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Hsu, Chen-Hao

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RESEARCH

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

Chen-Hao Hsu, chen-hao.hsu@uni-bamberg.de
University of Bamberg, Germany

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 analyse the employment–fertility relationship from a static perspective and only for women, which underemphasises 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.

Key words fertility • employment instability • self-employment • sequence analysis • East Asia

Key messages

- Using sequence analysis, this study illustrates the gendered career pathways in Taiwan and their associations to various fertility timing and quantum.
- For women, having a stable employment career in full-time positions relates to a delayed motherhood transition and lower fertility.
- For men, having an unstable career associates with a later fatherhood transition, postponed parity progressions and lower fertility.
- For both genders, self-employed Taiwanese are the earliest in parenthood transitions and have the highest number of children by midlife.

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Introduction

The demographic transition in East Asia has been fuelled 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 modernisation and industrialisation 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 (Raymo and Shibata, 2017; Piotrowski et al, 2018). In contrast, women who are highly attached to the labour market are often linked to delayed family formation and lower marital fertility (Jones, 2007; Raymo and Shibata, 2017; Brinton and Oh, 2019).

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 (Blossfeld and Mills, 2005; Kreyenfeld, 2010; Adsera, 2011b; Pailhé and Solaz, 2012; Vignoli et al, 2016; Raymo and Shibata, 2017; Piotrowski et al, 2018). 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 (Huinink and Feldhaus, 2009; Buhr and Huinink, 2014; Huinink and Kohli, 2014). However, these theoretical insights have rarely been tested using holistic approaches until recently (Özcan et al, 2010; Pailhé and Solaz, 2012; Ciganda, 2015; Busetta et al, 2019).

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 typologise 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; McDonald, 2009; Yu, 2009; Jones, 2019).

Background

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 bidirectional, namely, people's employment situations may affect their fertility behaviours and vice versa (Matysiak and Vignoli, 2008; Matysiak, 2011). With an aim to understand the economic and sociological factors behind Taiwan's low-fertility phenomenon, this study homes in on the discussions on how people's employment situations affect fertility.

The *New Home Economics theory* (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 (that is, the positive income effect) because stably employed individuals can afford more children at the same costs compared 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 (that is, the negative substitution effect). Whether employment affects fertility positively or negatively depends on which effect is dominating. Given a traditional gender division of labour, 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, emphasising 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 an 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 emphasises 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 unfavourable 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 et al's \(1994\)](#) theories indicate that women's fertility behaviours are negatively associated with employment stability.

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](#); [Raymo and Shibata, 2017](#); [Piotrowski et al, 2018](#)). 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 the 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 ([Elder et al, 2003](#); [Mayer, 2009](#); [Abbott, 2016](#)). According to [Bernardi et al \(2019\)](#), a life course is conceptualised as a multidimensional behavioural 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 in the labour 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](#); [Fuller and Stecy-Hildebrandt, 2015](#); [Devillanova et al, 2019](#)). 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](#); [Fuller and Stecy-Hildebrandt, 2015](#); [McVicar et al, 2019](#); [Reichenberg and Berglund, 2019](#); [Fauser, 2020](#)): 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 labour 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 (Huinink and Feldhaus, 2009; Buhr and Huinink, 2014). More importantly, fertility life courses have interdependent relationships with other life domains, particularly with one's work and employment careers (Krüger and Levy, 2001; Pollock, 2007; Aisenbrey and Fasang, 2017; Vignoli et al, 2020). In this regard, people's fertility histories are shaped not only by 'sequential institutionalisation', but also by 'simultaneous institutionalisation', in which fertility and employment life courses are unfolding simultaneously (Krüger and Levy, 2001; Huinink and Kohli, 2014).

Drawing on the life course perspective, I define a person's 'career' as a sequence of interdependent employment states evolving over time (Pollock, 2007; Simonson et al, 2011; Biemann et al, 2012). 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 multichannel 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 (Simonson et al, 2011; Aisenbrey and Fasang, 2017; 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 (that is, the quantum effect). In Germany, Auer and Danzer (2016) found that entering the labour market with a fixed-term contract delayed women's age at first birth and reduced their total number of children within ten years of 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 (that is, 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 (Del Boca et al, 2005; Adsera, 2011a; Begall and Mills, 2013; Noseleit, 2014; Sinyavskaya and Billingsley, 2015; Köppen et al, 2017; Tocchioni, 2018; Matysiak and Mynarska, 2020). 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 mobilise family resources, this career choice may serve as an ideal package to combine work with family (Anthias and Mehta, 2003).

The Taiwanese context

Taiwan is well known for its currently ultra-low fertility rates and late adulthood transitions in the demographic literature (Goldstein et al, 2009; Nauck et al, 2017; Jones, 2019; Cheng, 2020). During the post-Second World War industrialisation, 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 globalisation 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 labour-force participation in paid jobs (Yu, 2009; Gietel-Basten, 2019), 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 globalisation (Mills and Blossfeld, 2013), it is theoretically crucial to investigate whether and how Taiwanese women's and men's fertility behaviours 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, is usually ranked among the countries with the most inadequate conditions for combining work with family (Jones, 2007; McDonald, 2009; Frejka et al, 2010; Gauthier, 2016). This is especially true for Taiwanese women because childcare and housework tasks are conventionally considered as mothers' responsibilities (Cheng, 2020; Cheng and Hsu, 2020). Moreover, work-family reconciliation is weakly supported by public policies (Tsai, 2012; Gauthier, 2016). 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 leave is not common among Taiwanese until very recently. From 2009 to 2018, the percentage of eligible female workers receiving childcare benefits during their leave 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 enrolment rate in public-supported childcare facilities is extremely low in Taiwan, especially for infants and toddlers below age three. From 2005 to 2018, the enrolment 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 leave is argued to depress people's childbirth rates 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 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 labour 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 (Raymo and Shibata, 2017; Piotrowski et al, 2018). 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.

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 and 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 (Hypothesis 1a) and a lower number of children by midlife (Hypothesis 1b).

Hypotheses 2a and 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 (Hypothesis 2a) and a higher number of children by midlife (Hypothesis 2b).

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

Hypotheses 3a and 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 (Hypothesis 3a) and a higher number of children by midlife (Hypothesis 3b).

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 giving domestic help are generally lacking (Gauthier, 2016; Cheng and Hsu, 2020).

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 a context, self-employed men might have higher economic status than the majority of firm-employed men. They might also have superiority in mobilising 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 and 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 (Hypothesis 4a) and a higher number of children by midlife (Hypothesis 4b).

Method

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 more than 60 surveys over the past 30 years. It applies survey modules comparable to many international survey projects, such as the International Social Survey Programme (ISSP) and the East Asia Social Survey (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.

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. First, 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 (that is, work in family business), (3) non-standard employment, including part-time workers, temporary/fixed-term contractors and

agency workers,¹ (4) full-time standard employment, and (5) non-employment.² For men, I consider an additional state of (6) in military service because military service for up to three years is 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 and Fasang, 2010; Studer and 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 and Kriesi, 2011; Yeung and Alipio, 2013).³

After obtaining the distances matrix, I deploy the partitioning around medoids (PAM) procedure for clustering (Kaufman and Rousseeuw, 2009). This method aims to obtain the best partitioning of a data set into a predefined number of k groups. Through an iterative 'swapping' procedure, PAM seeks to minimise the weighted sum of distances between every sequence and the medoids – the 'best representative' sequences of each group (see Kaufman and 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 initialise the PAM algorithm using the result of the Ward procedure (that is, 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 meaningfulness (that is, 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 (Studer, 2013; Piccarreta and Struffolino, 2019), 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 γ_i by age 40 using the following equation:

$$\gamma_i = \mathbf{X}_i\boldsymbol{\beta} + \mathbf{Z}_i\boldsymbol{\varphi} + \varepsilon_i \quad (1)$$

where \mathbf{X}_i denotes the vector of career dummies specified from the sequence cluster analyses. \mathbf{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 compared 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 and Tibshirani, 1986](#); [Guan, 2003](#)).⁵

Regression models control for several socio-demographic covariates. Individuals are categorised into three *birth cohort* categories: 1946–57, 1958–67 and 1968–77. 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 that of other families, using a five-point Likert scale, ranging from 'much better' to 'much worse'. For seven 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.

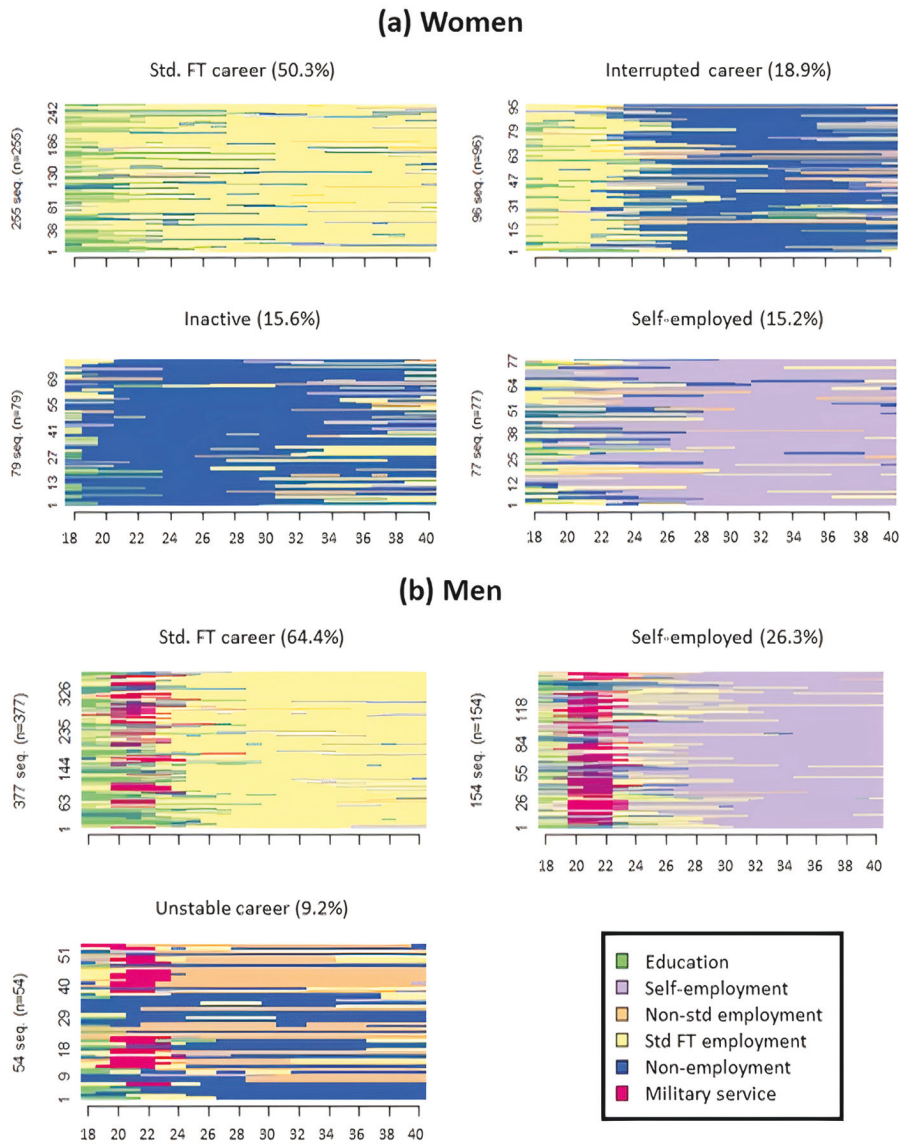
Sequence and cluster analyses in the first part are performed using the software R (version 4.0.2) and the R package TraMineR ([Gabadinho et al, 2011](#)). Survival analysis and multivariate regressions are performed using the software STATA (version 14.2).

Results

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 do not frequently switch to other employment tracks. The

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



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 seven years. After age 25, most of these women quit employment entirely or switch to more flexible self-employment or non-standard employment tracks. The emergence of this interrupted career pattern in East Asia is probably due to women’s career adjustment on family formation in order to reconcile work–family role conflicts (Yu, 2009; Raymo et al, 2015). 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-employed*, is featured by an extended time duration in self- or family-employment positions before midlife (on average 16.3 years).

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

For men, my results indicate a three-cluster solution. The most prevalent male career pattern is having a *standard full-time career* (64.4%). As 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.

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; Fuller and Stecy-Hildebrandt, 2015; Fauser, 2020), 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 and 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 labour-force attachment than women of interrupted careers. Therefore, I assume that inactive women have the least employment stability among Taiwanese women.

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 second (70.2%) and 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 (three children).

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 a second (59.3%) and a third birth (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.

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.

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 2a 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 their mid-30s. In sharp contrast, women with standard full-time careers 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. 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 (that is, inactive women) and self-employed careers.

Additional analyses in Figures 2b and 2c show that the gap between inactive and standard full-time career women in childbirth timing extends beyond the first birth. Economically inactive women lead women in all career groups in the second and third birth transitions, while women in standard full-time jobs constantly lag behind. The pace to second birth is similar between economically 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 childbirths.

Figure 3 presents men's cumulative transition hazards to each birth, estimated by the Nelson–Aalen method. Figure 3a indicates large career differentials in men's timing

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

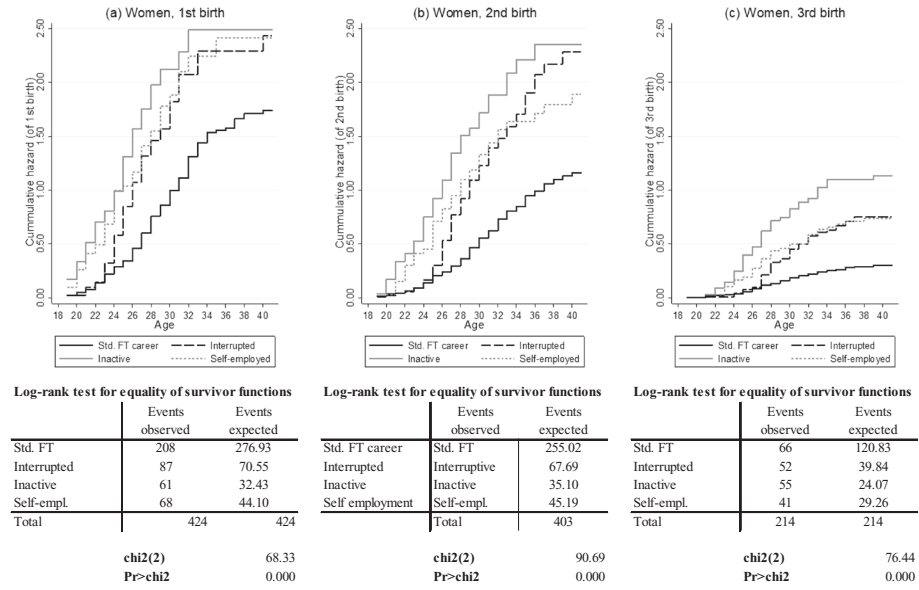
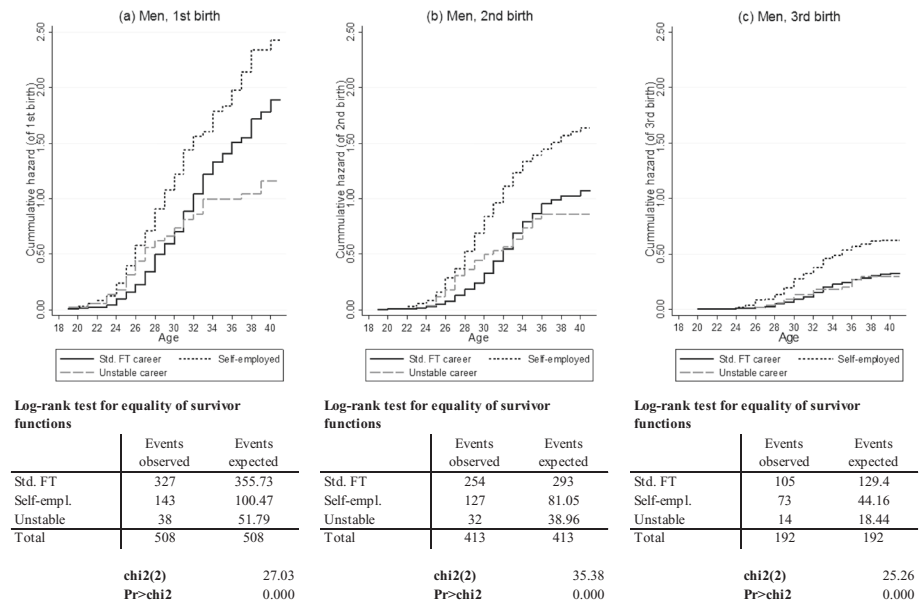


Figure 3: Nelson–Aalen cumulative hazard estimates and log-rank tests of group differences across men’s career types by birth transitions



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 men in standard full-time jobs are associated with a slightly slower fatherhood transition in early ages. This could be due to the longer

time spent on tertiary education for these full-time employed men, which prevents them from early-age family formation (Buchmann and 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 3a 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 3b and 3c 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 third births. The cumulative hazards have converged between men with standard full-time careers and unstable-career men at 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.

Employment careers and fertility quantum

Finally, I use multivariate regressions to adjust for group differences in socio-demographic characteristics (that is, 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 ($SE = 0.128$, $p < .001$) 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 ($SE = 0.140$, $p = .002$). 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 ($SE = 0.154$, $p = .047$) compared to having a stable full-time career. To the contrary, having a self-employed career, compared to a standard full-time career, associates with an increased fertility by 0.330 children ($SE = 0.104$, $p < .001$). Both findings on the relationship between men's careers and their number of children support Hypotheses 2b and 4b.

Additional analyses on model robustness and cohort heterogeneity

In the online supplementary materials S2,⁷ 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

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

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

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.

Conclusion and discussion

Research interest in how people's employment situations affect their family behaviours has been growing ([Kreyenfeld et al, 2012](#); [Buhr and Huinink, 2014](#)), particularly in an era when globalisation meets second demographic transition ([Blossfeld and Mills, 2005](#); [Mills and Blossfeld, 2013](#)). In East Asia, increased female labour-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 career stability and people's fertility behaviours 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 economically 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 compared to men with standard full-time careers, this early advantage 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 ([Anthias and Mehta, 2003](#); [Adsera, 2011a](#); [Noseleit, 2014](#); [Matysiak and Mynarska, 2020](#)). In Taiwan, given the shortage of work–family reconciliation policies ([Bumpass et al, 2009](#); [Gauthier, 2016](#)) and the superiority of self-employees in mobilising 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 leave becoming more prevalent and childcare facilities largely expanded since 2010, it will be interesting 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 analysing 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; Fuller and Stecy-Hildebrandt, 2015; McVicar et al, 2019; Devillanova 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 (that is, 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 to 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 behaviours. Second, due to the limited retrospective information in the TSCS data, my analysis cannot control for individual heterogeneities in subjective attitudes towards 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 bidirectional (Matysiak and Vignoli, 2008), indicating that people’s fertility is not only affected by but also affects 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 institutionalisation process (Krüger and Levy, 2001; Huinink and

Kohli, 2014). 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.

Notes

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 results from involuntary unemployment or from voluntary labour market inactivity. Both states in the focal analyses are categorised 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 three consecutive 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 online 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 and 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.

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

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.

⁷ Online supplementary materials S1 and S2 are available at https://osf.io/57m62/?view_only=a2a1042d9fa642a598c23401bdbc480a

⁸ For women, five out of the 12 career-cohort categories have a sample size fewer than 30 cases. For men, three out of the 9 career-cohort categories have a sample size fewer than 30 cases.

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Data availability statement

The data are publicly available under a licence agreement with the Survey Research Data Archive, Academia Sinica, Taiwan (https://srda.sinica.edu.tw/index_en.php).

Supplementary data

The online Appendix can be found here: https://www.ingentaconnect.com/content/bup/llcs/supp-data/content-llcsd2100020_supp and DOI: <https://doi.org/10.1332/175795921X16395725135971>

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Conflict of interest

The author declares that there is no conflict of interest.

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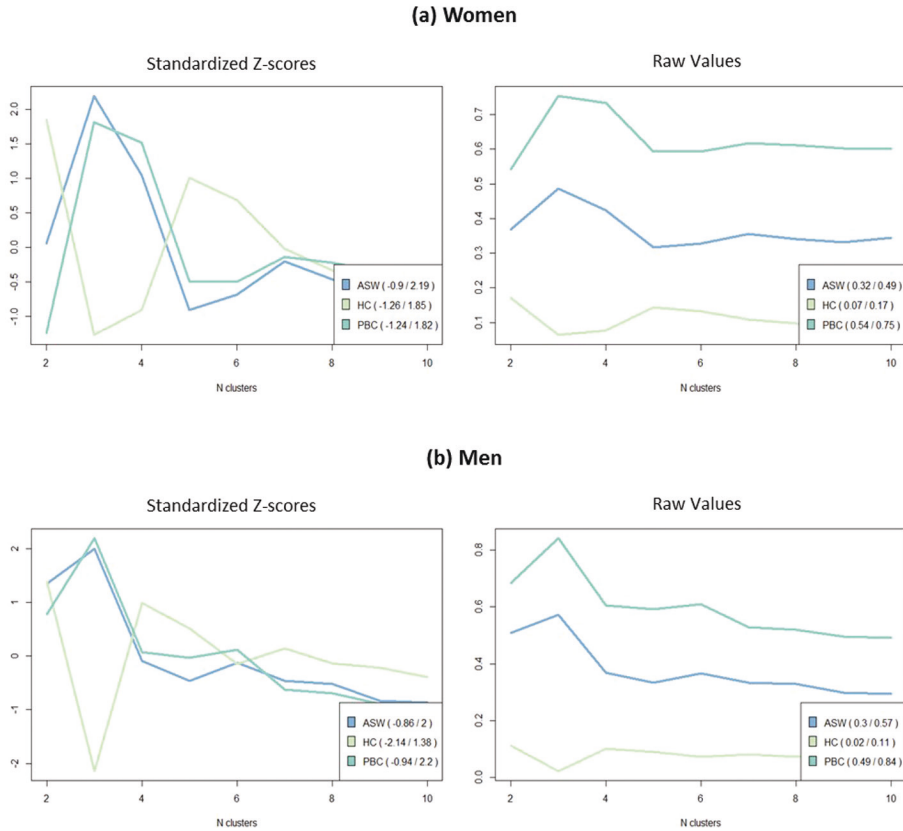
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Appendix

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 three clusters as the best solution, with four clusters being the second best in a close margin. After evaluating the substantive meaningfulness of clusters, I opt for the four-cluster solution because rather than pooling all women with relatively long non-employment duration into one large group, the four-cluster solution makes a theoretically meaningful distinction between the long-term 'inactive career' and the 'interrupted career'. For men, all three indicators indicate three clusters as optimal.

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

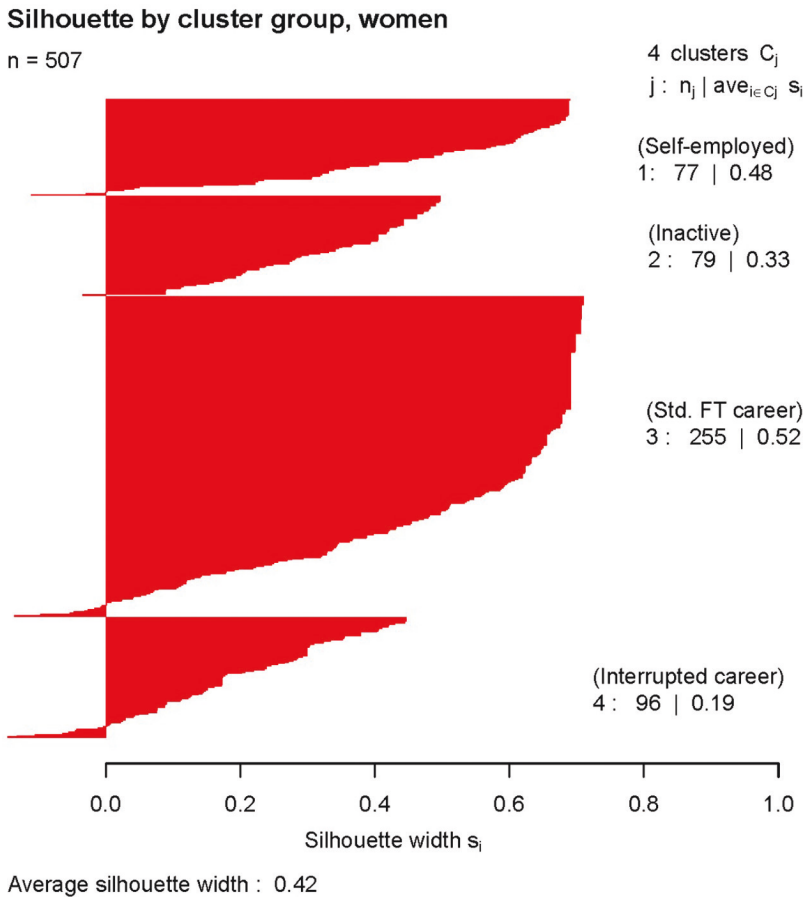


Figure A3: Silhouette widths by cluster for men's three-cluster solution.

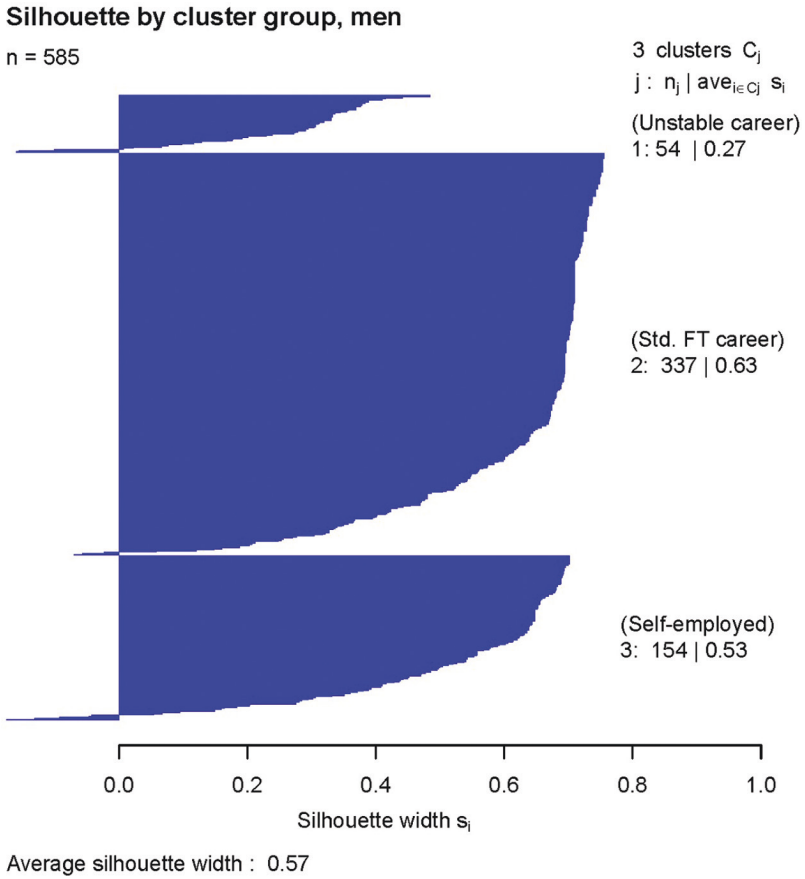


Table A1: Descriptive statistics of variables in each subsample.

	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 education	94.28		94.02	
At least one parent has tertiary education	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. 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, 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 women's clusters in the HAM with Ward procedure (that is, the subcluster with an ASW of -0.12).