81.05
Unstable	32	38.96
Total	413	413

chi2(2) 35.38
Pr>chi2 0.000

Log-rank test for equality of survivor functions

	Events observed	Events expected
Std. FT	105	129.4
Self-empl.	73	44.16
Unstable	14	18.44
Total	192	192

chi2(2) 25.26
Pr>chi2 0.000

Figure 3 presents men's cumulative transition hazards to each birth, estimated by the Nelson–Aalen method. Figure 3-a indicates large career differentials in men's timing of fatherhood transition. Against my expectation in Hypothesis 2a, men with stable full-time

careers have lower hazards of fatherhood before age 30 than men with unstable careers, indicating that standard full-time men are associated with a slightly slower fatherhood transition in early ages. This could be a result due to the longer time spent on tertiary education for these full-time employed men, which prevents them from early-age family formation (Buchmann & Kriesi, 2011). However, full-time employed men catch up with and surpass unstable-career men in their pace to fatherhood after age 30. Eventually, a much lower cumulative hazard of fatherhood by age 40 has been observed for the latter group. Results in Figure 3-a also show that self-employed men have higher hazards of fatherhood transition comparing to standard full-time men, and that the gap between these two groups has already emerged in their early career lives. This finding supports Hypothesis 4a, indicating that self-employed men are associated with faster fatherhood transition in Taiwan.

Additional analyses in Figures 3-b and 3-c show that the career gaps of transition hazards among men extend beyond the fatherhood transition. Again, self-employed men lead all male groups in terms of the pace to the second and the third births. The cumulative hazards have converged between standard full-time men and unstable-career men in the third birth. Given the results in Figure 3a, these additional findings hint that the fertility deficit for unstable-career men might primarily reflect their difficulty of fatherhood transition after age 30.

4.4 Employment careers and fertility quantum

Finally, I use multivariate regressions to adjust for group differences in socio-demographic characteristics (i.e., the confounding effects) to estimate the associations between career types and numbers of children by age 40. Table 3 presents the average marginal effects (AMEs) of employment careers based on the Poisson regressions for women and men. Model 1 shows that women being economically inactive associates with 0.771 more children (*S.E.*= 0.128, p <.001) compared to being standard full-time employed. This result supports Hypothesis 1b, suggesting that women of unstable employment careers associate with a larger family size than women of stable careers. Self-employed women, compared to full-time career women, associate with 0.428 more children (*S.E.*= 0.140, p = .002). This finding supports Hypothesis 3b, suggesting that working as a self-employee may allow female workers in Taiwan to have more children.

For men, having an unstable career associates with a decreased fertility by –0.306 children (*S.E.*= 0.154, p = .047) compared to having a stable full-time career. In contrary, having a self-employed career, compared to a standard full-time career, associates with an

increased fertility by 0.330 children (*S.E.*= 0.104, p = < .001). Both findings on the relationship between men's careers and their number of children support Hypotheses 2b and 4b.

Table 3: Poisson regression models of the number of children for women and men by age 40

	Model 1				Model 2		
	AME	*S.E.*	*p-value*		*AME*	*S.E.*	*p-value*
Women's careers				Men's career			
Std. FT career	Ref.			Std. FT career	Ref.		
Interrupted	0.407	0.115	< .001	Self-employed	0.330	0.104	< .001
Inactive	0.771	0.128	< .001	Unstable career	-0.306	0.154	.047
Self-employed	0.428	0.140	.002				
Birth cohorts				Birth cohorts			
1946-57	Ref.			1946-57	Ref.		
1958-67	-0.401	0.104	< .001	1958-67	-0.620	0.114	< .001
1968-77	-1.036	0.120	< .001	1968-77	-1.032	0.107	< .001
At least one parent has a tertiary degree	-0.170	0.195	.384	At least one parent has a tertiary degree	-0.158	0.231	.493
Ethnic minority	-0.186	0.160	.246	Ethnic minority	-0.031	0.224	.888
Family economic background by age 15	-0.060	0.038	.112	Family economic background by age 15	0.001	0.037	.978
N of cases	507				585		

Notes: The table presents predictive average marginal effects (AMEs) from the Poisson regression models. Bootstrapped standard errors with 200 bootstrap repetitions are calculated. p-values are calculated from the two-tailed Wald tests.

4.5 Additional analyses on model robustness and cohort heterogeneity

In the Supplementary materials S2, I perform three additional analyses to supplement the main findings on the career-fertility quantum associations presented in Table 3. The first analysis further controls for one's highest educational level by age 40 in the Poisson models to account for the confounding effect related to educational differences (see Table S2.1). The second analysis uses a set of logistic regressions to model the parity-specific probabilities by age 40 (see Figure S2.2). Different from Poisson regressions of birth counts, this analysis makes no assumption on the fertility outcome distributions and allows a closer look into the parity composition of the group-specific fertility quantum. Results from both analyses confirm Table 3's findings that having a stable employment career associates with lower fertility for women but higher fertility for men; and a self-employment career may enhance both women's and men's fertility in Taiwan. Finally, I include a set of interaction terms between career types and cohorts in the Poisson models to explore whether and how these career-fertility relationships change over time (see Figure S2.3). In summary, Taiwanese

people's "fertility rankings" by career groups are relatively stable across cohorts, although the "fertility differentials" by career have changed over time. The positive association between interrupted careers and fertility increased for younger women; and the negative association between unstable careers and men's fertility enlarged.

5 Conclusion and Discussion

Research interest in how people's employment situations affect their family behaviors has been growing (Buhr and Huinink, 2014; Kreyenfeld et al., 2012), particularly in an era when Globalization meets Second Demographic Transition (Blossfeld and Mills, 2005; Mills and Blossfeld, 2013). In East Asia, increased female labor force participation and rising employment precarity for men have been linked to the significant postponement of parenthood and the remarkable reduction of fertility (Jones, 2007; McDonald, 2009; Piotrowski et al., 2018). The current study adds to these discussions by exploring the holistic associations between women's and men's career types and their timing and quantum of fertility in Taiwan.

Overall, my findings largely support the theoretical predictions on the gendered relationship between employment careers' stability and people's fertility behaviors in familistic countries (Hypotheses 1a, 1b, and 2b are fully supported; 2a is partially supported). For Taiwanese women, having a stable employment career in full-time positions relates to a delayed motherhood transition comparing to staying economically inactive before midlife. After adjusting for individual socio-demographic variations, women who have a standard full-time career are associated with a significantly lower fertility quantum by age 40 comparing to inactive women. For Taiwanese men, it is having an unstable career, not a stable full-time career, that depresses the fatherhood transition, parity progressions, and total fertility. While results in Figure 3 show that unstable-career men might have a faster fatherhood transition before age 30 comparing to men with standard full-time careers, this early vantage waned in men's later life courses. Eventually, having an unstable career associates with a decreased male fertility by –0.306 children comparing to having a standard full-time career.

Besides the sharp gender contrasts in fertility outcomes between women and men with the most stable and the most unstable careers, my findings highlight the third career pathway toward a high fertility life course in Taiwan for both genders—a self-employment career. As discussed in the theory section, previous research suggests that whether self-employment has a fertility-enhancing or -depressing effect depends largely on the degree of institutional supports to combine work with childcare and the resource-related plausibility of self-employment comparing to other career choices (Adsera, 2011a; Anthias and Mehta, 2003;

Matysiak and Mynarska, 2020; Noseleit, 2014). In Taiwan, given the shortage of work-family reconciliation policies (Bumpass et al., 2009; Gauthier, 2016) and the superiority of self-employees in mobilizing family resources (Lu, 2001; Yu and Su, 2009), self-employed women and men not only have a faster pace in parenthood transitions (Hypotheses 3a and 4a) but also a larger number of children by midlife (Hypotheses 3b and 4b) than their counterparts in a standard full-time firm employment track.

It is worth noticing that while the supplementary analysis in Figure S2.3 shows a relatively stable fertility ranking by careers in the sample, the fertility differentials by careers are changing especially among the recent cohorts. With parental leaves becoming more prevalent and childcare facilities largely expended since 2010, it will be an interesting topic to examine whether institutional changes can alter the career-fertility associations in Taiwan.

Beyond these substantive conclusions, this study also highlights the methodological advantage of investigating the life-course associations between employment "careers" and fertility "histories" using holistic approaches. Rather than analyzing isolated employment states in cross-sectional settings, this study uses holistic employment sequences between ages 18 and 40 to capture the idea of stability or instability in one's employment career (Biemann et al., 2012; Ciganda, 2015; Devillanova et al., 2019; Fuller and Stecy-Hildebrandt, 2015; McVicar et al., 2019). It also better illustrates the heterogeneity of employment life courses by documenting multiple career tracks. More importantly, this study investigates how different careers are associated with multiple fertility outcomes (i.e., timings and quantum) across gender. Its results complement previous research's focus on only one specific fertility outcome in certain ages for either women or men. In summary, the current study contributes to the emergent methodological emphases on providing a "thick description" of gender-specific work-family life courses (Aisenbrey and Fasang, 2017). It introduces work-family researchers in Taiwan and East Asia with a novel design to examine the theoretical interplay between employment and fertility over the life course as "process outcomes" (Abbott, 2016).

Some limitations are acknowledged. First, while using the holistic sequences is more informative than using cross-sectional states in capturing the *objective stability* of employment careers, it is still possible that a seemingly stable career trajectory did not translate into people's *subjective feeling of stability*. Future studies can extend the research by exploring how people's perceived job insecurity (Glavin et al., 2020) or narrative to the future (Vignoli et al., 2020) affects their fertility intentions and behaviors. Second, due to the limited retrospective information in the TSCS data, my analysis cannot control for individual heterogeneities in subjective attitudes toward work and family decisions. These attitudinal

differences, including career-family preferences (Vitali et al., 2009) or risk aversion attitudes (Schmitt, 2021), are potential factors moderating the employment-fertility relationship. Finally, readers should be aware that this study's approach is designed to test the theoretical predictions on fertility variations by career types (see the hypotheses section). As mentioned before, the theoretical relationship between employment and fertility is bi-directional (Matysiak and Vignoli, 2008), indicating that people's fertility is not only affected by but also affecting their careers. In this regard, the empirical approach applied in this study is not an optimal tool to tackle the causal effects of careers on fertility or vice versa because it cannot isolate the sequential order of causality. However, the empirical focus on how people's holistic careers associate with their fertility outcomes is justified from a life course perspective, given the fact that work-family trajectories are unfolding in a simultaneous institutionalization process (Huinink and Kohli, 2014; Krüger and Levy, 2001). The present study's in-depth investigation into the employment-fertility associations brings valuable insights to examine whether the life-course work-fertility relationships are converging between Taiwan and other low-gender-equity societies (McDonald, 2013), including other East-Asian countries and Southern-European countries.

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7 Appendix

Table A1: Descriptive statistics of variables in each subsample.

	Female sample		Male sample	
	Mean; %	Std. Dev.	Mean; %	Std. Dev.
Fertility variables				
Age at birth (given a birth event)				
Age at 1st birth	24.98	4.58	28.77	4.41
Age at 2nd birth	27.20	4.91	30.59	4.40
Age at 3rd birth	28.33	4.56	32.32	4.73
Number of children by age 40	2.27	1.18	2.05	1.16
Control variables				
Individual's birth cohort				
1946-57	32.94		31.11	
1958-67	35.11		37.61	
1968-77	31.95		31.28	
Parental education				
Both parents have non-tertiary educ	94.28		94.02	
At least one parent has tertiary educ	5.72		5.98	
Ethnic minority				
No	89.35		90.94	
Yes	10.65		9.06	
Family economic background by age 15 (1-5 scale)	2.84	1.11	2.80	1.09
Individual's highest educational level by age 40				
Primary	42.41		33.16	
Secondary	42.21		49.06	
Tertiary	15.38		17.78	
Number of cases	507		585	
Number of observations (person-years)	11,661		13,455	

Table A2: Selective comparisons of average Silhouette widths (ASWs) across different clustering methods.

Algorithm for calculating sequence distances matrix	Clustering procedure	Clustering solution for women			Clustering solution for men		
		N of clusters	ASW	Cluster-specific ASW	N of clusters	ASW	Cluster-specific ASW
OMspell	Ward	4	0.38	0.61; 0.30; -0.02; 0.62	3	0.49	0.55; 0.45; 0.21
HAM	Ward	4	0.40	0.54; -0.12; 0.47; 0.59	3	0.54	0.57; 0.59; 0.21
OMspell	PAM+Ward	4	0.41	0.53; 0.48; 0.11; 0.42	5	0.38	0.43; 0.45; 0.48; 0.47; 0.26
HAM	PAM+Ward	4	0.42	0.48; 0.33; 0.52; 0.19	3	0.57	0.63; 0.53; 0.27

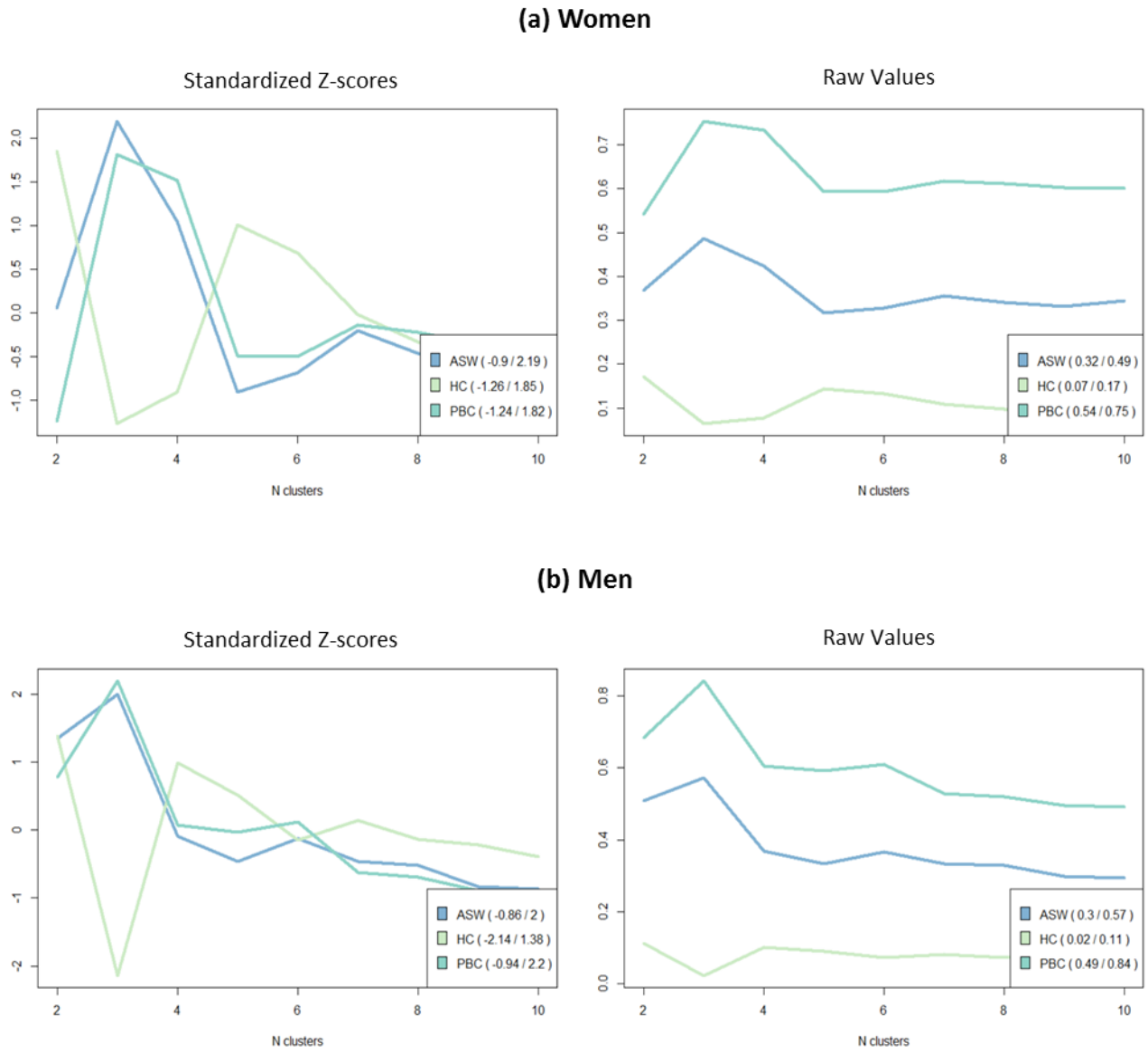
Note: The Silhouette width is a measure commonly used to evaluate the clustering quality. It compares the average distance of a sequence to sequences in its cluster with the average distance to the sequences in the closest clusters in a Euclidian space. At the global level, a higher average Silhouette width (ASW) for a clustering solution denotes a better clustering quality due to the averagely higher within-cluster homogeneity across subclusters. We can also use the cluster-specific ASWs to evaluate the closeness of sequences in each cluster. According to Table A2, the clustering results using the PAM+Ward method generally render a better global-level ASW. Both using the HAM algorithm for distance calculation, the PAM+Ward procedure outperforms the Ward procedure by scoring higher global-level ASWs for both genders. More importantly, women's results using the HAM with PAM+Ward method makes sure that every subclusters are appropriately specified by avoiding a negative ASW observed in one of the clusters in the HAM with Ward procedure (i.e., the subcluster with an ASW of –0.12).

Table A3: Poisson regression models of the number of children for women and men by age 40, conditioning on educational level by age 40.

	Model 1				Model 2		
	AME	*S.E.*	*p-value*		*AME*	*S.E.*	*p-value*
Women's careers				Men's career			
Std. FT career	Ref.			Std. FT career	Ref.		
Interrupted	0.251	0.121	.038	Self-employed	0.270	0.103	.009
Inactive	0.577	0.147	< .001	Unstable career	-0.381	0.179	.034
Self-employed	0.241	0.135	.074				
Birth cohorts				Birth cohorts			
1946-57	Ref.			1946-57	Ref.		
1958-67	-0.315	0.105	.003	1958-67	-0.539	0.103	< .001
1968-77	-0.847	0.137	< .001	1968-77	-0.918	0.122	< .001
At least one parent has a tertiary degree	0.027	0.218	.903	At least one parent has a tertiary degree	-0.097	0.218	.656
Ethnic minority	-0.220	0.150	.144	Ethnic minority	-0.017	0.209	.936
Family economic background by age 15	-0.016	0.042	.694	Family economic background by age 15	0.031	0.044	.487
Educational level				Educational level			
Primary	Ref.			Primary	Ref.		
Secondary	-0.407	0.099	< .001	Secondary	-0.222	0.105	.034
Tertiary	-0.729	0.156	< .001	Tertiary	-0.365	0.141	.010
Observation	507				585		

Note: The table presents predictive average marginal effects (AMEs) from the Poisson regression models. Bootstrapped standard errors with 200 bootstrap repetitions are calculated. p-values are calculated from the two-tailed Wald tests.

Figure A1: Partitioning quality indicators by clustering solutions.



Note: Using the PAM+Ward procedure for clustering, this study's method aims to allocate each sequence to their closest medoid. In this context, the higher the average Silhouette width (ASW), higher the intra-cluster closeness between sequences. Similarly, the higher the point biserial correlation (PBC), the closer the sequences within a cluster. The interpretation of the Hubert's C (HC) is from the opposite direction: the lower the HC, the better the intra-cluster closeness. For women. all three indicators indicate 3 clusters as the best solution, with 4 clusters being the second best in a close margin. After evaluating the substantive meaningfulness of clusters, I opt for the 4-cluster solution because rather than pooling all women with relatively long non-employment duration into one large group, the 4-cluster solution makes a theoretically meaningful distinction between the long-term "inactive career" and the "interrupted career." For men, all three indicators indicate 3 clusters as optimal.

Figure A2: Silhouette widths by cluster for women's four-cluster solution.

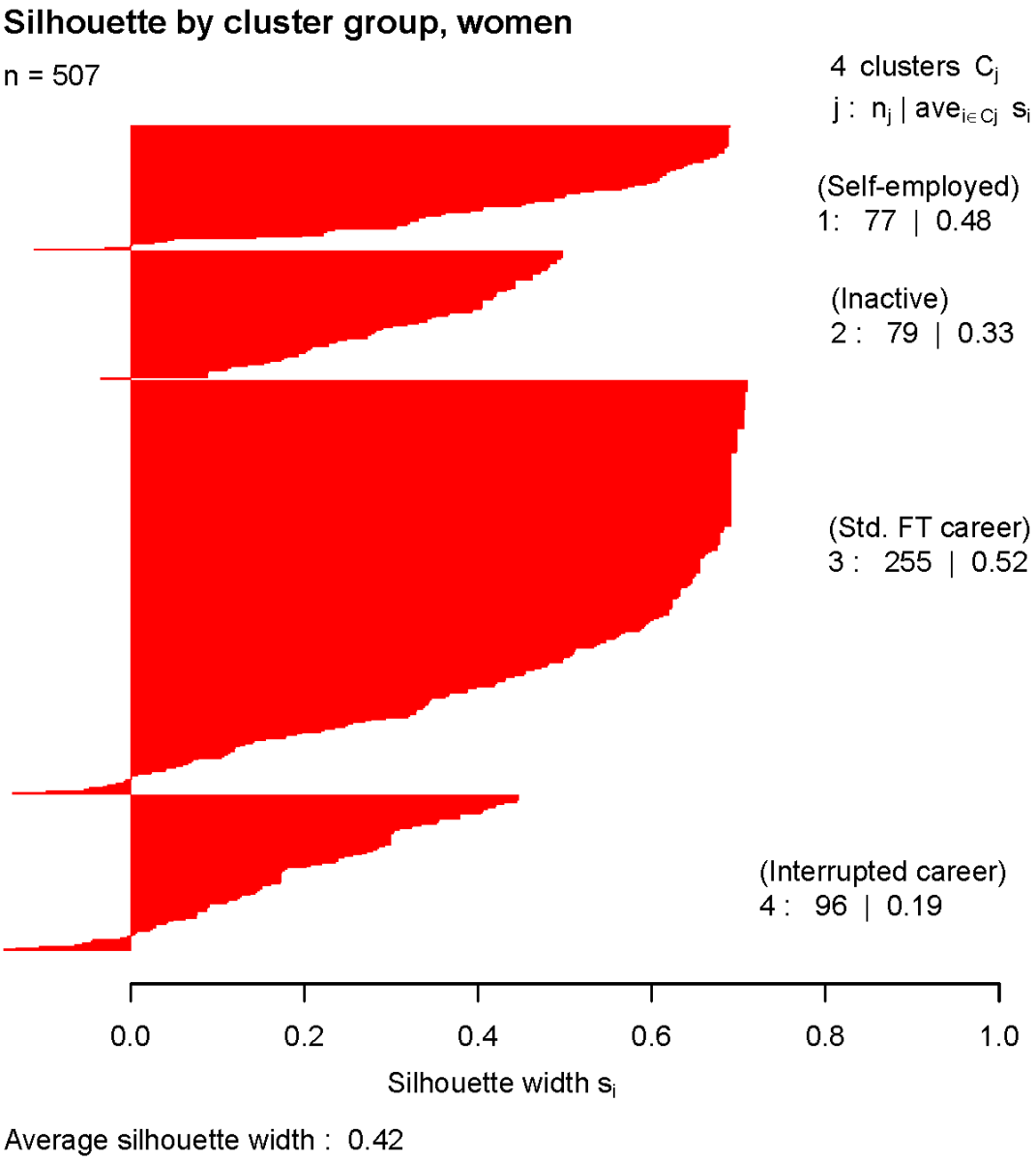
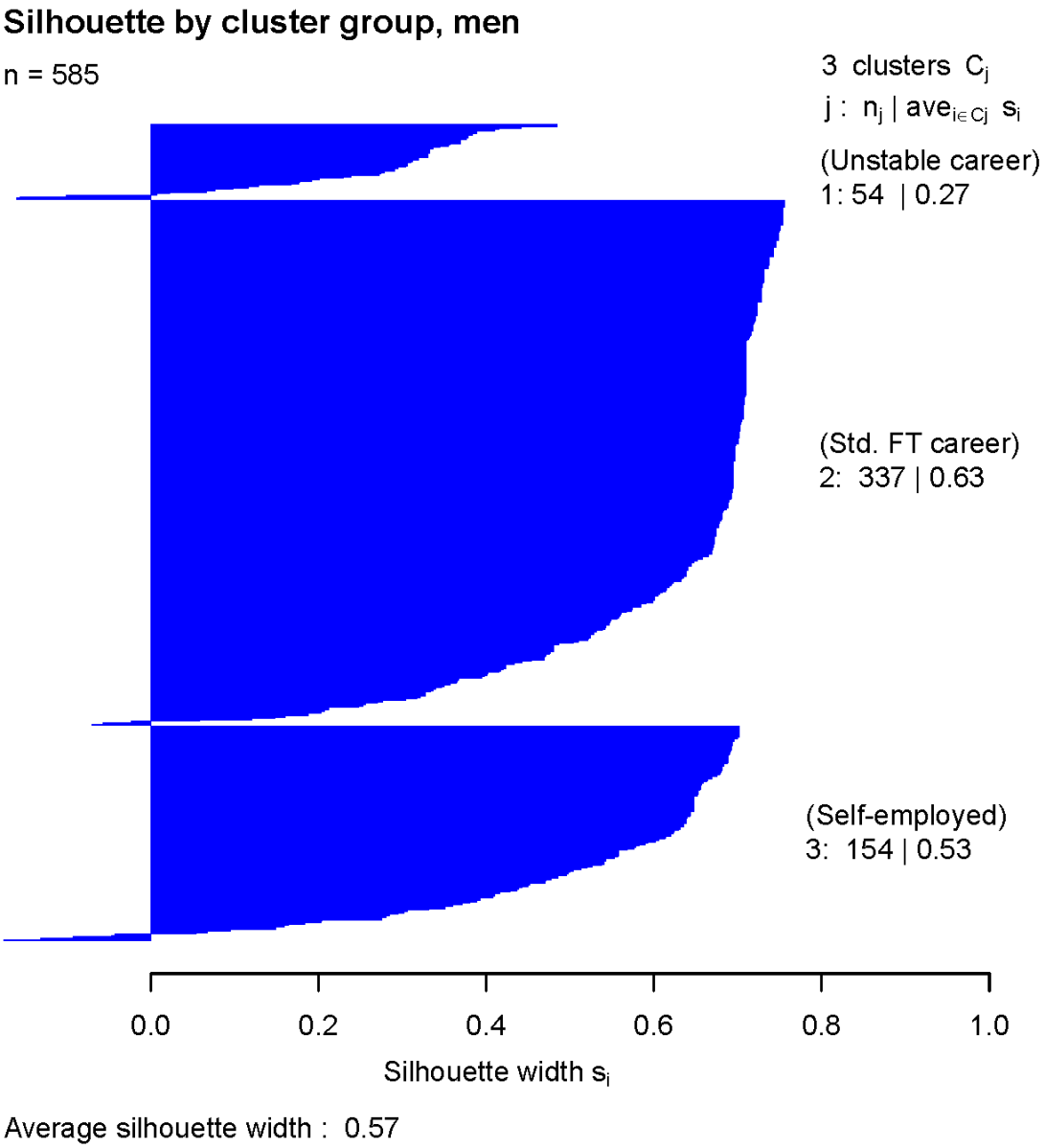


Figure A3: Silhouette widths by cluster for men's three-cluster solution.



8 Supplementary materials

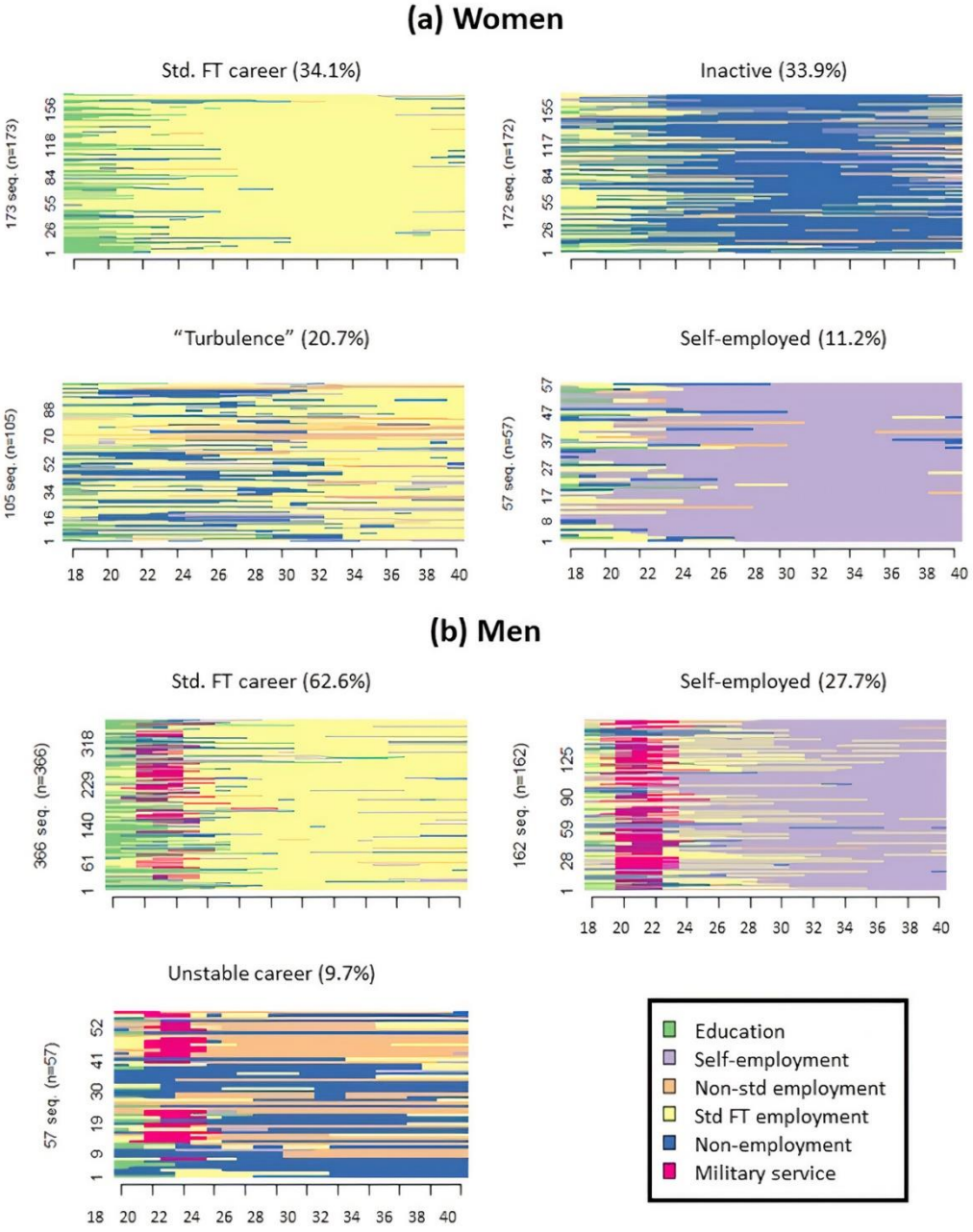
Supplementary material S1	Sensitivity analysis on the clustering results
Supplementary material S2	Additional analyses on model robustness and cohort heterogeneity

Supplementary material S1 Sensitivity analysis on the clustering results

This section performs a sensitivity analysis on clustering results by choosing another sequence distance calculation algorithm. I use the Optimal Matching of spells (OMspell) algorithm with an expansion cost $e = 0.5$ to calculate the distances matrix. Comparing to HAM, OMspell is more sensitive to the duration and the sequencing of spells (Studer & Ritschard, 2016). It thus serves as the benchmark algorithm to test whether shifting the theoretical focus from timing to the duration and sequencing of states will significantly change the clustering results.

Figure S1.1 visualizes the clustering results using the OMspell distance calculation. Partitioning quality measures indicate an optimal solution of four clusters for women and three clusters for men. In a substantive sense, the three clusters for men from the OMspell are identical to those identified from the HAM. For women, one cluster that used to represent the "interrupted career" from HAM is replaced by another cluster from OMspell's result, which might be defined as "turbulence" as there is no clear pattern in the timing or sequencing of states except for the higher frequency of transitions. From a statistical point of view, this newly found cluster from OMspell is not appropriately identified because the majority of sequences within this cluster has a negative Silhouette width (cluster average Silhouette = –0.02), signaling a bad intra-cluster homogeneity. The performance of global-level indices also favors the result from HAM because it outperforms the OMspell in both the overall ASW and PBC for women's 4-cluster solution and men's 3-cluster solution (see Table A2 in the Appendix for the comparison of global-level and cluster-specific ASWs between these two solutions).

Figure S1.1: Sensitivity analysis of clustering results using the OMspell algorithm.



Supplementary material S2 Additional analyses on model robustness and cohort heterogeneity

In this section, I perform three additional analyses to supplement the main findings on the career-fertility quantum linkage. Building on the Poisson models in Table 3, the first analysis further controls for individual's highest educational level by age 40 (see Table S2.1). Theories have pointed out that receiving higher education not only facilitates people's successful career development in the long run (Buchmann & Kriesi, 2011; Rosenfeld, 1992) but also influences his/her fertility behaviors in different cultural and welfare regimes (Begall & Mills, 2013; Huinink & Kohli, 2014; Lesthaeghe, 2010). Empirically speaking, one's educational level could serve as a crucial confounder in the relationship between careers and fertility and should be adjusted for in the regression models. However, the special feature of using longitudinal sequences as explanatory variables prevent the present study from including the education variable into the regression models because "in education" is an endogenous activity state forming the career sequences. In this context, adding the education variable that is endogenously determined by careers could introduce an overcontrol bias (Elwert & Winship, 2014). Nevertheless, coefficient estimates from the additional analysis could serve as the lower bars of the career effects on fertility, which have been isolated from the education-related effects. According to Table S2.1, the career "ranking" of fertility quantum is similar to what I have found in Table 3. Clear messages from both analyses are the same: (1) having an inactive career positively associates with women's fertility; (2) having an unstable career negatively associates with men's fertility; (3) compared to standard full-time careers, self-employed careers are associated with higher fertility quantum for both sexes. While the estimated career differentials in women's fertility quantum have decreased, these gaps remain unignorable from a statistical point of view. For men, the negative association between having an unstable career and fertility becomes even stronger. In summary, the similar patterns found in Table S2.1 confirm the robustness of my main findings in Table 3.

Secondly, I model the parity-specific probabilities by age 40 using a set of logistic regressions. Comparing to the Poisson regressions of birth counts, the logistic regressions of parity-specific probabilities have the advantage of not making any assumption on the outcome variable distributions. This modeling strategy also allows a closer look into the parity composition behind the group average of fertility quantum. Figure S2.2 presents the predicted marginal probabilities of women's (S2.2-a) and men's (S2.2-b) parity status by age 40.

Table S2.1: Poisson regression models of the number of children for women and men by age 40, conditioning on educational level by age 40.

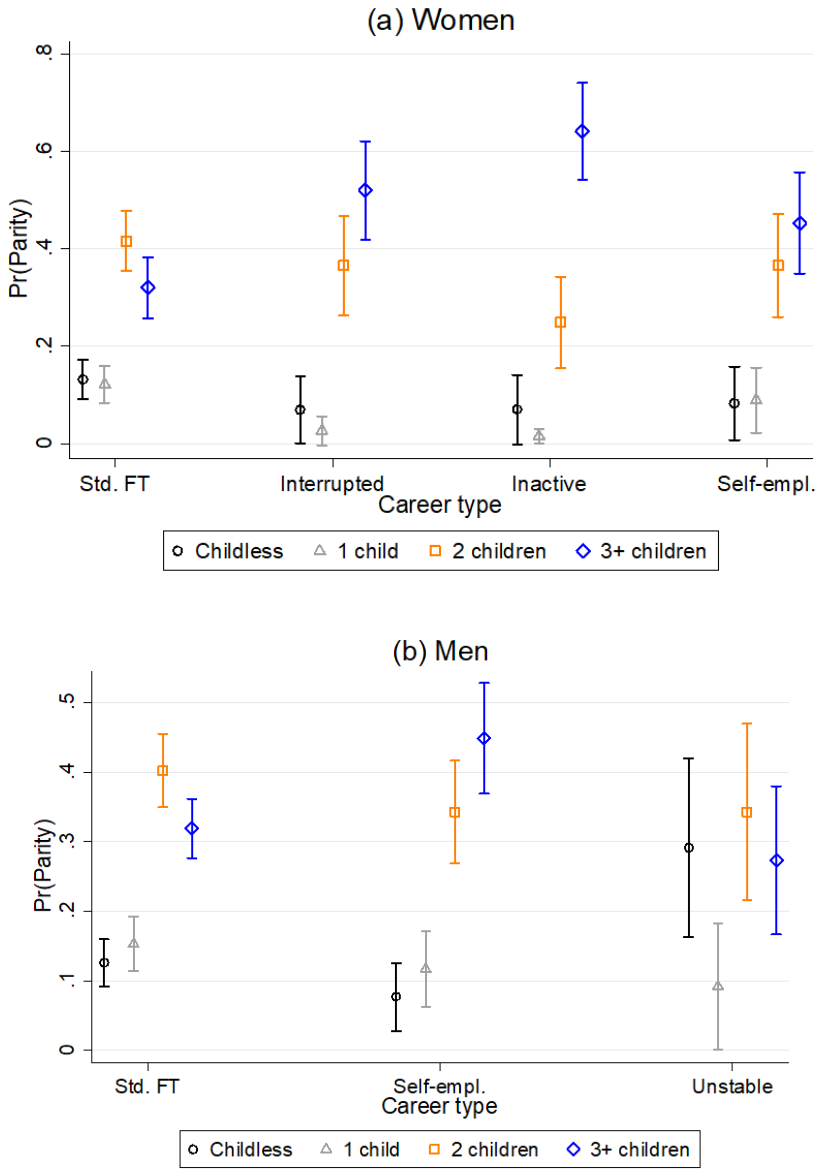
	Model 1				Model 2		
	AME	*S.E.*	*p-value*		*AME*	*S.E.*	*p-value*
Women's careers				Men's career			
Std. FT career	Ref.			Std. FT career	Ref.		
Interrupted	0.251	0.121	.038	Self-employed	0.270	0.103	.009
Inactive	0.577	0.147	< .001	Unstable career	-0.381	0.179	.034
Self-employed	0.241	0.135	.074				
Birth cohorts				Birth cohorts			
1946-57	Ref.			1946-57	Ref.		
1958-67	-0.315	0.105	.003	1958-67	-0.539	0.103	< .001
1968-77	-0.847	0.137	< .001	1968-77	-0.918	0.122	< .001
At least one parent has a tertiary degree	0.027	0.218	.903	At least one parent has a tertiary degree	-0.097	0.218	.656
Ethnic minority	-0.220	0.150	.144	Ethnic minority	-0.017	0.209	.936
Family economic background by age 15	-0.016	0.042	.694	Family economic background by age 15	0.031	0.044	.487
Educational level				Educational level			
Primary	Ref.			Primary	Ref.		
Secondary	-0.407	0.099	< .001	Secondary	-0.222	0.105	.034
Tertiary	-0.729	0.156	< .001	Tertiary	-0.365	0.141	.010
Observation	507				585		

Note: The table presents predictive average marginal effects (AMEs) from the Poisson regression models. Bootstrapped standard errors with 200 bootstrap repetitions are calculated. p-values are calculated from the two-tailed Wald tests.

For women working standard full-time, the highest probability is having 2 children (*Pr* = 0.415, *95% CI* = [0.353; 0.477]). However, for women in other career trajectories, the highest probability is having 3 or more children by age 40. Moreover, standard full-time women have the highest probabilities of staying childless (*Pr* = 0.131, *95% CI* = [0.090; 0.171]) or having only one child (*Pr* = 0.121, *95% CI* = [0.083; 0.160]) by age 40. A sharp contrast in midlife parity status is observed especially between standard full-time and inactive women. My estimation shows that inactive women have the highest probability of having more than three children and the lowest probability of staying childless. In summary, these results are in line with the findings in Table 3. They further suggest that the negative association between women's standard full-time career and fertility results mainly from a higher probability of staying childless and a lower probability of progressing to higher-order births. Results in Figure S2.2-b also support the findings for men in Table 3. Comparing to standard full-time men, men of unstable careers have a higher probability of staying childless (*Pr* = 0.291, *95% CI* = [0.163; 0.424]) and lower probabilities of having two (*Pr* = 0.343, *95% CI* = [0.216; 0.470]) or three children (*Pr* = 0.273, *95% CI* = [0.166; 0.380]). I also found that self-

employed men have the highest probability of having 3 or more children (*Pr* = 0.449, *95% CI* = [0.369; 0.528]) among Taiwanese men. These results confirm my findings that having an unstable career could depress men's fertility in Taiwan, while a self-employment career may enhance Taiwanese men's fertility.

Figure S2.2: Predicted marginal probabilities of women's and men's parity status by age 40 from parity-specific logistic regression models, by career type.

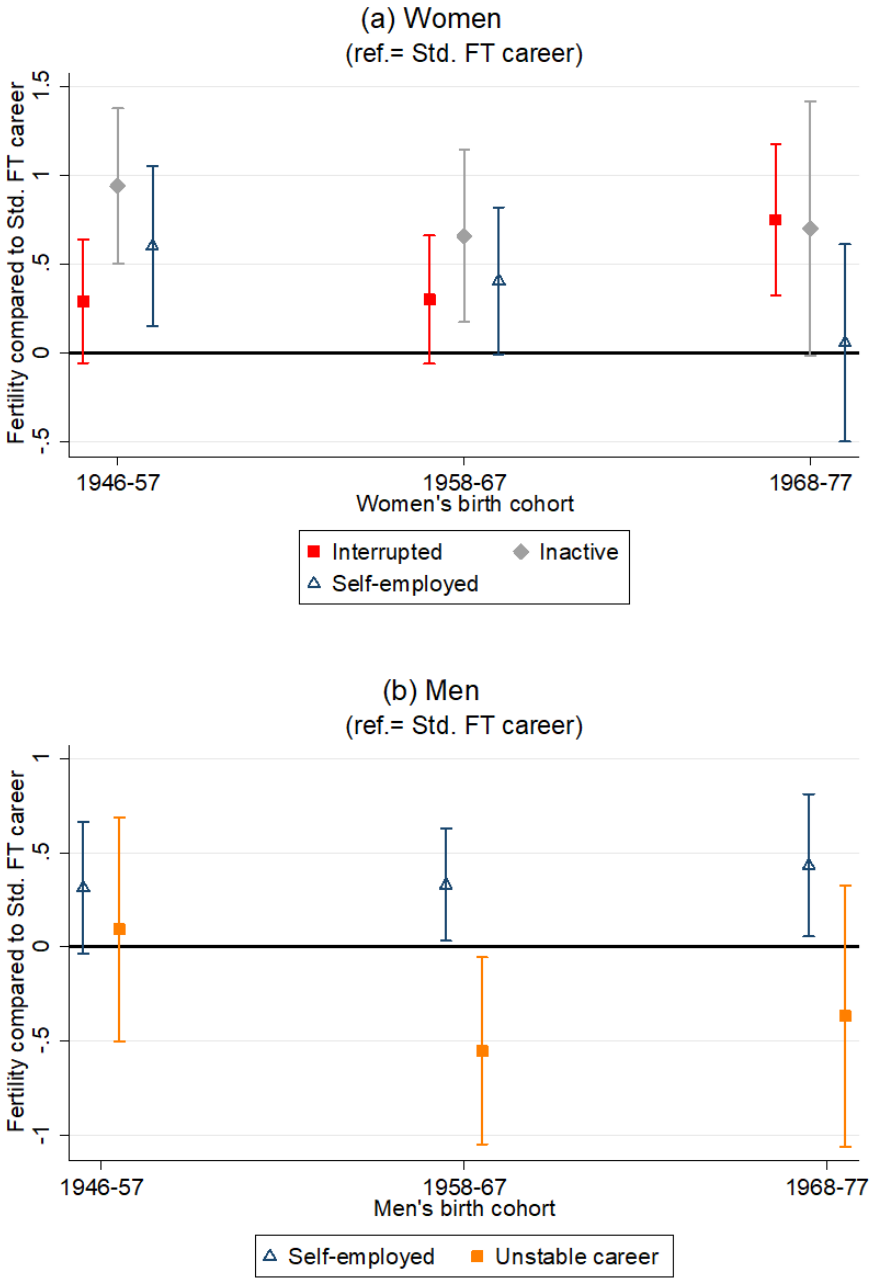


Finally, I include a set of interaction terms between career types and cohorts to the Poisson regression models to explore whether and how career-fertility relationships in Taiwan change across cohorts. Readers should notice that the following results are only supplementary and should be interpreted with caution due to small sample sizes in some

career–cohort interaction categories.[7] Figure S2.3 graphically summarizes the estimation results. According to Figure S2.3-a, comparing to being standard full-time employed, being economically inactive relates to women's significantly higher fertility across all cohorts, ranging from +0.66 children for the 1958–67 cohorts to +0.94 children for the 1946–57 cohorts. Meanwhile, the fertility surplus of self-employed women compared to standard full-time women has decreased over time, ranging from +0.60 children for the 1946–57 cohorts to only +0.06 children for the 1968–77 cohorts. Interestingly, having an interrupted career becomes more and more associated with higher fertility, particularly in the most recent cohorts. For men, Figure S2.3-b shows that the fertility surplus of self-employment comparing to a stander full-time career remains between +0.31 children for the 1946–57 cohorts and +0.43 children for the 1968–77 cohorts. More surprisingly, while having an unstable career does associate with lower fertility for men who were born after 1958, it does not negatively associate with men's fertility for the oldest cohorts. In a nutshell, my findings in Figure S2.3 indicate that Taiwanese people's "fertility rankings" by careers are largely stable over time, although the "fertility differentials" by careers have changed more significantly.

[7] For women, 5 out of the 12 career–cohort categories have a sample size fewer than 30 cases. For men, 3 out of the 9 career–cohort categories have a sample size fewer than 30 cases.

Figure S2.3: Effects of career types on fertility quantum from Poisson regression models, by gender and birth cohorts.



Note: Point estimates of the average marginal effects (AMEs) are calculated from the Poisson models, which control for individual's birth cohort, parental education, ethnicity, and family economic background by age 15. Bootstrapped confidence intervals (95% confidence level) from 200 repetitions are presented.

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Study IV:

Parity-specific Motherhood Penalties:

Long-term Impacts of Childbirth on Women's Earnings in Japan

Status: Published in *Advances in Life Course Research*

Citation: Hsu, C.-H. (2021). Parity-specific motherhood penalties: Long-term impacts of childbirth on women's earnings in Japan. *Advances in Life Course Research*, *50*, 100435, 1–12. https://doi.org/10.1016/j.alcr.2021.100435

Acknowledgements: Data of this research are provided by the Panel Data Research Center, Keio University (Project ID: 1218). The author thanks Michael Gebel and Henriette Engelhardt for their insightful comments on the earlier version of this article. The author was financially supported by the DAAD Graduate School Scholarship Programme during his research.

Abstract

The issue of motherhood earnings penalty has been well-documented in many Western countries. However, only a few studies discussed how earnings penalty evolves over time and varies across different parity of birth. Moreover, related research in non-Western developed countries is scant. This study contributes to the motherhood penalty literature by examining the long-term impacts (up to 10 years after childbirth) of the first and the second birth on women's employment, work hours, wage rates, and earnings in Japan. It proposes a novel research design based on the event-study approach and fixed effects regressions to quantify the dynamic effects of motherhood resulted from two consecutive birth transitions. Drawing on longitudinal data from the Japanese Panel Survey of Consumers (from 1993 to 2015), our results show that both the first and the second birth trigger short-term earnings penalties by causing a considerable employment slump upon pregnancy. In the long run, while women's employment rates recover, work hours and wage rates remain significantly lower than their pre-pregnancy level, leading to the long-term earnings penalty. More importantly, the long-term negative impacts of childbirth on labor supply and wage rates result mostly from women's first-time rather than the second-time birth transition in Japan. These findings imply that motherhood in Japan imposes long-term penalties on women's earnings, primarily by depressing maternal labor supply after their first-time motherhood transition.

1 Introduction

Despite the considerable convergence in male and female labor market opportunities during the last few decades, the gender gaps in earnings continue to be substantial in many developed countries. A key feature behind the gender earnings gap is the "motherhood earnings penalty." Scholars have claimed that the long-term negative impact of childbirth on women's paid working careers is central to the "stalled gender revolution" where gender inequality persists (England, 2010). While motherhood penalties in women's earnings and wages have been well documented (Cukrowska-Torzewska & Matysiak, 2020; de Linde Leonard & Stanley, 2020), most studies tackled the issue from a static perspective and underemphasized its dynamic nature across life stages (Kahn et al., 2014). Following scholars' call for life-course research on work-family relationships (Jalovaara & Fasang, 2020; Winkle & Fasang, 2020), the current study would like to know: How long does the motherhood penalty persist? And whether working mothers can catch up with their pre-motherhood career track in later lives? Using longitudinal microdata and dynamic modeling strategies, previous studies in North America and European countries have reported significant earnings penalty for a woman within her first few years after childbirth (Cools & Strøm, 2016; Kleven, Landais, & Søgaard, 2019; Mari & Cutuli, 2020; Musick et al., 2020; Sieppi & Pehkonen, 2019, 2019; Van Winkle & Fasang, 2020; Zhang, 2010). However, the long-term earnings impacts of childbirth and their trajectories differ across countries. The largest and the most persistent earnings penalty has been found in Austria and Germany, while a relatively mild earnings penalty is observed in Scandinavian countries (Kleven, Landais, Posch, et al., 2019).

The current study adds to the emerging literature on the long-term trajectories of motherhood earnings penalty by exploring the case of Japan. While Japan is an important case for studying motherhood penalties due to its highly intertwined work-family trajectories (Yu, 2009), empirical studies in this country are limited and mostly rely on cross-sectional data. Two studies used panel data and fixed effects regressions to quantify a 4–6% residual wage penalty per child (Kawaguchi, 2008; Takeuchi, 2018). However, their static approach provides little evidence on how motherhood wage and earnings penalties evolve over time. The current study fills the gap by quantifying the ten-year trajectories of motherhood earning penalties since women's birth transitions in Japan.

Another focus of this study is to tackle the heterogeneous effects of motherhood transitions across different parity of birth. Researchers have long argued that the opportunity costs of childbirth are "parity-specific" (Diprete et al., 2003) and that women's career pathways may

diverge after each birth transition (García-Manglano, 2015; Hynes & Clarkberg, 2005). While many studies have reported larger wages and earnings penalties for women with multiple children (Budig & England, 2001; Davies & Pierre, 2005; Petersen et al., 2010; Takeuchi, 2018; Van Winkle & Fasang, 2020; J. Yu & Xie, 2018), only few studies investigate how these aggregate penalties are generated across different birth transitions (de Hoon et al., 2017; Doren, 2019b; Zhang, 2010). Such an empirical gap remains because most studies discuss the parity differentials of motherhood penalties based on women's *motherhood status* rather than focusing on the causal effect of *each birth event*. Theoretical discussions regarding the different mechanisms operating behind the first and the higher-order birth transitions are also limited. Against the background, our study provides a systematic literature review and proposes a novel design using fixed effects panel regressions in the event-study framework (Kleven, Landais, & Søgaard, 2019; Mari & Cutuli, 2020; Musick et al., 2020) to quantify the dynamic effects of two consecutive childbirth events (i.e., the first and the second birth) on women's earnings. Our method permits a more accurate estimation of the long-term motherhood impacts of these two interconnected yet separately defined birth transitions.

It is worth highlighting that the motherhood earnings penalty comes potentially from three economic channels: lowered employment rates, reduced work hours, and declined wage rates. Rather than focusing only on employed women's wage penalty, recent studies have shown valuable insights by considering all channels contributing to mothers' earning losses (Cools et al., 2017; Kahn et al., 2014; Kleven, Landais, & Søgaard, 2019; Mari & Cutuli, 2020). In many cases, women's long-term earnings prospects may depend more on their post-motherhood labor supply (including employment and work hours) rather than on their wage rates (Cools et al., 2017; Kleven, Landais, & Søgaard, 2019). Using rich data from the Japanese Panel Survey of Consumers (JPSC, years 1993-2015), I explore the long-term effects of the first and the second birth on women's labor supply and earnings in Japan. Our findings not only enrich East Asian family studies but also shed light on how life-course relationships between family and work may differ in a non-Western social context (Mayer, 2009; W. Yu, 2009).

2 The Japanese context

Being the first East Asian country to modernize, Japan has long been influenced by Western economics and welfare policies. Like many developed countries, Japanese society has changed during globalization and post-industrialization. With the rapid expansion of service sectors and female education, women's employment opportunities have largely increased since the 1980s. From 1980 to 2015, Japan's female labor force participation rate (ages 15-64) increased from

52.5% to 66.7%, comparing to 66.9% for the US in 2015 (OECD, 2020). Meanwhile, the number of dual-income households has surpassed that of the single-income, male-employed households (Fig. 1-a).

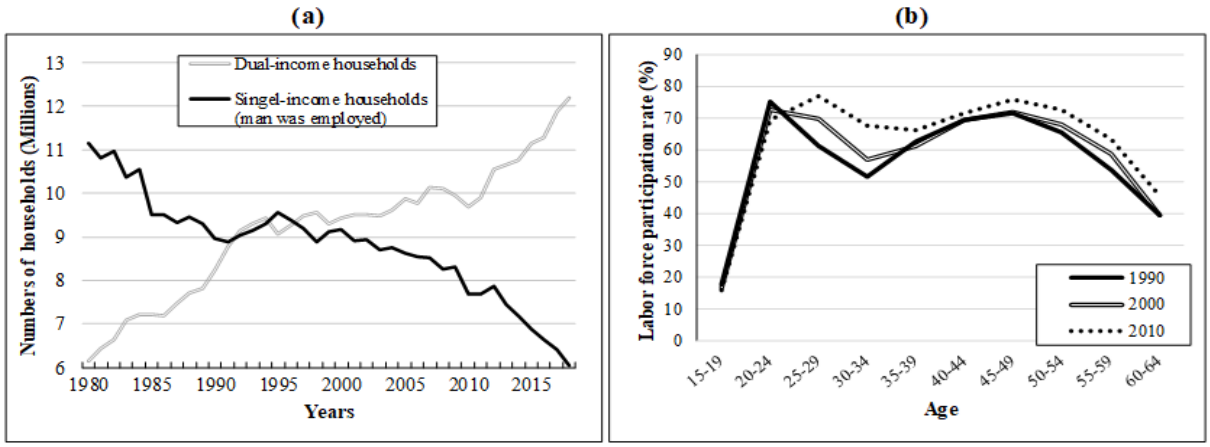

Fig. 1. Changes in household economic foundation and women's employment in Japan.

Note: (a) Numbers of dual-income and single-income households in Japan, 1980-2018. (b) Age-specific labor force participation rates for women aged 15-64, 1990-2010.

Source: *Japanese Labor Force Survey*, Statistical Bureau of Japan; the *OECD.Stat*

Although the economic foundation of Japan's male-breadwinner social system has deteriorated, the system's cultural and institutional bases remain, creating significant obstacles for women to combine work with family (Tsuya & Bumpass, 2004). Japan and South Korea are the only two OECD countries that continue to demonstrate the "M-shaped" curves in female labor force participation rates (Fig. 1-b), where the youth and the mid-age women have higher employment rates than women aged 25 to 40—the prime ages for childbirth. Japan also records one of the highest gender earnings gaps in the developed world: Japanese women only earn 76.5% of men's median earnings (OECD, 2020). These aggregate-level patterns reflect the mutually inhibited relationship between women's work and family formation in Japan (Tsuya & Bumpass, 2004).

On the one hand, the Japanese family system is influenced by the Confucian family model, which applauds women's ultimate role as a housekeeper and a caring mother (Bumpass et al., 2009). Even in recent years, performing family duties rather than pursuing an employment career is still considered a life priority for many women (Piotrowski et al., 2019). Meanwhile, Japanese women usually face strong social expectations of intensive parenting after family formation while receiving little help from their husbands (Raymo et al., 2015).

On the other hand, the Japanese labor market has been structured around male breadwinners and predisposes employers against hiring women with children (Boling, 2015). Japan has a closed employment system where workers' labor market opportunities are rigidly stratified (Nishimura, 2016). It has a long history of implementing the seniority-based promotion system, in which employers commit to honoring the tenure employment contract and rewarding those who are intermittently loyal to the same company (Brinton & Oh, 2019). Standard employees are expected to fulfill employers' demands without hesitation, even by sacrificing their time with family and children (Yu, 2009). This institutional constellation has created a "long-hours" workplace culture in Japan (Boling, 2015; Brinton & Oh, 2019), which is very hostile to working women with young children.[8]

With a foreseeable labor shortage in the context of low maternal labor supply, the Japanese government has implemented a series of family policies since the 1990s (see Yamaguchi (2017) for a review). Major reforms on parental leave policies were introduced during the early 2000s, including raising the cash benefit from a 25% replacement rate to 40% in 2001 and extended policy eligibility to cover limited-term contract workers in 2005.[9] Meanwhile, the percentage of 0–5 years old children enrolled in formal childcare centers also raised from 25% in 2000 to around 30% in 2005 under the New Angel Plan's guideline (1999-2004) (Yamaguchi, 2017). However, the stimulating effects of the 2001 parental leave reform and the childcare expansions since the late 1990s on maternal reemployment have been limited (Asai 2015; Asai et al. 2015), partly due to the still limited childcare supports for mothers to work in a time-demanding full-time job when they return to the labor market. Such policy inefficacies imply that childbirth transitions have unique social implications on women's working careers in Japan other than simply posing economic constraints.

In summary, the double burden of demanding workplace culture and family responsibilities leaves many women with limited choice but to settle for less demanding part-

[8] In 2010, 33% of men and 15% of women aged 15-64 worked more than 48 hours per week in their paid jobs (comparing to 17% of men and 4% of women in Germany or 17% of men and 7% of women in the US) (ILO, 2011).

[9] Japan's parental leave policies have been reformed several times since the early 1990s. A job-protected, no-payment parental leave until the child reach age 1 was first introduced in 1992. It only covered workers who had a permanent contract and worked at firms with 30 or more employees. In 1995, an amendment to the Parental Leave Act removed the firm size restriction and introduced a cash benefit with a 25% replacement rate. In 2001, the replacement rate of cash benefit during the one-year parental leave rose to 40%. In 2005, a major reform further extended the leave eligibility to cover all workers, including those who worked with a limited-term contract. The cash benefit replacement rate for the 44 weeks paid parental leave further rose to 50% in 2007. Overall, parental leaves policies in Japan have wider coverage rates and replacement rates over time. The proportion of mothers taking parental leave has increased from 49.1% in 1996 to 81.5% in 2015 (MHLW, 2018).

time jobs[10] or retire from the labor market entirely upon family formation (Lim & Raymo, 2014; Yu, 2009). Women quitting their full-time jobs during pregnancy is expected implicitly among Japanese employers (Boling, 2015; Yu, 2009). Once leaving the standardly employed positions for childbirth, many women cannot reenter the labor market with a job of comparable quality and wages as their previous ones (Raymo & Lim, 2011). It is clear from previous research that having children in Japan negatively affects women's earnings by lowering their employment, work hours, and wages to some extent. However, we do not know whether mothers could recover their pre-birth career track in the long run. We also have little knowledge about the career impacts of second birth in Japan, although researchers have underscored that the high opportunity costs of motherhood were keeping many Japanese women from having more than one child (Brinton & Oh, 2019). The following section builds on multiple theories to formulate our hypotheses on the time dynamics and birth-parity heterogeneities of motherhood earnings penalty in Japan.

3 Theory and Hypotheses

3.1 Motherhood and career penalties: the theoretical foundation

Four lines of literature laid the theoretical foundation of the motherhood penalty research. Firstly, *the human capital theory* highlights that women's child-related employment interruptions may disrupt human capital accumulation and, in some cases, may cause the depreciation of skills (Becker, 1985). Lowered human capital among mothers creates a disadvantage in labor productivity compared to non-mothers, thereby leading to a lower wage return. Following this theory, mothers' cumulatively lower working experiences (Anderson et al., 2003; Budig & England, 2001) and more extended periods out of the labor market for childcare (Aisenbrey et al., 2009) are usually referred to as the central mechanisms causing motherhood penalties in wages and earnings.

Secondly, women's *career adaptation to work-family role conflicts* around childbirth may lead to lower labor supply and wages. From an economic perspective, Becker (1991) argued that women's workplace productivity should decrease after childbirth because taking care of children may exhaust the effort and resources that could have been invested in career development. Sociological explanations further emphasize the work-family role conflict after

[10] In Japan, working "part-time" (*paato*) does not necessarily mean working short hours. A part-time work usually refers to an employment status without regular benefits, promotion opportunities, and job protected contracts compared to the standardly employed full-time positions.

motherhood and its negative impact on women's work efforts (Bielby & Bielby, 1988). Strenuous family obligations embedded in a mother's role routinize women's homemaking and childcaring behaviors (Macmillan & Copher, 2005; Moen, 2018). The inflexibility of childcare tasks may cause time pressure and exhaustion, which discourages women from highly attached to the labor market (Anderson et al., 2003; Greenhaus & Beutell, 1985; Kühhirt & Ludwig, 2012). The need for flexibility to combine work with family triggers women's subsequent reactions to reduce their work hours or to settle with "family-friendly" jobs (Glass, 2004), which may also lead to lower wage returns in the long run (Anderson et al., 2003).

Thirdly, women's post-childbirth career decisions reflect their *work-family preferences and commitment*. According to the preference theory (Hakim, 2000), most women follow an "adaptive preference" to work-family lives, combining employment and family works without giving a fixed priority to either. Around the time of childbirth, women may adjust their work-family preferences in favor of their current role as a mother. In a similar vein, women's work commitment tends to weaken after childbirth due to more exposure to family-oriented environments (Bielby & Bielby, 1984). Both changes in work-family preferences and commitment after motherhood may influence women's labor market behaviors (Evertsson, 2013), leading to lower labor supply and wage returns (Bielby & Bielby, 1984; Gangl & Ziefle, 2015).

Finally, the *status-based discrimination* against working mothers is another source of motherhood penalties (Correll et al., 2007; Correll & Benard, 2006).[11] Because the socially constructed role characteristics of "a mother" are, in general, contradictive to those of "an ideal worker," tension between these two culturally incompatible schemas could bias employers'

[11] There is another form of discrimination called statistical discrimination (Arrow, 1973; Phelps, 1972), which is often referred to in the economic literature of motherhood penalty. The theory of statistical discrimination in Phelps's original formulation builds on three assumptions: (1) there are "real" differences in the average marginal productivity across statistical groups; (2) employers' information to recruit or evaluate employees' performance is incomplete (i.e., biased information); and (3) employers are rational and risk-averse (i.e., unbiased employer decisions). Based on these assumptions, the theory of statistical discrimination predicts that employers may prefer non-mothers than mothers as recruit or promotion candidates because hiring mothers are on average riskier under the situation of incomplete information. It is worth noticing that the subtle mechanistic differences between the status-based discrimination and the statistical discrimination could predict differently in terms of motherhood penalty (Correll & Benard, 2006). The former builds on the sociological theory of systematic discrimination against a devalued social status (e.g., mothers), while the latter builds on the economic theory of transaction and information costs. Given the "complete information" on a mother's and a non-mother's productivity, the theory of statistical discrimination predicts that employers will have the same evaluation on these two candidates if they show similar experiences and workplace capability, while the status-based discrimination theory predicts that the employer will make an evaluation in favor of the non-mother. In the current study, I focus on the status-based discrimination for theoretical deduction (Correll et al., 2007) because it involves social mechanisms distinct from the productivity-based explanations that have been discussed above (i.e., the human capital theory and the career adaptation explanation). Emphasizing status-based mechanisms also allows us to formulate a coherent theoretical prediction regarding childbirth's heterogeneous earnings effects across parity of birth.

evaluation on working mothers' work commitment (Correll et al., 2007). In some cases, mothers who outperform their non-mother colleagues in work are even discriminated because their labor market competitiveness may violate the social norm that mothers should cary feminized caring characteristics and act less aggressively in the workplace (Benard & Correll, 2010).

Based on these theories, previous research has shown that motherhood could negatively affect women's labor supply (Doren, 2019; García-Manglano, 2015; Gash, 2009; Yu, 2009) and wage rates (Budig & England, 2001; de Hoon et al., 2017; Kühhirt & Ludwig, 2012; Yu & Xie, 2018), which ultimately create motherhood penalty in women's earnings (Budig et al., 2016; Cools et al., 2017; Kleven, Landais, Posch, et al., 2019; Kleven, Landais, & Søgaard, 2019; Lundberg & Rose, 2000).

3.2 The long-term effects of motherhood

From a dynamic perspective, the theories above predict two contradictory trajectories of post-motherhood earnings. The first hypothesis suggests a *cumulative disadvantage* in women's earnings profiles after the motherhood transition. According to the career adaptation explanation, working mothers may experience a long-term reduction in workplace productivity because their energy invested in childcare continuously crowds out work effort invested in employment careers. Meanwhile, working part-time or shifting to the "family-friendly" track may halt women's progress on the career ladder (Abendroth et al., 2014; Gash, 2009; Stojmenovska & England, 2020). Mothers who have extensive employment interruption also tend to suffer downward career mobility upon their labor market reentry (Aisenbrey et al., 2009). Besides, women's work-family preferences are emerging in an "adaptive process," where gender role attitudes and labor market experiences are dynamically reinforced (Hakim, 2000). For women following a husband-breadwinner-wife-homemaker division of labor, specialization in domesticity could reshape women's anchoring identity from being a worker to a mother, resulting in a persistently downward trend of career commitment (Evertsson, 2013). From employers' perspective, family formation and the following time out of work may signal female workers' increasing commitment to family, which produces negative perceptions about working mothers and reduces their wage bargaining power (Correll et al., 2007). This status-based discrimination triggers a persistent discrepancy of labor market returns between mothers and non-mothers, even with equivalent work effort and human capital.

On the contrary, some theories suggest a *declining motherhood penalty* in the long run. Firstly, women's work and family roles are the most conflicting right after the motherhood transition. Mothers of young children usually shoulder strenuous family duties and childcare tasks, especially in a male-breadwinner-female-homemaker family system (Kühhirt & Ludwig, 2012). The time-inflexible nature of toddler childcare causes a short-term surge of work-family conflicts. However, as children grow older, alternative childcare channels such as kindergarten gradually take over mothers' childcare responsibilities. Such alleviation of work-family role conflicts is one reason why many inactive female workers reenter the labor market again in their midlife (Yu, 2009). Secondly, according to the human capital theory, career breaks for childrearing halt women's skill formation processes. However, the process of human capital accumulation is time-neutral and can be resume at any life stage (Becker, 1985). When mothers reenter the labor market, their workplace skills are polished, leading to a re-accumulation of human capital. Following this logic, the gap in human capital between mothers and non-mothers should shrink over time, suggesting a declining motherhood penalty in older ages (Van Winkle & Fasang, 2020).

3.3 Parity matters: effect heterogeneity across birth transitions

Do motherhood penalties occur mostly around the first-time birth transition? Or do they intensify after women's second birth transition? Empirical evidence on this issue is inconclusive. Some studies reported significant wage penalty related to the second or the higher-order births (Budig & England, 2001; Davies & Pierre, 2005; Doren, 2019b; Takeuchi, 2018; Van Winkle & Fasang, 2020; Zhang, 2010), while others found that most motherhood wage penalty occurred during the first-birth transition (de Hoon et al., 2017; Kühhirt & Ludwig, 2012). Theories also point to two opposite hypotheses: one focuses on *the first birth as a pivotal transition* in women's working careers, while the other refers to *the second birth as a tipping point*.

First, individuals structure their career pathways according to ongoing role configurations (Macmillan & Copher, 2005). Because becoming a mother has been granted enormous socioeconomic meanings, it is expected that women's major career adaptation takes place around the first-time motherhood transition. The most drastic employment reduction has been observed shortly after the first birth (Doren, 2019a). Women are also more likely to switch to less privileged occupations (Abendroth et al., 2014) or part-time jobs (Ejrnæs & Kunze, 2013) following the first-time motherhood transition. Second, the economy of scale (Nelson, 1988) predicts that women's marginal energy spent on an additional child should decrease with the

rising number of children because prior experiences and existing resources could be used for multiple childcare tasks. Third, Individual preferences also cope with concurrent role configurations. Because becoming a mother for the first time is often marked as a "life-changing event" (Baxter et al., 2015), the subsequent identity change may foster women's affirmative adaptations to conservative family attitudes and depress commitments to career development. Fourth, the theory of status-based discrimination also predicts parity differentials. Motherhood is a "status characteristic" to which the widely held social expectations and cultural beliefs are attached (Correll et al., 2007). With salient work-restricted expectations binding to this status characteristic, employers tend to have biased evaluations of working mothers' competence and workplace commitment. Following the logic, women's life status transition from "single workers" to "working mothers" signals their compromise on working careers. These four theories highlight *the first birth as a pivotal transition* in women's career life courses, implying that women may experience a more considerable earnings penalty following their first birth rather than the second birth transition.

A contradictive opinion argues that women's career penalties are mostly triggered by having a second child. Some women, especially those with higher educational degrees, would still carry on their career plans after the first birth and strive to balance work and family lives. However, up to the second birth, their effort to "have it all" is no longer possible, leaving them with no choice but to compromise working careers (Doren, 2019b; Slaughter, 2012). According to Cools et al. (2017), having a second child leads to a marginal increase in the existing work-family conflicts, which may further depress mothers' workplace productivity. Moreover, the cumulatively longer career breaks and lower working experience may depreciate women's human capital, leading to even lower career prospects (Aisenbrey et al., 2009). Higher financial costs of institutional childcare could also trigger women's labor market exit to take care of multiple children (Givord & Marbot, 2015). In summary, these arguments predict that one's career *tipping point* only comes after the second birth, beyond which one's efforts to reconcile work development with family needs become infeasible. This hypothesis suggests a more considerable earnings penalty following the second birth transition.

3.4 Research hypotheses in the Japanese context

In modern Japanese society, people's gender role attitudes toward couple division of labor and women's employment remain relatively conservative than other Western developed countries (Piotrowski et al., 2019). With the prominent social norms on mothers' childrearing roles, many

women reduce labor supply by dropping out of the labor force or switching to a part-time job after family formation (Raymo & Iwasawa, 2016; W. Yu, 2009). Meanwhile, the closed employment relationship and the highly specialized firm- or sector-specific training system indicate that an "uninterrupted" human capital accumulation is crucial for workers' long-term career prospects in Japan, creating another career disadvantage for working mothers (Nishimura, 2016). Along with these conditions, I also expect more persistent status-based discrimination against working mothers "as a group," regardless of their parity status. Taken together, in terms of the effect dynamics over time, I predict that motherhood earnings penalty in Japan is more likely to follow the *cumulative disadvantage hypothesis*, which predicts a long-term reduction in women's earnings after childbirth without a sign of recovery. In terms of the effect heterogeneity across birth transitions, I expect that the most significant earnings penalty should be observed following Japanese women's first motherhood transition (i.e., the *first-birth pivotal transition hypothesis*).

4 Method

4.1 Data

Our data came from 23 waves of the Japanese Panel Survey of Consumers (JPSC), collected between 1993 and 2015. The JPSC is an annual survey project with nationally representative samples of young adult women in Japan. The first wave of the JPSC was launched in 1993, where 1,500 women aged 24-34 were sampled. Four refreshment samples were added consecutively in 1997, 2003, 2008, and 2013, which targeted young women aged 24-28 in the baseline years. A long observational window of relatively young cohorts (cohorts 1959-1989) makes the data suitable for studying women's family formation and its long-term career impacts. The raw dataset included 41,996 person-years from 4,120 female respondents. Focusing on the interplay between work and family, I excluded those who had never participated in the labor force during the survey years (3,091 person-years from 471 respondents) and those person-years without valid working and employment records (156 person-years). I also excluded two persons (26 person-years) who had inconsistent answers to child-related information. For fixed effects estimates, I excluded 289 respondents who had only one interviewed record. The remaining sample included 38,437 person-years from 3,358 women, among whom 902 had their first birth and 737 had their second birth during the observational period. Using the remaining sample, I constructed two subsamples for our panel analyses. In the first-birth transition model, 20,441 person-years from 2,634 women were investigated. The second-birth

transition model included 18,239 person-years from 1,779 women. The selection criteria for each subsample are elaborated in the next section.

4.2 Analytical strategy

Our goal is to quantify the dynamic effects of the first and the second birth on women's earnings.[12] Using an event-study approach and fixed effects (FE) regressions (Brüderl & Ludwig, 2015; Musick et al., 2020), our analyses deviated from most studies of motherhood penalties in two aspects.

Firstly, I used FE estimators with the "dummy impact function" (Brüderl et al., 2019), also known as "distributed fixed effects models" (Stojmenovska & England, 2020), to identify the dynamic motherhood effects over a ten-year observation window. This method combines the strengths from both the *analytic* and the *holistic* approaches of life course research (Mayer, 2009), in which the causal analysis is integrated into the analysis of life trajectories. More specifically, I formulated the career outcome y_{it} for a woman i at time t as:

$$y_{it} = \sum_{r=-1}^{10} \boldsymbol{\delta_r D_{itr}}(\boldsymbol{n}) + \beta_1 Age_{it} + \beta_2 \boldsymbol{W}_{it} + c_i + \nu_{it} \quad (1)$$

where the dynamic effects were specified by an impact function of $\sum_{r=-1}^{10} \boldsymbol{D_{itr}}(\boldsymbol{n})$ that measured the time trend of y_{it} before and after a specific birth event n. A set of dummy variables $\boldsymbol{D_{itr}}(\boldsymbol{n})$ indicated the event time relative to a birth occurred at $r = 0$, whereas the parameter vector $\boldsymbol{\delta_r}$ denoted effects of such birth after r years. The long-term impact of each childbirth was estimated for up to 10 years ($r = 1, 2, \ldots, 10$). Following previous studies (Kleven, Landais, & Søgaard, 2019; Zhang, 2010), I also considered the "expectation effect" on women's careers before the childbirth transition. Two years before the second birth ($r = -2$) was included as the reference period in the second-birth penalty models. In the first-birth penalty models, the reference period was extended to three years before the birth ($r = -3$) because a considerable proportion of Japanese women may have already resigned from work before their first pregnancy to "prepare for motherhood" (Yu, 2009).

FE regression is an ideal tool for empirical causal inference because it rules out all individual-specific, time-invariant heterogeneity such as social background or cohorts, either observed or unobserved (Brüderl & Ludwig, 2015; Gangl & Ziefle, 2009). Through a demeaning procedure, the time-constant, individual-specific effect c_i in equation (1) is

[12] I focused on these two births for two reasons. First, the theoretical mechanisms generating motherhood penalties following these two birth transitions are wildly different. Second, Japan has been a low fertility society for several decades, where the total fertility rate has fallen below two children since the late 1970s. Given that very few women were at risk of having three children, I restricted the analyses up to the second birth transition.

canceled out, which eliminates the necessity of imposing the problematic exogeneity assumption $E(c_i|\boldsymbol{D_{itr}}, Age_{it}, \boldsymbol{W}_{it}) = 0$ as required in pooled-OLS or random effects regressions. However, the existence of the observation-specific, time-varying error term ν_{it} indicates that time-varying heterogeneity can still bias the FE estimates. To partial out the bias, a set of time-varying confounding variables (the vector $\boldsymbol{W}_{it}$) were controlled. To account for the maturation effects in women's fertility and career outcomes (Brüderl & Ludwig, 2015), I also include individual age and its quadratic term (denoted as Age_{it}). Deploying the age variables in an FE event-study framework accounts for both the individual-specific heterogeneity and the general life-cycle trend of career growth (Appendix B illustrates technical details and assumptions of this approach). Modeling equation (1) using the FE estimator provides dynamic estimates of the *total effects* of childbirth by years relative to a birth event without assuming any parametric effect distribution over time. I use this approach to identify the total motherhood penalties in employment, work hours, wage rates, and earnings.

$$y_{it} = \sum_{r=-1}^{10} \boldsymbol{\delta_r^R D_{itr}}(\boldsymbol{n}) + \beta_1^R Age_{it} + \beta_2^R \boldsymbol{W}_{it} + \beta_3^R \boldsymbol{M}_{it} + c_i + \nu_{it}^R \quad (2)$$

Building on the same event-study approach, equation (2) adds several mediators (the vector $\boldsymbol{M}_{it}$) to partially identify the *indirect effects* channeled through observable mechanisms. Following previous studies (Abendroth et al., 2014; Aisenbrey et al., 2009; Budig & England, 2001; Gangl & Ziefle, 2009; Taniguchi, 1999), I include one's cumulative labor force experience and the duration of work interruption to capture the mechanism of human capital depreciation. Another set of mediators including one's employment status, sector of employment, and total hours in housework are used to capture the mechanism of career adaptation to work-family role conflicts (Budig & England, 2001; Gangl & Ziefle, 2009; Kühhirt & Ludwig, 2012). Netting of these indirect effects measured by mediators, $\boldsymbol{\delta_r^R}$ in equation (2) present the *residual effects* of childbirth on women's career outcomes due to other mechanisms unobserved in our study, such as unobserved changes in productivity, work-family preferences, commitment, or being discriminated by employers. I deploy this model to identify the residual motherhood penalties in earnings and wage rates.[13]

[13] Following Budig and England (2001), I use the term "residual motherhood penalties" to declare the effects of motherhood on earnings and wages that are not explained by the indirect causal paths for which I do have measures.

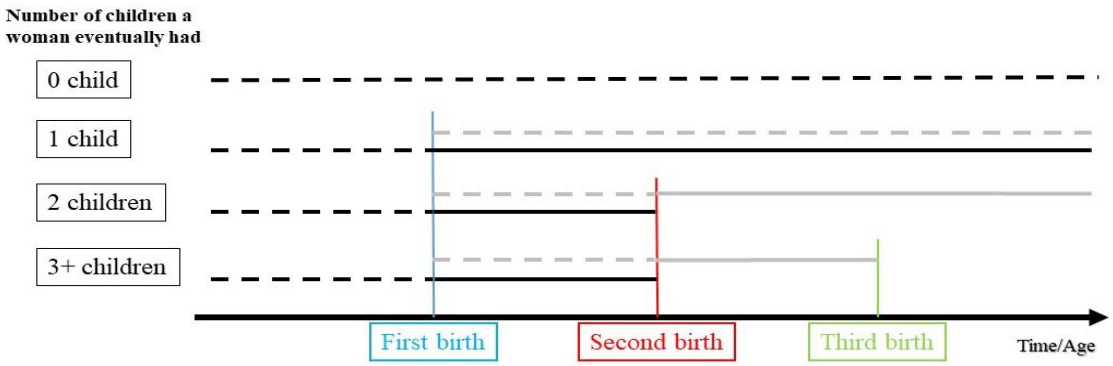

Fig. 2. Dynamic specifications of the treatment and control spells

Note: Analytical spells for models of the first-birth transition are shown in black lines; spells for models of the second-birth transition are shown in gray. Solid lines denote treatment spells, while dashed lines denote control spells.

Secondly, I applied *multiple estimation models and samples* to analyze parity-specific motherhood penalties. Due to the possibility of selection into a consecutive treatment based on the previous treatment's heterogeneous effects, modeling multiple causal effects in one FE regression model could lead to biased estimates (Brüderl & Ludwig, 2019). To address this issue, I constructed two estimation subsamples and used the parity-specific event-study approach to separately estimate the impacts of each birth. Intuitively, this approach aims to disaggregate the overall effects of motherhood into multiple, separate effects following consecutive birth transitions by assigning the "true" control group for each birth of interest. Using FE estimators, our models, separately, are able to account for the level-based selection into childbirth based on the pre-birth level of outcomes. Meanwhile, a separate model for the second birth also avoids the biased parameter estimates of δ_r due to an effect-based selection into the treatment. Appendix C elaborates in detail how this model specification issue may bias the estimates and how I address it using the multiple estimation samples approach.

I applied a dynamic specification of the treatment and control spells based on the event time relative to each childbirth (See Fig. 2). A general guideline for constructing control spells is to include person-years where one is still at risk of being treated (i.e., having the corresponding birth) (Brüderl & Ludwig, 2015). For models estimating the effect of first birth, the treatment spells were person-years where individuals had already transited to first birth but had not yet reached the second, whereas all person-years when women remained childless were included as control spells. That is, year spells were right-censored in this subsample if a respondent reached her second birth, no matter how many children she eventually had. Following the same logic, the second birth's treatment spells were person-years where

individuals had already transited to second birth and were right-censored upon reaching the third birth. All person-years when women remained at parity one were included as controls. The inclusion of untreated individuals (non-mothers) as the control group extended the standard FE model to a counterfactual causal framework, allowing the estimated childbirth effects to be de-trended by the life-cycle age trend of career outcomes (i.e., the maturation effect over the life course). Appendix B elaborates methodological reasons for including the control group.

4.3 Variables and measurement

This study has four outcome variables. Women's *employment* was a dummy variable coded as 1 if a respondent reported that she was currently working or on job-protected temporary leave, 0 otherwise (non-employment status including being a student, housewife, and others). *Work hours* were measured on a weekly basis and set to zero if the individual was not employed. *Earnings* were also calculated on a weekly basis, measuring individual gross earnings before tax, including all types of paid incomes but bonus payments. Values were deflated by the consumer price index to Japanese currency (JPY) in the year 2010. Earnings at non-employment years were set to zero.[14] Finally, women's *hourly wage rates* were calculated by dividing weekly earnings by weekly work hours, given at least 10 hours of work per week. Women who earned more than 2,500 JPY per hour (above the 99th percentile) were top-coded at 2,500 to avoid inflated estimation due to outliers in the sample. Following previous studies in Japan, all types of female participation in economic activities were considered (Yu, 2009). For a small proportion of person-years when work hours and earnings were not available (1,610 person-years, 4.2% of the estimation sample), I performed multiple imputations to handle missing values.[15]

The treatment events are *women's first and second births*. The time paths of these treatment events were measured by a set of dummy variables $\boldsymbol{D_{itr}(n)}$, coded as 1 if it was currently *r* years after the *n* birth that occurred at year *t-r*, and 0 otherwise. The timing of birth events was constructed either by birth transitions observed in prospective survey years or by

[14] Unlike studies using a logarithmic specification of wage rates and earnings, using the raw values permits more flexible modeling strategies and allows person-years with zero income to be included in the analyses. This refinement is theoretically important because previous findings based only on years of employment tended to ignore the most extreme case of earnings penalty—earnings losses during the time of labor market exit.

[15] A multiple imputation by chained equations (MICE) has been used to handle missing values in work hours and earnings. All predictors of our focal models were included in the imputation procedure. To gauge the panel data structure, I also utilized the non-missing information from other time points as predictors. Ten imputations across the 23 survey years were performed. Sensitivity analyses using a listwise deletion method, a mean imputation by age and year at missing, and a regression imputation showed no significant difference in the estimation results (available on request).

the ages of co-resident children observed. For example, if a respondent had her first birth in 1995, her treatment variable $D_{2000,5}(1)$ would be coded as 1 in the year 2000.

Control variables were included across all models to control for time-varying confounding effects. First, respondents' *marital status* was a dichotomous variable coded as 1 when a respondent was currently married, 0 for non-married states (including single, divorced, and widow). Compared to non-married women, married women might have a higher propensity of childbirth and lower earnings due to their economic dependence on spouses (Budig & England, 2001). Second, the *living arrangement with parents* was a dichotomous variable coded as 1 when a woman lived with her parents (own or in-law) and as 0 when she lived independently or only with her spouse. Previous studies in East Asia argued that grandparents in extended families might provide economic and childcare resources, both of which have crucial influences on young adults' fertility and labor market decisions (Yu & Xie, 2018). Third, I included the aggregate-level *female unemployment rates* and *total fertility rates* to account for the economic cycle and social trend affecting both individual fertility and work (Hofmann et al., 2017). Yearly data of these two variables were lagged for one year. Finally, a dummy variable of years before or after *the 2005 Act on Advancement of Measures to Support Raising Next-Generation Children* was added to account for period effects resulting from changing family policies (Yamaguchi, 2017).

The analyses of the *residual effects* of birth on employed women's wage rates and earnings further included several observable mediators. Following Gangl and Ziefle (2009), I include the *cumulative work experience* (i.e., actual labor force experience) and the *duration of work interruption* to measure a woman's human capital. Both variables were measured in years. Longer work experience reflects higher human capital accumulated (Becker, 1985; Taniguchi, 1999), while longer time duration out of work could deteriorate such accumulation process (Aisenbrey et al., 2009). I included three sets of dummies variables to capture women's career adaptation to work-family role conflicts. To measure women's changing job characteristics around motherhood (Budig & England, 2001; Gangl & Ziefle, 2009), I firstly categorized women's current *employment status* as standard employment (i.e., full-time regular positions with permanent contracts), non-standard employment (i.e., irregular positions, part-time jobs, or fixed-term contractors), or self-employment or family workers.

Table 1. Descriptive statistics of samples and variables.

	Sample 1: Transition to first birth		Sample 2: Transition to second birth	
	Mean; %	S.D.	Mean; %	S.D.
Demographic characteristics				
Age	32.7	6.4	36.7	6.9
Number of children				
No child	69.9%			
One child	30.1%		33.8%	
Two children			66.2%	
Mean age at birth transitions	28.8	4.3	29.8	3.9
Outcome variables				
Employed	77.9%		62.9%	
Weekly work hours	30.1	19.5	19.7	18.5
Weekly wages (JPY)	33,198.8	26,490.3	19,670.1	24,369.6
Hourly wage rates (JPY)	1,094.0	439.1	960.6	448.4
Control variables				
Marital status				
Married	44.2%		92.2%	
Non-married	55.8%		7.8%	
Living arrangement with parents				
Living independently	62.1%		70.7%	
Living with parents	37.9%		29.3%	
Female unemployment rates	4.0	0.7	4.0	0.7
Total fertility rates	1.4	0.1	1.4	0.1
Years after the 2005 reform	54.7%		54.9%	
Mediating variables (for employed women)				
Cumulative work experiences (year)	11.5	6.4	14.4	6.7
Duration of work interruption (year)	0.7	1.6	2.6	3.3
Sector of employment				
Primary sector	0.7%		0.9%	
Construction and Manufacturing	23.6%		19.5%	
Services	64.1%		63.7%	
Public sector or others	9.1%		9.4%	
No information	2.5%		6.5%	
Employment status				
Standard employment	61.7%		35.3%	
Non-standard employment	32.8%		53.3%	
Self-employment or family workers	5.6%		11.4%	
Daily housework hours				
Less than 2hr	58.8%		8.1%	
2~4hr	24.0%		33.3%	
4~7hr	12.1%		42.5%	
7~10hr	2.5%		11.7%	
More than 10hr	1.2%		3.5%	
No information	1.5%		1.0%	
Number of observations per respondent	7.8		10.3	
Number of person-years	20,441		18,239	
Number of respondents	2,634		1,779	

Secondly, *employment sectors* are included as proxies for occupation characteristics (Yu & Xie, 2018), which measure individual employment in the primary sector, construction and manufacturing, services, and public sectors or others. Thirdly, I included categorical dummies of *daily housework hours* to measure the total work load on non-paid domestic work, which reflects women's work-family role conflicts during the course of motherhood transition (Kühhirt & Ludwig, 2012; Yu & Xie, 2018). Table 1 presents the descriptive statistics of variables in each estimation sample.

5 Results

5.1 Impacts of first birth on women's labor supply, wage rates, and earnings

Fig. 3 plots the impacts of first birth on women's labor supply, wage rates, and earnings across the event time. Tables A1 and A2 in Appendix A present the full estimation results of corresponding models. Fig. 3-a shows that Japanese women's employment rates have already declined around the time of first pregnancy (i.e., the anticipation effect) and further dropped to the lowest level in the year of first birth. Such an employment slide since the motherhood transition was, however, temporary. The predicted employment rates gradually recuperated to near the pre-pregnancy level after ten years (back to above 80%). Fig. 3-b shows that work hours also decreased significantly shortly after the first birth. Working mothers reduced 7 hours of work per week in the first year after their first birth. The declining curve of work hours has flattened afterward, remaining for ten years at a level around 34 to 35 hours per week if a mother remained employed. Combining results from Fig. 3-a and Fig. 3-b, I found that first birth in Japan affected women's labor supply negatively by causing a significant employment drop in the short term and a long-term reduction of work hours.

Fig. 3-c shows that women's wage rates after the first birth also followed a declining trend in the long run. Among employed women, total wage penalty (black lines) was mild within three years following the first birth (wage reduction from 0 to 4 percentage points). Four years since the first birth, women began to suffer significant reduction in wage rates. With the negative effect intensifying over time, wage rates reduced by 8.7 percentage points relative to the pre-pregnancy level after ten years since the first birth. Controlling for mediators (gray lines in Fig. 3-c), our model for the residual wage effects found a continuous wage growth for mothers-to-be before the year of first birth. However, wage rates began to decline following the birth event. The initial wage growth turned sour after four years and continued to decline thereafter. The long-term residual wage penalty as the gap between $t=0$ and $t=10$ amounted to

6.5 percentage points. Findings on the long-term residual wage penalty indicate that other unobserved mechanisms, including changes in labor market productivity, commitment, or wage discrimination, might operate continuously after Japanese women's first birth.

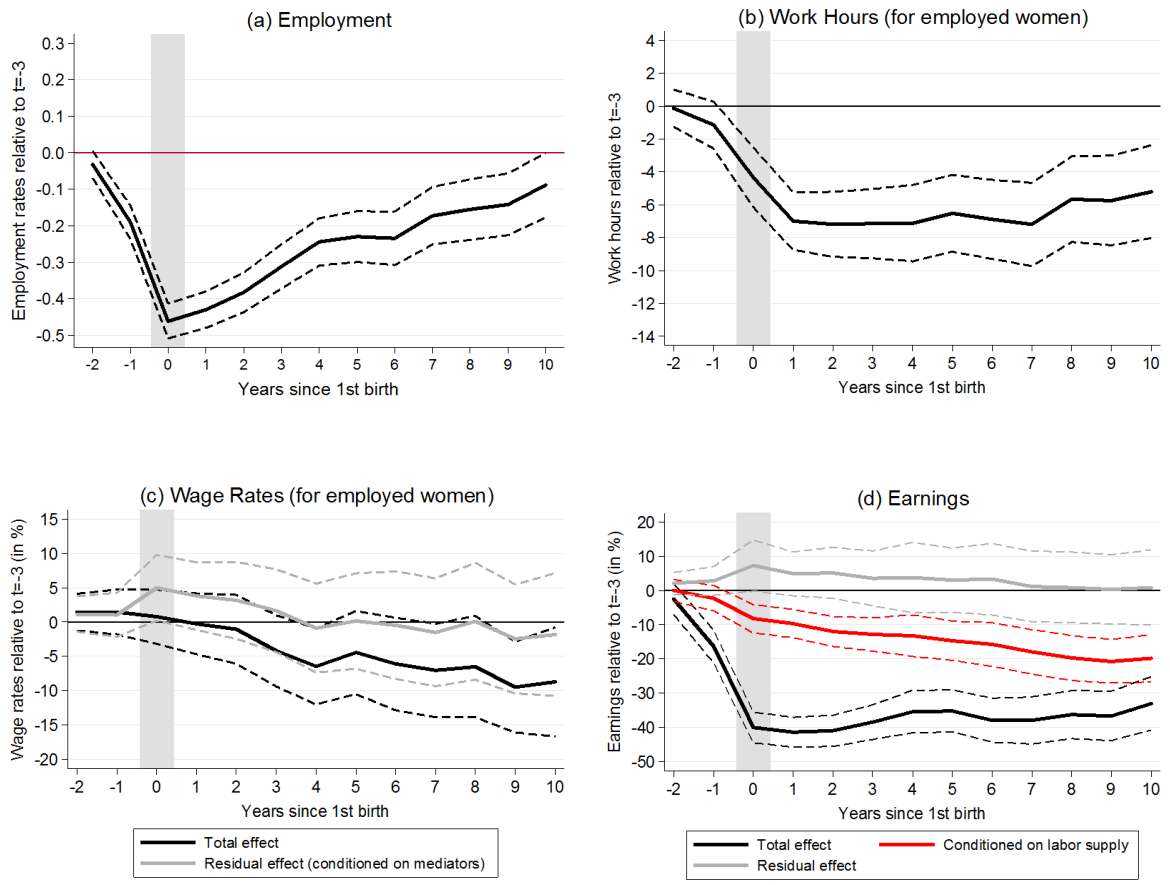

Fig. 3. Impacts of first birth on women's labor supply, wage rates, and earnings.
Notes: Thick lines present estimated effects from FE models with impact functions; thin dash lines indicate 95 percent confidence intervals based on individual-clustered standard errors. All models control for individuals' age, marital status, living arrangement with parents, female unemployment rates, total fertility rates, and the period effect of the 2005 family policy reform. Models for residual effects on wage rates and earnings in (c) and (d) additionally control for mediators, including cumulative work experiences, duration of work interruption, employment status, employment sectors, and daily housework hours. See Table A1 in Appendix A for full coefficient estimates from models in graphs (a), (b), and (c); see Table A2 for full coefficient estimates from models in the graph (d).

Fig. 3-d presents the impacts of first birth on women's earnings. Consider all channels causing mothers' earnings loss, the estimation of total effect (black line) shows that women's earnings had already reduced by 16.4% one year before the first birth, reflecting the anticipation effect on women's employment exit during the year of pregnancy (see Fig. 3-a). The total earnings penalty further enlarged to – 40% of the pre-pregnancy level in the year of first birth and remained at such level for the following ten years without a sign of recovery. After conditioning on women's labor supply (gray line), the negative effect on women's earnings reduced to – 9.7% in the first year following the first birth ($t=1$). This gap between the total and

the conditioned effects shows that women's reduced labor supply accounted for a large share of the first-birth earnings penalty in the short term. However, in the long run (i.e., the tenth years after the first birth), the gap between these two effects has converged, indicating that the total wage rate penalty accounts for a more considerable share of motherhood earnings penalties over time. Finally, by including all mediators in the earnings model (red line), I found that women's earnings continued to grow until the year of first birth. After the first birth, the growth in earnings turned negative. In the tenth year after the first birth, the residual effect of the first birth was nearly zero. For the first birth, the long-term residual earnings penalty, measured as the gap between $t=0$ and $t=10$, amounted to 6 percentage points.

5.2 Impacts of second birth on women's labor supply, wage rates, and earnings

Fig. 4 shows the impacts of second birth on women's labor supply, wage rates, and earnings across the event time (corresponding modeling results presented in Tables A3 and A4 in Appendix A). According to Fig. 4-a, women's employment rates declined by 17.6 percentage points to the lowest level in the year of the second birth. After three years since the second birth, women's employment resumed to their pre-second-birth level. While the short-term employment effect of the first birth seemed to be larger than that of the second birth, their long-term recuperation trends were similar. Fig. 4-b shows that work hours among employed mothers reduced by additional 3 hours in the year of having second birth. The reduction in work hours became insignificant after the second year following the second birth. In the tenth year ($t=10$), women's post-second-birth work hours were only 0.8 hours per week shorter than their pre-second-birth level.

Fig. 4-c shows that the total effect of the second birth on women's wage rates (black line) was relatively large in the short term (6.1 percentage points wage penalty in $t=2$) yet gradually became irrelevant in the long run. In the tenth year after the second birth, the total second-birth penalty in wage rates amounted to 1.7 percentage points. Controlling for observed mechanisms, the residual effects of second birth on wage rates were consistently small and insignificant (gray line). The long-term residual wage penalty, measured as the gap between $t=0$ and $t=10$, was nearly zero (– 0.2%). Unlike what I have found regarding the first birth penalties, findings here indicate that other unobserved mechanisms, including changes in labor market productivity, commitment, or wage discrimination, might not contribute significantly to the wage penalty after the second birth.

Fig. 4. Impacts of second birth on women's labor supply, wage rates, and earnings.
Notes: Thick lines present estimated effects from FE models with impact functions; thin dash lines indicate 95 percent confidence intervals based on individual-clustered standard errors. All models control for individuals' age, marital status, living arrangement with parents, female unemployment rates, total fertility rates, and the period effect of the 2005 family policy reform. Models for residual effects on wage rates and earnings in (c) and (d) additionally control for mediators, including cumulative work experiences, duration of work interruption, employment status, employment sectors, and daily housework hours. See Table A3 in Appendix A for full coefficient estimates from models in graphs (a), (b), and (c); see Table A4 for full coefficient estimates from models in the graph (d).

Figure 4-d presents the impacts of second birth on women's earnings. According to the estimation of the total effect (black line), women's earnings reduced significantly by 28 percentage points at the year of having second birth. Such penalty in earnings disappeared in the long run due to long-term recovery in women's labor supply after the second birth. Conditioning on labor supply (gray line), women's earnings remained at 8–10% lower than their pre-second-birth level, reflecting the existence of the wage penalty. Finally, I included all observable mediators to quantify the residual effects of second birth on earnings (red line). Results suggested nearly zero residual effects of second birth on earnings over a decade. For the second birth, the long-term residual earnings penalty, measured as the gap between *t=0* and *t=10*, amounted to 0.8 percentage points.

5.3 Robustness analyses: Additional heterogeneity by marital status and birth timing

So far, the analyses in Fig. 3 and Fig. 4 (called the "focal analyses" hereafter) present the *average effects* of motherhood on women's labor supply, wages, and earnings by event time and birth parity. However, motherhood career impacts might still differ by other factors such as race, education level, marital status, birth timing, etc. (see Gough and Noonan (2013) for a literature review). This section includes two sets of robustness analyses to examine additional heterogeneities by mothers' marital status and the birth (period) timing relative to policy reform. I constructed disaggregated subsamples by women's group characteristics and used the same parity-specific approach as performed in the focal analyses. These robustness analyses focus on each birth's total effects, which permit a straightforward decomposition of earnings penalties via three channels: employment declines, work hours reduction, and lower wage rates. Appendix D presents the modeling results.

Firstly, previous studies in the U.S. and Europe found that variation in mothers' marital status could lead to heterogeneous motherhood penalties (Budig and England 2001; Budig and Hodges 2010; Gangl and Ziefle 2009). Comparing to married mothers, single mothers might face higher economic constraints in the absence of spousal income. This situation makes single mothers less likely to withdraw from the labor force upon childbirth because they are the only financial source of a household (Gangl and Ziefle 2009). Moreover, married mothers are more likely to choose mother-friendly jobs and spend more time with their children, leading to decreased work hours and wage rates (Budig and England 2001). Fig. D1 and Fig. D2 in Appendix D present the first- and second-birth penalties in Japan for married and single mothers.[16] According to Fig. D1, single mothers in Japan tended to recover employment and work hours faster than married mothers after their first birth, supporting previous studies' predictions on labor supply. However, single mothers in Japan also suffered more considerable reductions in wage rates after their first birth. Taken together, the long-term first-birth earnings penalty for single mothers was not significantly different from that of married mothers.

Fig. D2 extends the current literature by showing that the second birth could trigger significant and long-term reductions in single mothers' work hours, leading to the diverging earnings prospects after the second birth between mothers of different marital status. These findings indicate that single mothers with multiple children in Japan comprise an economically disadvantaged group. Without sufficient financial and childcare supports from partners and

[16] Single mothers are defined as women who have ever been non-married (i.e., single, divorced, widow) at least for one year during her post-motherhood period.

welfare policies, Japanese single mothers could face a high risk of poverty (Shirahase & Raymo, 2014).

Secondly, previous studies found that the introduction or expansion of parental leave and childcare policies could affect women's post-motherhood labor supply, wages, and earnings (Budig et al., 2016; Mari & Cutuli, 2020; Ziefle & Gangl, 2014). Major policy reform took place in Japan from 2000 to 2005, with several expansions of childcare services and paid parental leaves (see Yamaguchi, 2017 for a literature review). Hence, I deployed mothers' timing of birth before or after the year 2005 to examine whether the long-term dynamics of motherhood penalties have changed systematically after the reform. Fig. D3 shows that the post-2005 mothers had a relatively small employment slump during the year of first birth and also resumed pre-motherhood labor force participation much faster than the pre-2005 mothers. The impacts of first birth on employed work hours were similar among the two groups. Most strikingly, I found that the trajectories of first-birth wage penalty could diverge between the pre-2005 and the post-2005 mothers. The first-birth effects on wages were more negative and had intensified over time among the pre-2005 mothers, while post-2005 mothers' wage rates remained around the pre-first-pregnancy level over almost a decade. The combining results of a faster labor market reentry and a smaller wage rates penalty led to a faster recovery in earnings after the first birth among the post-2005 mothers. Regarding the impacts of second birth, Fig. D4 shows that post-2005 mothers reduced their labor supply more significantly than pre-2005 mothers. The wage impacts of having a second birth were similar among the two groups. Combining these effects, I found a slower recovery in earnings after the second birth for mothers who had the second child after 2005.

In summary, the robustness analyses show that while motherhood earnings penalties varied across Japanese mothers by marital status and birth (period) timing, their *parity-specific pattern*s and *time dynamics* were similar. In all mothers-subgroups, the total earnings penalties of the first birth have been more significant and more persistent than those of the second birth. However, these seemingly similar earnings penalties across mother-subgroups might involve different economic channels, either through reduced labor supply or declined wage rates. These additional findings indicate that policymakers should consider various supporting packages across different birth parity and marital status to effectively tackle women's post-motherhood career disadvantages.

6 Conclusions and Discussions

This study contributes to research on motherhood penalties by providing an analytical framework to quantify the long-term dynamics and parity-specific impacts of childbirth on women's labor supply, wages, and earnings. It also extends the empirical knowledge to a non-Western country—Japan—using one of the longest-running panel data in Asia. Our analyses found that having the first child in Japan affected women's labor supply negatively and persistently by causing a significant employment drop in the short term and reduced work hours in the long run. Japanese women's wage rates also declined over time after the first birth, even after several observed explanatory mechanisms were accounted for. This finding indicates that other mechanisms unobserved in our study, including women's changing workplace productivity, commitment, or discrimination from employers, might partially account for the long-term first-birth penalty in wages. Combining all impacts on labor supply and wage rates, I found that the first-birth transition consistently reduced Japanese women's earnings by 35–40% for ten years following the first birth. While this total earnings penalty was mostly explained by women's reduced labor supply and other observed mechanisms, I still found a long-term residual penalty of first birth in earnings amounted to 6%.

Having a second child also negatively affected women's earnings in Japan, although the impacts were relatively mild in its sizes than those found following the first birth. An initial drop of employment at the year of the second birth was followed by a long-term recovery to the pre-motherhood level within a decade. Among working mothers with two children, work hours also recuperated after the second birth. Moreover, the long-term reduction in wage rates caused by second birth was statistically insignificant. Combining these results, the total earnings penalty of the second birth amounted to 28% in the year of birth yet had declined to only 2% after ten years. Accounting for womens' labor supply and observed mechanisms, I only found a 0.8% long-term residual penalty of second birth in earnings.

In summary, motherhood had long-term, negative impacts on Japanese women's earnings, mainly through depressing maternal labor supply after the first birth. Our findings in Japan support the *cumulative disadvantage hypothesis*, which predicts that women's earnings may not recover to their pre-birth level in the long run. Moreover, the parity-specific analyses indicate that mothers' cumulative disadvantage in earnings is triggered mostly by the first rather than the second birth, supporting the *first-birth pivotal transition hypothesis*. Contributions of the current study are primarily twofold.

From a theoretical perspective, this study advances the motherhood penalties research by emphasizing the time dynamics and effect heterogeneities across birth transitions (Kahn et al., 2014; Van Winkle & Fasang, 2020; Zhang, 2010). Its empirical results add nuance to the "converging" perspective in work-family life course research (Therborn, 2014). While the short-term impact of childbirth, especially the first birth, on Japanese women's employment was overwhelming, it did not cause a life-long employment inequality. However, conditioning on labor supply, both birth transitions affected Japanese women's earnings negatively in the long run. The fact that motherhood penalties persisted into women's midlife may reflect women's difficulties reconciling work with family under Japan's patriarchal social norms and labor market practices (Brinton, 2001; Brinton & Oh, 2019). This finding also resonates with previous studies (Kleven, Landais, Posch, et al., 2019; Muller et al., 2020), showing that motherhood earnings penalty was more likely to persist to midlife for women who followed conservative gender norms and family trajectories in societies with limited work-family supports. Because younger generations in Japan remain relatively conservative in their attitudes on gender divisions of labor and female employment (Piotrowski et al., 2019), the significant motherhood earnings penalty in Japan is likely to persist in the near future.

From a public policy perspective, significant motherhood penalties are especially harmful to aging and low-fertility societies like Japan because high opportunity costs of childbirth may discourage women's fertility intention (Brinton & Oh, 2019). Our findings suggest that the Japanese government should pay special attention to the long-term reduction in working mothers' work hours, particularly after the first birth. Long-term motherhood earnings penalty in Japan resulted primarily from mothers' shorter work hours rather than lower wage rates. Especially after accounting for women's career and family roles adaptation and human capital depreciation, the residual penalty of first birth in wage rates was relatively mild, staying below 6% within a decade. This number is roughly comparable to the 4–5% (no time dynamics) residual wage penalty of having one child in Anglo-Saxon countries (U.S., U.K., Australia, and Canada), Germany, and the Netherland (Cukrowska-Torzewska & Matysiak, 2020). However, a relatively low penalty in wage rates should *not* be interpreted as no labor market discrimination against working mothers in Japan. Quite the opposite, a large and persistent work hours reduction might imply an implicit labor market stratification by motherhood status in Japan, where working mothers are disproportionately settled in part-time jobs upon their employment reentry (Raymo & Lim, 2011; Yu, 2009). It might also imply insufficient childrearing supports from public childcare or male partners, both of which could suppress women's labor supply in Japan (Asai et al., 2015; Nishimura, 2016). While the Japanese

government has implemented several family policy reforms since the 2000s, their stimulating effect on maternal labor supply has been limited (Asai, 2015; Asai et al., 2015). This policy inefficacy is also reflected in our additional analyses (Fig. D3 and Fig. D4 in Appendix D), where women who had their first birth after 2005 still experienced considerable work hours reductions similar to earlier mothers; women who had their second birth after 2005 even reduced more work hours than earlier second-birth mothers. Maybe substantial reforms on the employment regulation and workplace culture are needed to tackle the structural issue of low maternal labor supply and earnings in Japan.

Finally, motherhood career penalties could reinforce the gender earnings gap between men and women, especially when men are enjoying the "fatherhood career premiums" (England, 2010; Musick et al., 2020; Van Winkle & Fasang, 2020). In contrast to our findings of significant motherhood penalties for Japanese women in labor supply, wages, and earnings, previous studies in Japan have reported significant increases in men's labor supply and wage rates following the fatherhood transition (Kawaguchi, 2008; Yukawa, 2011). Given that Japanese women already have a hard time catching up with their pre-motherhood career tracks, the gender disparities between men's and women's career outcomes could enlarge in their later life course following the family formation.

Apart from these contributions, some unresolved issues are brought forward for future studies. Firstly, with a focus on quantifying the dynamic motherhood penalties across different parity of birth, this study did not evaluate the relative explanatory capacity of different theories. Further discussions on how motherhood penalties are mediated through each theoretical mechanism in various social contexts will provide fruitful academic and policy implications (Cukrowska-Torzewska & Matysiak, 2020; Gangl & Ziefle, 2009). Secondly, previous studies have shown that motherhood imposes different impacts on women's careers across distinct groups (Gough & Noonan, 2013). Apart from the already-discussed heterogeneities by marital status and birth (period) timing (see Appendix D), future studies may benefit from exploring parity-specific effects by other factors, including women's race (Van Winkle & Fasang, 2020), educational levels (Doren, 2019b), skill and wage hierarchy (England et al., 2016), or workplace conditions (Yu & Kuo 2017). Finally, previous research found that the magnitude of motherhood penalties depends on women's (age) timing of motherhood (Miller, 2011). Testing this hypothesis, however, requires a research design different from ours. The event-study approach applied in this study is formulated to test the causal hypotheses of motherhood penalties *around* each birth transition, where women's age timing is controlled for as a confounder rather than an explanatory variable of motherhood penalties. Nevertheless, based

on our fruitful findings in parity differentials, I believe that simultaneous consideration of the parity-specific effects and women's birth age timing would benefit future motherhood penalties research.

7 References

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8 Appendix

Appendix A. Full Estimation Results

Table A1. *Fixed effects regressions of the first birth on women's labor supply and wage rates*

	(1)	(2)	(3)	(4)
	Employment	Work hours	Wage rates (total effect)	Wage rates (residual effect)
Time relative to the birth				
3 and more years before	Ref.	Ref.	Ref.	Ref.
2 years before	-0.032+	-0.123	17.456	13.092
	(0.019)	(0.578)	(16.281)	(14.784)
1 year before	-0.190***	-1.151	17.705	12.113
	(0.023)	(0.729)	(19.778)	(18.479)
First child born	-0.461***	-4.336***	9.294	56.867*
	(0.024)	(0.933)	(24.130)	(26.900)
1 year after	-0.429***	-6.992***	-3.006	43.063
	(0.026)	(0.895)	(27.329)	(27.637)
2 years after	-0.382***	-7.191***	-12.762	35.885
	(0.028)	(1.010)	(31.040)	(31.621)
3 years after	-0.311***	-7.145***	-50.460	18.909
	(0.031)	(1.074)	(33.014)	(34.399)
4 years after	-0.244***	-7.114***	-77.846*	-9.933
	(0.033)	(1.186)	(35.859)	(37.746)
5 years after	-0.230***	-6.513***	-53.492	1.799
	(0.036)	(1.193)	(38.527)	(40.149)
6 years after	-0.234***	-6.888***	-73.627+	-5.044
	(0.037)	(1.226)	(43.311)	(45.556)
7 years after	-0.172***	-7.195***	-85.011+	-16.911
	(0.040)	(1.293)	(44.179)	(46.001)
8 years after	-0.156***	-5.664***	-78.195	1.449
	(0.042)	(1.328)	(47.540)	(49.250)
9 years after	-0.141**	-5.737***	-114.232**	-27.895
	(0.043)	(1.388)	(44.001)	(46.859)
10 years after	-0.089*	-5.205***	-105.049*	-20.584
	(0.045)	(1.445)	(51.709)	(52.349)
11 and more years after	-0.070	-2.217	-121.197*	-30.762
	(0.045)	(1.584)	(50.187)	(51.888)
Age	0.023**	0.047	76.473***	-55.864
	(0.009)	(0.251)	(7.529)	(67.181)
Age-squared	-0.000**	-0.001	-0.823***	-0.792***
	(0.000)	(0.003)	(0.104)	(0.094)
Marital status				
Not married	Ref.	Ref.	Ref.	Ref.
Currently married	0.140***	5.235***	32.532*	43.055***
	(0.016)	(0.637)	(13.622)	(12.746)
Living arrangement with parents				
Living independently or with spouse	Ref.	Ref.	Ref.	Ref.
Living with parents	0.011	-0.002	-2.185	-1.344
	(0.011)	(0.364)	(9.218)	(8.780)
Female unemployment rates	-0.005	-0.593**	14.944**	16.544***

	(0.005)	(0.183)	(4.726)	(4.332)
Total fertility rates	0.238**	-8.384**	123.321+	63.000
	(0.081)	(2.674)	(74.223)	(71.351)
Period effect				
before 2005	Ref.	Ref.	Ref.	Ref.
after 2005	0.005	0.108	11.310	5.789
	(0.013)	(0.414)	(11.151)	(10.300)
Work hours (labor supply)				-11.439***
				(0.511)
Cumulative working experience				133.477+
				(68.289)
Duration of work interruption				82.956
				(68.699)
Employment status				
Standard employment				Ref.
Non-standard employment				-146.502***
				(14.313)
Self-employment or family workers				-129.864*
				(63.180)
Sector of employment				
Primary sector				Ref.
Construction and Manufacturing				85.272+
				(49.909)
Services				53.059
				(50.008)
Public sector or others				59.415
				(54.070)
Daily housework hours				
2hr-				Ref.
2~4hr				-10.427
				(7.471)
4~7hr				-39.910**
				(12.564)
7~10hr				-78.176***
				(19.019)
10hr+				-61.072*
				(27.825)
Individual constant	0.120	50.826***	-631.135***	2504.070+
	(0.207)	(6.347)	(184.871)	(1368.530)
Person-years	20441	15928	14780	14780
R^2	0.153	0.0679	0.108	0.252
F	46.85	14.79	17.83	26.70

Individual-clustered standard errors are presented in parentheses. Significance levels: + p<0.1, * p < 0.05, ** p < 0.01, *** p < 0.001. Based on individual-clustered standard errors.

[a] Note: the binary outcome variable *Employment* in model 1 was modeled by a FE linear probability model. This model specification not only keeps all analytical spells for FE estimation, but also offers clear interpretation of the coefficients δ_r as a set of average discrete changes in the probability of the outcomes (Wooldridge, 2010).

Table A2. *Fixed effects regressions of the first birth on women's earnings*

	(1)	(2)	(3)
	Total effects	Net effects conditioned on labor supply	Residual effects
Time relative to the birth			
3 and more years before	Ref.	Ref.	Ref.
2 years before	-1.174	0.009	0.876
	(1.093)	(0.656)	(0.696)
1 year before	-7.593***	-0.904	1.187
	(1.262)	(0.769)	(0.878)
First child born	-18.534***	-3.318***	3.108*
	(1.362)	(0.911)	(1.556)
1 year after	-19.161***	-3.873***	2.082
	(1.398)	(0.921)	(1.334)
2 years after	-18.976***	-4.795***	2.204
	(1.546)	(1.013)	(1.550)
3 years after	-17.796***	-5.131***	1.511
	(1.677)	(1.121)	(1.685)
4 years after	-16.382***	-5.292***	1.600
	(1.927)	(1.368)	(2.185)
5 years after	-16.288***	-5.866***	1.284
	(1.934)	(1.321)	(1.995)
6 years after	-17.541***	-6.322***	1.404
	(2.073)	(1.470)	(2.221)
7 years after	-17.572***	-7.182***	0.512
	(2.208)	(1.530)	(2.230)
8 years after	-16.798***	-7.901***	0.369
	(2.254)	(1.574)	(2.239)
9 years after	-16.959***	-8.288***	0.132
	(2.312)	(1.542)	(2.198)
10 years after	-15.273***	-7.945***	0.370
	(2.392)	(1.657)	(2.376)
11 and more years after	-14.192***	-9.280***	-0.524
	(2.645)	(1.889)	(2.577)
Age	3.713***	3.023***	-3.431
	(0.508)	(0.354)	(2.944)
Age-squared	-0.043***	-0.033***	-0.030***
	(0.007)	(0.005)	(0.005)
Marital status			
Not married	Ref.	Ref.	Ref.
Currently married	11.233***	2.602***	1.337*
	(0.956)	(0.619)	(0.668)
Living arrangement with parents			
Living independently or with spouse	Ref.	Ref.	Ref.
Living with parents	0.237	0.263	0.115
	(0.644)	(0.440)	(0.467)
Female unemployment rates	-0.203	0.331	0.633**
	(0.281)	(0.207)	(0.234)
Total fertility rates	6.345	5.963+	1.845
	(4.608)	(3.267)	(3.686)
Period effect			
before 2005	Ref.	Ref.	Ref.
after 2005	0.280	-0.067	0.145

	(0.698)	(0.482)	(0.563)
Work hours (labor supply)		0.862***	0.492***
		(0.018)	(0.031)
Cumulative working experience			6.480*
			(2.953)
Duration of work interruption			4.325
			(2.962)
Employment status			
Standard employment			Ref.
Non-standard employment			-6.769***
			(0.680)
Self-employment or family workers			-14.170***
			(3.732)
Sector of employment			
Primary sector			Ref.
Construction and Manufacturing			4.484
			(3.170)
Services			3.529
			(3.204)
Public sector or others			3.288
			(3.361)
Daily housework hours			
2hr-			Ref.
2~4hr			-1.049*
			(0.468)
4~7hr			-2.726***
			(0.569)
7~10hr			-3.900***
			(0.821)
10hr+			-5.141***
			(1.545)
Individual constant	-41.580***	-58.742***	84.316
	(11.859)	(8.370)	(60.381)
Person-years	20441	20441	15868
R^2	0.128	0.554	0.273
F	41.08	223.5	43.47

Individual-clustered standard errors are presented in parentheses. Significance levels: + p<0.1, * p < 0.05, ** p < 0.01, *** p < 0.001. Based on individual-clustered standard errors.

Table A3. *Fixed effects regressions of the second birth on women's labor supply and wage rates*

	(1)	(2)	(3)	(4)
	Employment	Work hours	Wage rates (total effect)	Wage rates (residual effect)
Time relative to the birth				
2 and more years before	Ref.	Ref.	Ref.	Ref.
1 year before	-0.060***	-1.405	22.081	23.430
	(0.017)	(0.870)	(19.789)	(18.562)
Second child born	-0.176***	-3.208**	-16.606	13.791
	(0.019)	(0.997)	(20.792)	(21.428)
1 year after	-0.120***	-2.462*	-38.013	-14.718
	(0.021)	(1.168)	(24.617)	(22.648)
2 years after	-0.059*	-1.794	-61.929*	-26.154
	(0.025)	(1.291)	(24.574)	(22.623)
3 years after	0.007	-2.085	-42.076	-6.030
	(0.028)	(1.441)	(26.454)	(24.774)
4 years after	0.052+	-2.889+	-43.044	-12.752
	(0.030)	(1.507)	(27.644)	(26.138)
5 years after	0.086**	-1.436	-44.619	-11.811
	(0.032)	(1.653)	(30.334)	(28.092)
6 years after	0.090**	-2.046	-36.395	-8.040
	(0.034)	(1.744)	(32.675)	(30.221)
7 years after	0.126***	-2.095	-29.912	-5.529
	(0.036)	(1.824)	(34.164)	(31.833)
8 years after	0.132***	-1.255	-39.572	-9.419
	(0.038)	(1.907)	(35.788)	(33.495)
9 years after	0.164***	-1.044	-25.346	7.068
	(0.041)	(1.993)	(37.512)	(35.308)
10 years after	0.160***	-0.812	-17.057	12.353
	(0.043)	(2.062)	(37.937)	(35.275)
11 and more years after	0.168***	1.483	4.627	40.289
	(0.046)	(2.247)	(43.901)	(40.959)
Age	0.075***	0.823+	36.105***	-10.091
	(0.012)	(0.486)	(9.907)	(26.736)
Age-squared	-0.001***	-0.008	-0.315**	-0.338**
	(0.000)	(0.006)	(0.116)	(0.107)
Marital status				
Not married	Ref.	Ref.	Ref.	Ref.
Currently married	0.122***	6.141***	16.679	21.652
	(0.031)	(1.232)	(22.735)	(21.540)
Living arrangement				
Living independently or with spouse	Ref.	Ref.	Ref.	Ref.
Living with parents	0.071**	1.243+	0.864	-2.928
	(0.023)	(0.754)	(17.771)	(16.848)
Female unemployment rates	-0.008	-0.173	10.009*	13.183**
	(0.006)	(0.214)	(4.956)	(4.709)
Total fertility rates	0.080	-8.447*	-134.407+	-125.235+
	(0.098)	(3.335)	(81.198)	(75.975)
Period effect				
before 2005	Ref.	Ref.	Ref.	Ref.
after 2005	0.007	1.393**	11.679	12.044
	(0.015)	(0.496)	(11.671)	(11.550)

Work hours (labor supply)				-7.312***
				(0.649)
Cumulative working experience				49.528*
				(24.879)
Duration of work interruption				19.452
				(25.770)
Employment status				
Standard employment				Ref.
Non-standard employment				-164.640***
				(17.203)
Self-employment or family workers				-156.305**
				(53.544)
Sector of employment				
Primary sector				Ref.
Construction and Manufacturing				164.600**
				(63.152)
Services				150.665*
				(61.928)
Public sector or others				138.170*
				(67.965)
Daily housework hours				
2hr-				Ref.
2~4hr				3.409
				(12.439)
4~7hr				-20.223
				(13.175)
7~10hr				-26.562+
				(15.627)
10hr+				-67.076**
				(23.457)
Individual constant	-1.239***	21.965*	247.140	1442.103*
	(0.287)	(10.780)	(233.363)	(574.130)
Person-years	18239	11469	10007	10007
R^2	0.165	0.0882	0.106	0.197
F	41.01	9.774	9.703	13.93

Individual-clustered standard errors are presented in parentheses. Significance levels: + p<0.1, * p < 0.05, ** p < 0.01, *** p < 0.001. Based on individual-clustered standard errors.

[a] Note: For the modeling strategy of the Employment variable, please refer to the note in Table A1.

Table A4. *Fixed effects regressions of the second birth on women's earnings*

	(1)	(2)	(3)
	Total effects	Net effects conditioned on labor supply	Residual effects
Time relative to the birth			
2 and more years before	Ref.	Ref.	Ref.
1 year before	-2.191***	-0.270	0.158
	(0.589)	(0.439)	(0.949)
Second child born	-5.602***	-0.836	0.493
	(0.637)	(0.529)	(1.072)
1 year after	-4.485***	-0.927	0.084
	(0.824)	(0.671)	(1.292)
2 years after	-4.452***	-2.033**	-1.003
	(0.916)	(0.736)	(1.457)
3 years after	-3.162**	-1.734*	0.115
	(1.049)	(0.831)	(1.579)
4 years after	-3.740**	-2.371**	-0.586
	(1.142)	(0.892)	(1.693)
5 years after	-2.527*	-2.438**	-0.468
	(1.235)	(0.930)	(1.568)
6 years after	-2.666*	-2.277*	-0.557
	(1.321)	(1.010)	(1.673)
7 years after	-1.967	-2.025+	-0.167
	(1.422)	(1.085)	(1.764)
8 years after	-1.600	-2.306*	-0.371
	(1.517)	(1.154)	(1.835)
9 years after	-0.758	-2.009+	-0.059
	(1.615)	(1.220)	(1.922)
10 years after	-0.393	-1.736	0.240
	(1.683)	(1.251)	(1.935)
11 and more years after	2.616	-0.329	1.570
	(2.091)	(1.590)	(2.364)
Age	2.773***	0.858*	0.702
	(0.488)	(0.367)	(1.781)
Age-squared	-0.028***	-0.008+	-0.013*
	(0.006)	(0.004)	(0.005)
Marital status			
Not married	Ref.	Ref.	Ref.
Currently married	10.418***	3.223	2.971
	(2.534)	(2.035)	(2.901)
Living arrangement			
Living independently or with spouse	Ref.	Ref.	Ref.
Living with parents	0.980	-0.733	-1.570
	(1.515)	(1.323)	(1.945)
Female unemployment rates	-0.068	0.055	0.514+
	(0.238)	(0.176)	(0.271)
Total fertility rates	-5.894	-2.797	-6.474
	(4.437)	(3.395)	(4.836)
Period effect			
before 2005	Ref.	Ref.	Ref.
after 2005	0.597	-0.318	-0.133
	(0.558)	(0.415)	(0.759)
Work hours (labor supply)		0.778***	0.568***

		(0.025)	(0.035)
Cumulative working experience			0.870
			(1.728)
Duration of work interruption			-0.539
			(1.761)
Employment status			
Standard employment			Ref.
Non-standard employment			-8.542***
			(1.107)
Self-employment or family workers			-18.371***
			(3.196)
Sector of employment			
Primary sector			Ref.
Construction and Manufacturing			7.407*
			(3.419)
Services			4.504
			(3.218)
Public sector or others			3.273
			(3.409)
Daily housework hours			
2hr-			Ref.
2~4hr			0.950
			(1.484)
4~7hr			-0.356
			(1.552)
7~10hr			-0.336
			(1.796)
10hr+			-2.024
			(2.046)
Individual constant	-36.310**	-11.430	4.431
	(12.201)	(9.233)	(37.939)
Person-years	18239	18239	11267
R^2	0.156	0.540	0.381
F	30.18	123.4	34.22

Individual-clustered standard errors are presented in parentheses. Significance levels: + p<0.1, * p < 0.05, ** p < 0.01, *** p < 0.001. Based on individual-clustered standard errors.

Appendix B. Detailed Introduction to the Analytical Strategy

This section introduce the statistical and counterfactual frameworks involved in our approach. Relatedly, I also discuss the reasons for including person-years from non-mothers as the control group in our FE regression. In a nutshell, our modelling approach utilizes a counterfactual framework to account for the differences in career outcomes that *would have been observed* if none of the mothers had experienced childbirth. It estimates the age-specific career growth curves for both mothers (the treatment group, which is used for the within estimation) and non-mothers (the control group, which is used for life-cycle trend extrapolation). By utilizing both groups' information, the method accounts for the unobserved individual characteristics, as the standard FE estimator does, and addresses the *unobserved life-cycle trend* that could cause biases in panel data analyses (Brüderl & Ludwig, 2015). The next section will illustrate the operating logic behind this modeling strategy using a counterfactual causal analysis framework, which has become more popular among social scientists in the past decades (Gangl, 2010; Morgan & Winship, 2015).

1. Counterfactual Causal Analysis in Sociological Research

In a counterfactual causal model, the causal effect of receiving a treatment D is identified using the counterfactual differences of the outcome Y between the treatment and the control groups (Morgan and Winship 2015). To illustrate, I use the effect of childbirth (D) on women's weekly work hours (Y) as an example (see Table B1).

Table B1. A counterfactual causal analysis framework for motherhood effects on work hours.

		State of outcome	
		$E(Y^0)$	**$E(Y^1)$**
Treatment assignment	**D=0**	$E(Y^0\|D=0)$ Observed (Factual) (Hours a non-mother works in the state of being a non-mother)	*$E(Y^1\|D=0)$* *Unobserved (Counterfactual)* *(Hours a non-mother works in the state of being a mother)*
	D=1	*$E(Y^0\|D=1)$* *Unobserved (Counterfactual)* *(Hours a mother works in the state of being a non-mother)*	$E(Y^1\|D=1)$ Observed (Factual) (Hours a mother works in the state of being a mother)

In an ideal scenario, the real causal effect of childbirth on a woman's work hours is the difference between her hours in the state of being a mother and *her own* hours without being a mother. Accordingly, the causal effect $\Delta = E(Y^1|D=1) - E(Y^0|D=1)$. However, in the real world,

the E($Y^0|D$=1) can never be observed because we cannot observe *the same person with different states of treatment at the same time*. What we have are the observed work hours of mothers E($Y^1|D$=1) and those of non-mothers E($Y^0|D$=0) in their given states. Fortunately, with appropriate counterfactual designs, one can still approximate the average causal effects using different causal estimands and methods.

The causal estimand this study aims for is the Average Treatment effect for the Treated (ATT), which can be identified using a naïve estimator of difference between the treatment and the control group and adjusting for the baseline differences between groups:

$$ATT = \underbrace{E(Y_i^1|D_i = 1) - E(Y_i^0|D_i = 0)}_{\text{naive estimator}} - \underbrace{[E(Y_i^0|D_i = 1) - E(Y_i^0|D_i = 0)]}_{\text{baseline differences}}$$

Since this equation involve one counterfactual factor $E(Y_i^0|D_i = 1)$, one has to rely on assumptions regarding the baselined differences to identify the ATTs. In a longitudinal (panel) research design, the ATTs can be identified under more realistic assumptions than those required in a cross-sectional design (Morgan & Winship, 2015).

A popular strategy to identify ATTs is using a standard FE regression in a *pure within estimation framework* that compares the outcome Y *within* the same person *i* in different observational time. That is, $\hat{\Delta} = Y_{i,t1}^1 - Y_{i,t0}^0$. A valid causal inference using this strategy requires a temporal homogeneity assumption: the changes in Y over time are caused only by the treatment D, given the other time-dependent effects on Y held constant over time. With this assumption, one can extend the observed work hours ($Y_{i,t0}^0|D$=1) of a mother *i* in her pre-childbirth period t_0 using a time-constant trend to approximate her counterfactual work hours ($Y_{i,t1}^0|D$=1) in the post-childbirth time t_1. Empirically, a standard fixed effects model only includes the yearly observations for those who are treated. In order to apply this temporal homogeneity assumption to the model, one has to assume that there is no period effect or maturation effect by age in the investigation of a woman's work hours growth. While the temporal homogeneity assumption is less restricted than the unit-homogeneity assumption required in a cross-sectional research design, it is still a strong assumption. This assumption is usually violated in life course studies due to age- and period-related maturation in individual attributes over time, such as the age-dependent growth curves in health, happiness, or career outcomes (Brüderl & Ludwig, 2015).

To account for the maturation effects in a panel analysis, I utilize a *within estimation with the control group*. Specifically, in addition to the within estimation, this strategy uses the

observed time trend (e.g., the age growth curve) of the control group to specify a parallel trend and the treatment group's counterfactual outcome. The trend-related bias in the pure within estimation is thus adjusted for. That is, $\hat{\Delta} = (Y^1_{i,t1} - Y^0_{i,t0}) - (Y^0_{j,t1} - Y^0_{j,t0})$. An underlying assumption is that the treatment group's unobserved life-cycle time trend is assumed to be parallel to that of the control group (the parallel trend assumption). In life course studies, this assumption is more plausible than the temporal homogeneity assumption required by a pure within estimation. A popular method following this logic is the difference in differences method (DID). The current study applies a similar modeling approach by including non-mothers as a control group in the FE regression.

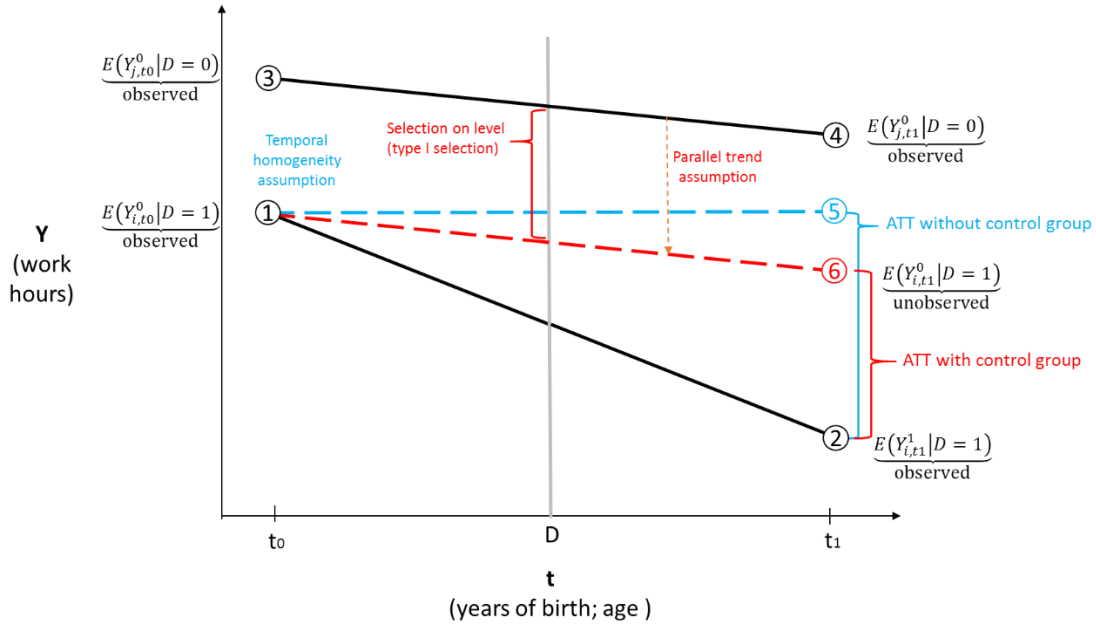

Fig. B1. Idealized scenario regarding the effect of childbirth on women's weekly work hours

To compare the two types of within estimation method (i.e., FE regressions with or without the control group), let us consider the example of women's work hours. Fig. B1 presents the idealized scenario of women's growth curves of work hours with the occurrence of a childbirth event (i.e., the treatment event). Three theoretical factors operate behind this scenario: (1) childbirth has a negative effect on women's work hours (the causal effect); (2) women who have a lower level of work hours are more likely to have children (the selection effect based on outcome levels, the type I selection); (3) individual work hours are declining over the life course (the maturation effect, a life-cycle trend).

In the standard FE regression *without* specifying the non-treated as a control group, only the within changes for the treated are concerned (points 1 and 2). A counterfactual point 5 is approximated using the observed point 1 with the operation of the temporal homogeneity

assumption. In this specification, the ATT in t_1 is estimated as the difference between points 5 and 2. In contrast, the FE regression *with* the control group not only utilizes the within changes for the treated but also adjusts for the life-cycle trend using the observed information from the control group (points 1, 2, 3, and 4). With the parallel trend assumption, this method approximates a counterfactual point 6 using the observed point 4 of the control group. The ATT in this framework is the difference between points 6 and 2.

2. Application: The Effect of the First Birth on Women's Work Hours in Japan

From a causal perspective, both FE regression methods address the level-based selection bias because they only consider the within changes for the treated. However, one should notice that their estimated ATTs are different. In our idealized scenario, individual work hours *do* change over the life course, with or without the motherhood transition. If our assumption about the declining trend in the growth curve is correct, unable to specify a control group in a FE regression would overestimate the negative effect of childbirth on women's work hours.

(a) (b)

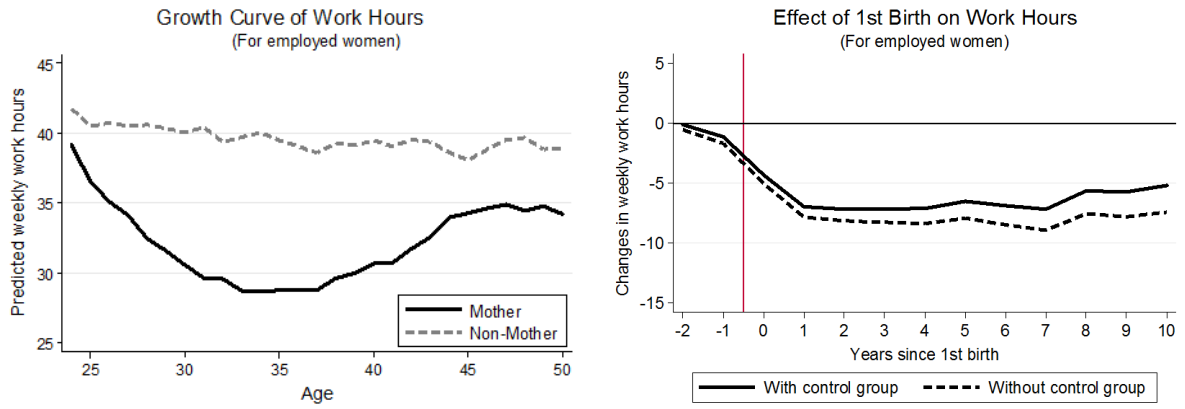

Fig. B2. The effect of childbirth on women's weekly work hours in the Japanese context.

Notes: The predicted work hours by age in Graph (a) were calculated using the random effect growth curve models controlling for women's time-varying marital status, living arrangement with parents, female employment rates, and total fertility rates. Graph (b) compares the total effects of first birth on work hours using the FE model with the control group (same as the focal model in the main text Fig. 3-b) to the estimation results using a FE model without the control group.

Previous studies have shown that Japanese women's work hours tend to decline over the life course (Yu, 2009). In our sample, I also found a declining trend in women's work hours

by age, even among non-mothers who had not experienced a motherhood transition during the observational window (Fig. B2-a). This result indicates that the temporal homogeneity assumption required by the standard FE regression is likely violated. With the accumulation of age-related effects, the biased results from the standard FE regression model could escalate over time. As shown in Fig. B2-b, the overestimated effects of childbirth of the standard FE regression have deviated from those of the FE regression with the control group.

Appendix C. Modeling the impacts of consecutive life course transitions

Many topics in life course research involve, whether explicitly or implicitly, the issue of consecutive life course transitions. In the motherhood penalty research, how women's long-term career outcomes are affected by motherhood may involve the cumulative effects resulted from multiple birth transitions. As I have argued, distinguishing the impacts of the first birth from those of the second birth is important because their motherhood penalties may involve different mechanisms and require different policy measures. Among studies using FE regressions, a popular strategy is using *one estimation sample* to identify the different childbirth effects in *one estimation model* using either (1) *categorical treatment-state dummies* (e.g., Budig & England, 2001; de Hoon et al., 2017) or (2) *multiple transition-specific dummies* (e.g., Abendroth et al., 2014; Doren, 2019). The first model specification is written as:

$$Y_{it}^{All} = \beta_0 X0_{it} + \beta_1 X1_{it} + \beta_2 X2_{it} + u_{it} \quad (1)$$

where $X0_{it}, X1_{it}, X2_{it}$ are three dummies of women's current state of motherhood (e.g., no child, one child, and two children) and u_{it} is the idiosyncratic error term. The second model specification is written as:

$$Y_{it}^{All} = \delta_1 D1_{it} + \delta_2 D2_{it} + u_{it} \quad (2)$$

where $D1_{it}$ and $D2_{it}$ are dummies of two consecutive state transitions (e.g., first birth and second birth) and u_{it} is the idiosyncratic error term. Conclusions have been drawn based on intuitive comparisons of the effect size of each birth treatments (i.e., among β_0, β_1, β_2 or $\delta_1$versus δ_2).

Although this *one estimation model approach* seems to permit straightforward group comparison, a direct interpretation of its estimated parity-specific effects could be misleading, especially in a within estimation framework (e.g., fixed effects models, first difference models) involving consecutive transitions (see Brüderl & Ludwig, 2019: 125-130 for related discussion). The FE model regresses changes in outcomes on changes in states (i.e., transition). In this regard, the effect of the second birth in both equations (1) and (2) is not purely "causal" in a FE model because there is no state transition from no birth to the second birth (except for rare twin births). Moreover, while the model using equation (2) estimates the effects of both births in one model (same logic as in equation (1)), the estimated results of δ_1 and δ_2 are still not comparable because they are estimated based on "two subsamples" if the FE estimators are applied. That is, the estimation of δ_1 is based on the subsample of no-child women who eventually have one child, whereas the estimation of δ_2 is based on another

subsample of one-child women who eventually have two children. Modeling the causality of two consecutive transitions in one model is problematic if the heterogeneous effects of the first birth (i.e., the previous transition) serve as the selection factor into the second birth (i.e., the consecutive transition). By specifying multiple treatments in one FE model, the estimated effect of the second birth (either β_2 or δ_2) mixed up both the causal effect of the second birth and the noncausal effects resulting from such selection.

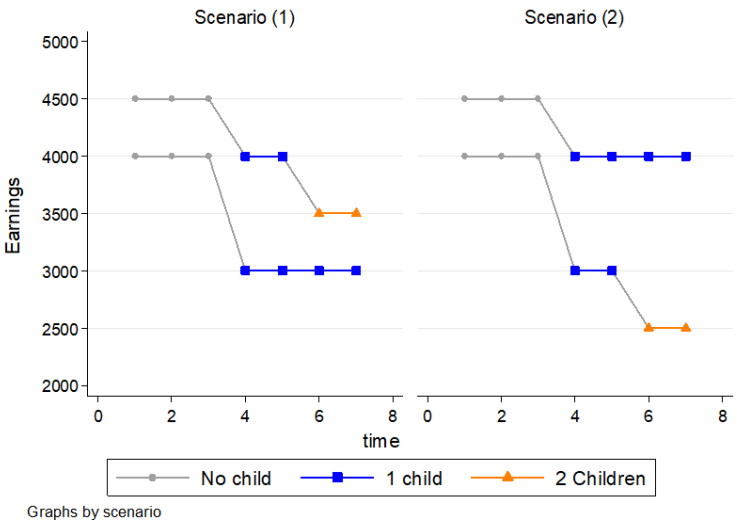

Fig. C1. Two scenarios of selection into a consecutive birth transition. *Scenario (1) presents a positive selection on the first-birth effect into the second birth; Scenario (2) presents a negative selection on the first-birth effect into the second birth.*

Depending on how women's second birth is selected based on the effect of the first birth, the estimated results of δ_2 may bias in two directions. Consider an idealized panel sample of two women in two scenarios (Fig. C1). Scenario (1) presents a positive selection on the first-birth effect, where the first woman who experiences a smaller earnings loss (-500) continues to have her second birth, while the other who has a larger earnings loss (-1000) remains at parity one. Using equation (2) to model this scenario, the FE regression estimates an effect of -794 for the first birth (not biased from the -750 real effect when the weight of unbalanced panels is adjusted for) and an effect of -323 for the second birth. The negative effect of the second birth is significantly underestimated because the parameter estimate of δ_2 in Scenario (1) mixed up both the causal effect of the second birth and the noncausal effect of the positive selection into the second birth. A contrary Scenario (2) presents a negative selection on the first-birth effect, where only the second woman with a larger earnings loss (-1000) continues to have her second child. Using equation (2) and a FE regression to model

Scenario (2) will report an effect of -706 for the first birth (not biased from the -750 real effect when the weight of unbalanced panels is adjusted for) and an effect of -677 for the second birth. The second birth's negative effect is now overestimated due to including the noncausal effect of the negative selection into second birth.

In real-world panel data analyses, it is difficult to evaluate which selection effect dominates because they might exist in parallel. However, it is possible to avoid this empirical issue by constructing *multiple estimation samples* and specifying *multiple transition-specific models* for each birth event (Brüderl & Ludwig, 2019; Zhang, 2010). As I have illustrated in the main text (Fig. 2), when modeling the first birth penalty, I only consider a subsample of women who are "at risk" of the first birth and use the information after the first birth to estimate the earnings losses. Following the same logic, for the second birth penalty, I consider another subsample of women who are "at risk" of the second birth. Corresponding to each estimation subsamples, I specify two estimation models for the effects of the first birth ($Y_1 = \delta_1 D_1 + u_1$) and the second birth ($Y_2 = \delta_2 D_2 + u_2$), separately. Using FE estimators in both models, our analyses are able to account for the selection into both treatments based on the pretreatment *level* of outcomes Y_{it}. At the same time, this approach also avoids the biased parameter estimates of δ_2 resulted from the selection into second birth on the first-birth effect.

Appendix D. Robustness Analyses

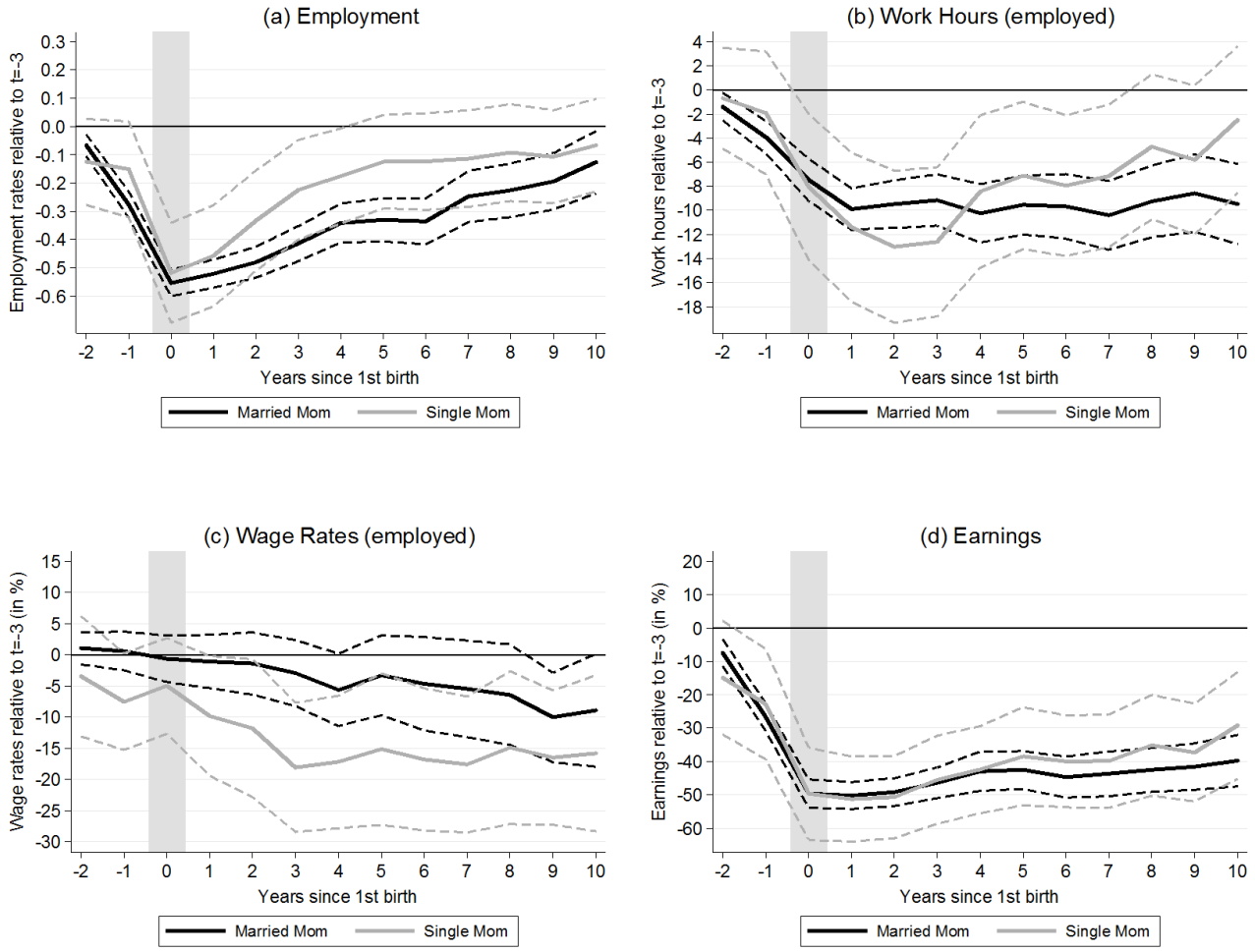

Fig. D1. The total effects of first birth on women's labor supply, wage rates, and earnings by mother's marital status.

Notes: Thick lines present estimated effects from FE models with impact functions; thin dash lines indicate 95 percent confidence intervals based on individual-clustered standard errors. All models control for individuals' age, living arrangement with parents, female unemployment rates, total fertility rates, and the period effect of the 2005 family policy reform. The subsample for "Single Mom" comprises women who have ever been non-married (i.e., single, divorced, widow) during her post-motherhood period. The subsample for "Married Mom" comprises women who have always been married during her post-motherhood period.

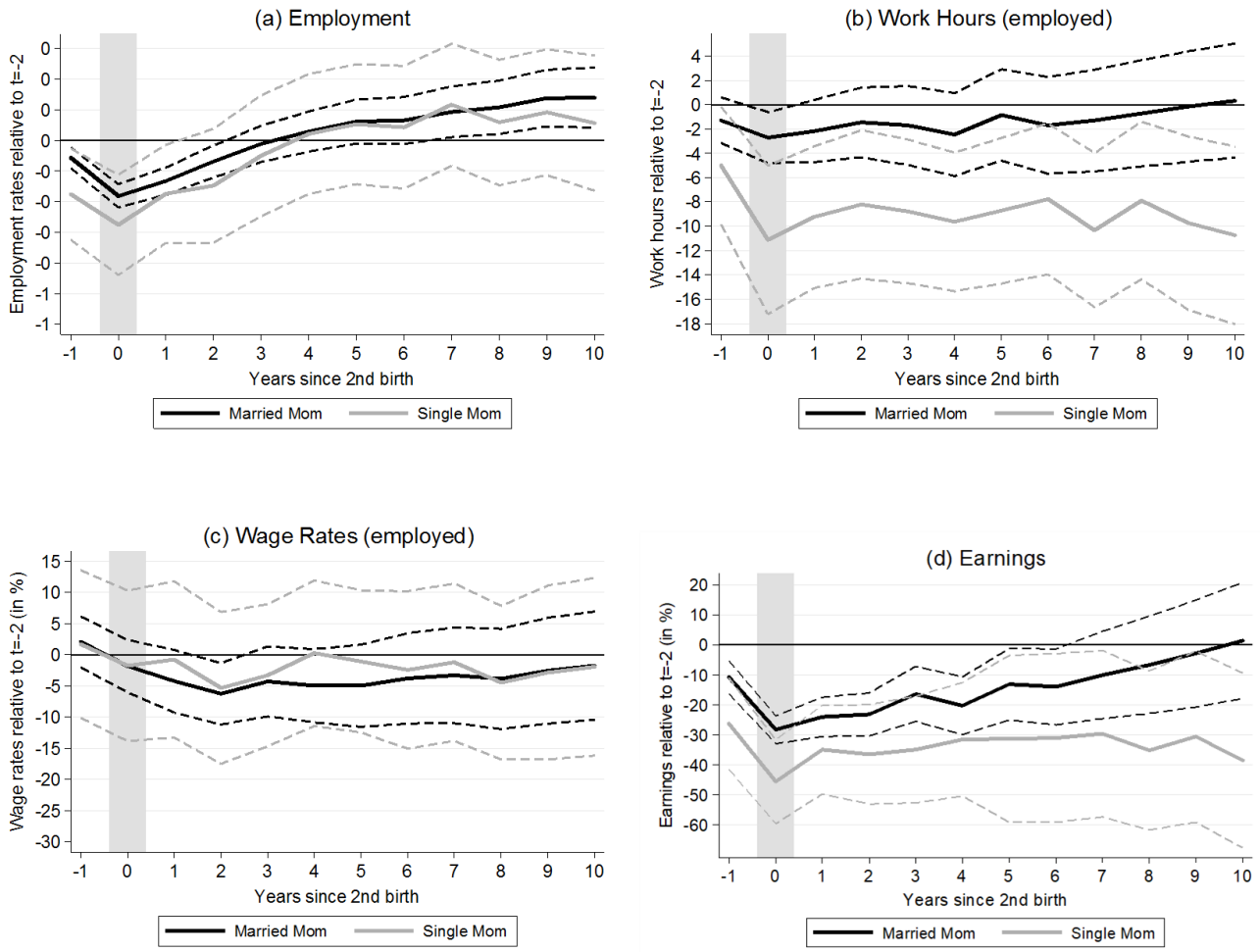

Fig. D2. The total effects of second birth on women's labor supply, wage rates, and earnings by mother's marital status.

Notes: Thick lines present estimated effects from FE models with impact functions; thin dash lines indicate 95 percent confidence intervals based on individual-clustered standard errors. All models control for individuals' age, living arrangement with parents, female unemployment rates, total fertility rates, and the period effect of the 2005 family policy reform. The subsample of "Single Mom" comprises women who have ever been non-married (i.e., single, divorced, widow) during her post-motherhood period. The subsample of "Married Mom" comprises women who have always been married during her post-motherhood period.

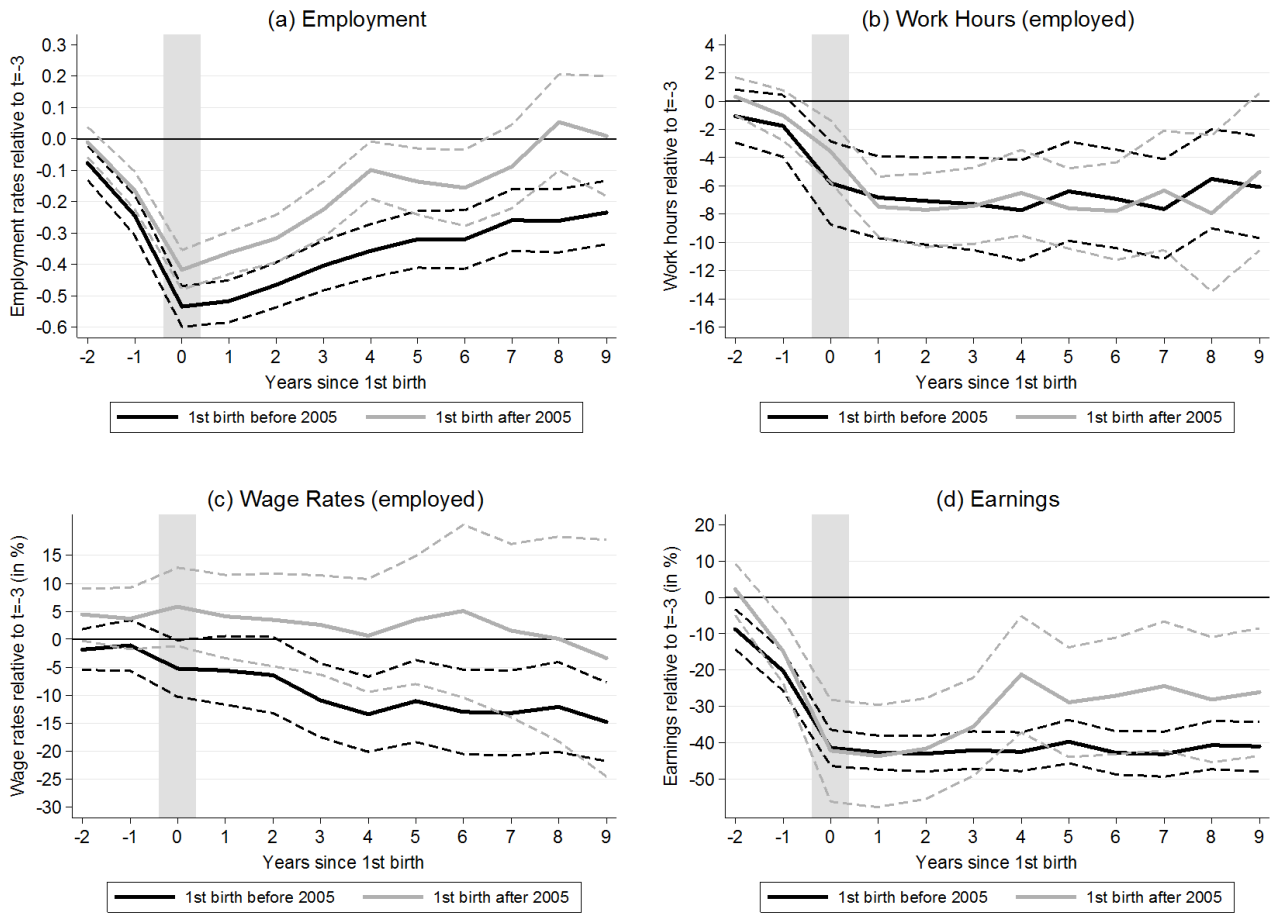

Fig. D3. The total effects of first birth on women's labor supply, wage rates, and earnings by the timing of first birth before or after the 2005 family policy reform.

Notes: Thick lines present estimated effects from FE models with impact functions; thin dash lines indicate 95 percent confidence intervals based on individual-clustered standard errors. All models control for individuals' age, marital status, living arrangement with parents, female unemployment rates, total fertility rates. The subsample of "1st birth before 2005" comprises women who had first birth between the years 1993 and 2004. The subsample of "1st birth after 2005" comprises women who had first birth between the years 2005 and 2015. Because the sample size of post-2005 mothers who were 10 years after the first birth were too small to provide robust estimation, I restricted the time window of comparison up to 9 years since the birth.

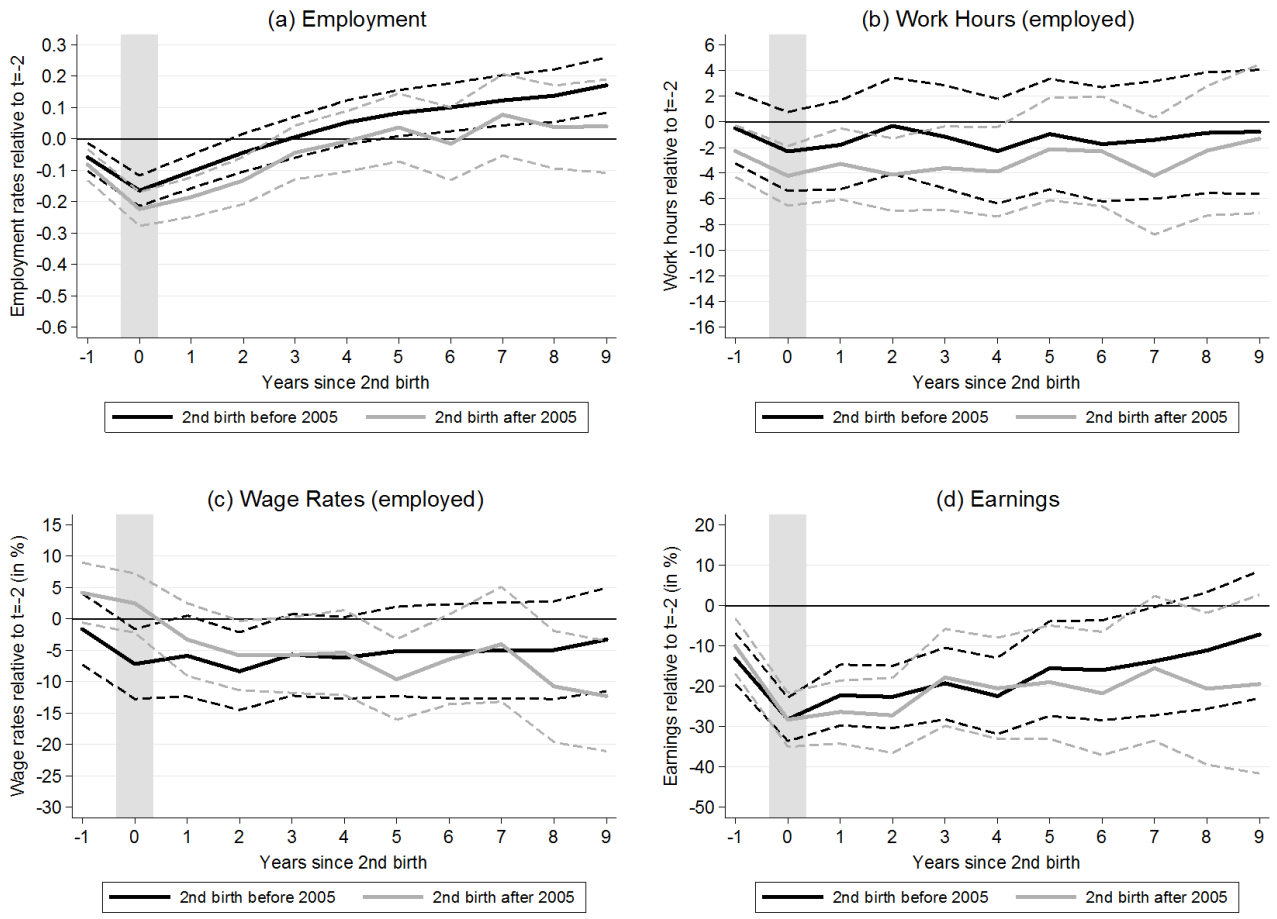

Fig. D4. The total effects of second birth on women's labor supply, wage rates, and earnings by the timing of first birth before or after the 2005 family policy reform.

Notes: Thick lines present estimated effects from FE models with impact functions; thin dash lines indicate 95 percent confidence intervals based on individual-clustered standard errors. All models control for individuals' age, marital status, living arrangement with parents, female unemployment rates, total fertility rates. The subsample of "2nd birth before 2005" comprises women who had second birth between the years 1993 and 2004. The subsample of "2nd birth after 2005" comprises women who had second birth between the years 2005 and 2015. Because the sample size of post-2005 mothers who were 10 years after the second birth were too small to provide robust estimation, I restricted the time window of comparison up to 9 years since the birth.

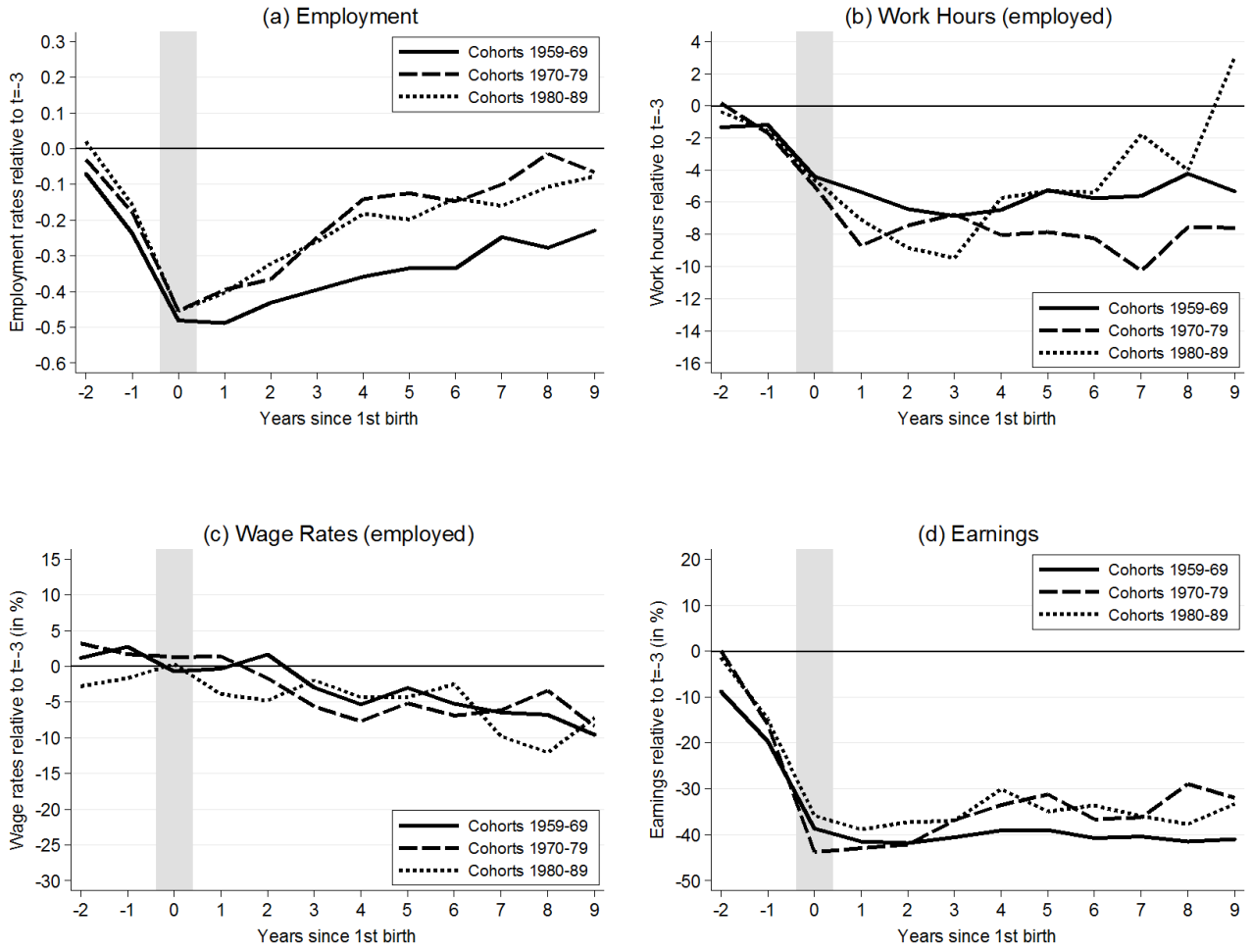

Fig. D5. The total effects of first birth on women's labor supply, wage rates, and earnings by women's birth cohorts.

Notes: Effects were estimated from FE models with impact functions. All models control for individuals' age, marital status, living arrangement with parents, female unemployment rates, total fertility rates, and the period effect of the 2005 family policy reform. Three cohort subsamples were created based on women's birth cohorts. Because the sample size of cohorts 1980-89 mothers who were 10 years after the first birth were too small to provide robust estimation, I restricted the time window of comparison up to 9 years since the birth.

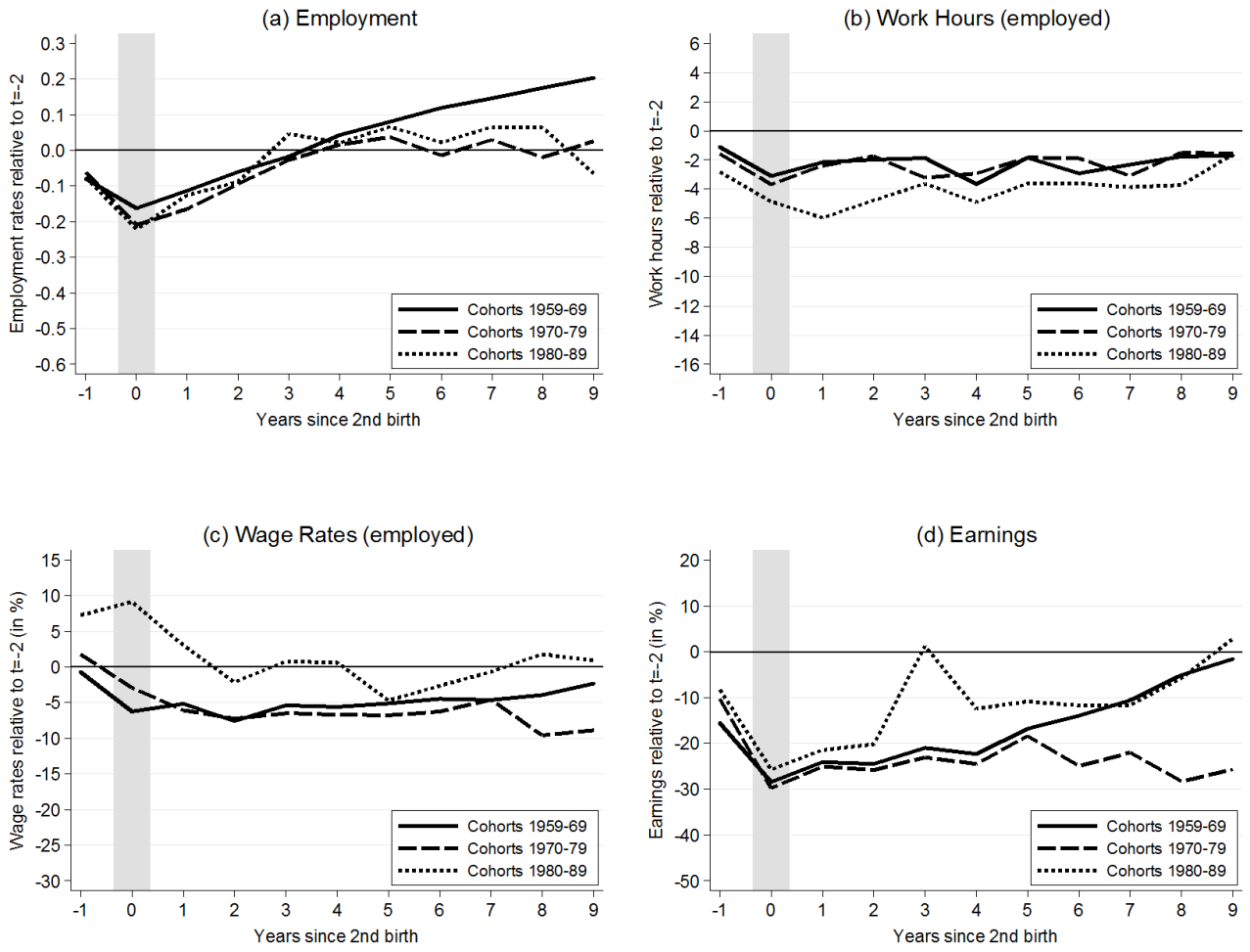

Fig. D6. The total effects of second birth on women's labor supply, wage rates, and earnings by women's birth cohorts.

Notes: Effects were estimated from FE models with impact functions. All models control for individuals' age, marital status, living arrangement with parents, female unemployment rates, total fertility rates, and the period effect of the 2005 family policy reform. Three cohort subsamples were created based on women's birth cohorts. Because the sample size of cohorts 1980-89 mothers who were 10 years after the second birth were too small to provide robust estimation, I restricted the time window of comparison up to 9 years since the birth.

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Share of contributions to the articles included in this cumulative dissertation.

Article	Author(s)/Share	Year	Title	Status/Journal
I	Hsu, C.-H. / 90% Engelhardt, H. / 10%	2024	A Precarious Path to Partnership? The Moderating Effects of Labour Market Regulations on the Relationship Between Unstable Employment and Union Formation in Europe	Published in *European Journal of Population*
II	Hsu, C.-H. / 100%	2023	How women's employment instability affects birth transitions: The moderating role of family policies in 27 European countries	Published in *European Sociological Review*
III	Hsu, C.-H. / 100%	2022	Work and fertility in Taiwan: how do women's and men's career sequences associate with fertility outcomes?	Published in *Longitudinal and Life Course Studies*
IV	Hsu, C.-H. / 100%	2021	Parity-specific motherhood penalties: Long-term impacts of childbirth on women's earnings in Japan	Published in *Advances in Life Course Research*