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Research Article

Job creation, job destruction, and fertility in Germany

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Abstract

BACKGROUND
Labour market dynamics, such as job creation and job destruction, bear different associations with fertility. The relationship between job loss and fertility has been a core topic in family demography. However, little attention has been paid to examining how the expansion of some industries is associated with childbearing.

OBJECTIVE
This study investigates how job creation and job destruction are associated with regional-level total fertility rates in Germany. By including gender-specific job creation and destruction, it also aims to explore the drivers behind gender differences in the employment–fertility nexus.

METHODS
We use data from 400 NUTS 3 regions in Germany covering the period from 2008 to 2020. Spatial panel data modelling is used to examine the association between the creation and destruction of jobs and regional fertility rates. The approach allows us to identify both temporal and spatial processes associated with fertility.

RESULTS
We find a positive association between jobs created for female workers and regional fertility rates. Conversely, job destruction among male workers is negatively associated with regional fertility rates. Industry-level analyses suggest that particularly for women, the characteristics of the newly created jobs could matter for childbearing.

CONTRIBUTION
This study provides a nuanced picture of the association between job creation, job destruction, and fertility. In particular, our findings highlight gender differences in the relationship between dynamic labour market processes and childbearing. The relatively

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high degree of job creation, particularly in the female-dominated industries, might have contributed to the increase in fertility in Germany since 2009.

1. Introduction

The link between macro-level labour market conditions, such as unemployment rates, and fertility is well-established in demographic literature. Empirical evidence suggests that high unemployment rates contribute to a postponement of birth decisions, resulting in a decline in period fertility rates (Adserà 2004; Cazzola, Pasquini, and Angeli 2016; Goldstein et al. 2013; Sobotka, Skirbekk, and Philipov 2011). This is because a high unemployment rate entails not only income stagnation (or loss) but also increased uncertainty regarding future income or career prospects, including remaining or becoming unemployed (Kristensen and Lappegård 2022). A growing body of literature combining individual and contextual unemployment data (Adserà 2011; Kristensen and Lappegård 2022; Yu and Sun 2018) has demonstrated that the impact of aggregate unemployment on individuals' fertility behaviours may be significant regardless of their own employment situation (Adserà 2011; Kristensen and Lappegård 2022). Uncertainty concerning one's future employment is an important factor affecting fertility decisions (Vignoli et al. 2020). In relation to this, the availability of jobs can directly affect fertility, as people who observe a scarcity of jobs around them tend to postpone their childbearing plans (Adserà 2011).

Existing literature has emphasized the importance of job stability for individual fertility decisions (Gatta et al. 2022). However, there have been few attempts to examine the role of job creation and job destruction. While job loss and the resulting scarcity of jobs may lower fertility due to rising uncertainty regarding one's future income or career (Adserà 2011; Alderotti et al. 2021), it remains unclear how the expansion of some industries and the generation of new jobs might be associated with childbearing decisions. What is more, since job creation captures only employment growth from the expanding industries, it may coexist with job destruction from contracting industries in the same region and at the same time. For example, during an economic crisis, job creation tends to decrease, but it is unlikely to disappear completely (Carneiro, Portugal, and Varejão 2014). Although individuals may still experience job loss, the emergence of new jobs could make their job search less challenging (Kuhn, Manovskii, and Qiu 2021) and increase their confidence in finding a new position. Adopting a perspective that captures both job destruction and job creation enables us to gain a clearer insight into the complex and dynamic association between labour market processes and fertility.

This study investigates the relationship between job creation and job destruction and regional-level total fertility rates (TFR) in Germany. We use data from 400 NUTS 3 regions (*Landkreis* or *Stadtkreis*) and employ a spatial data modelling approach. Our analyses cover the years from 2008 to 2020. We look not only at total job creation and job destruction but also at the type of industry in which jobs are lost or generated. Furthermore, regional TFR could be affected by local job creation and destruction as well as labour market processes in the surrounding areas. Spatial modelling permits exploring the spill-over effects of local labour market changes, an aspect that has not been thoroughly investigated.

Based on the existing research evidence, we propose that job destruction is negatively related to fertility. The mechanism is similar to that of unemployment: a high rate of job destruction lowers the average income and raises uncertainty regarding future income and career prospects. Conversely, job creation may be positively associated with fertility: an increase in the number of jobs created could reduce overall uncertainty, including the uncertainty caused by potential job losses. However, the association between job creation and fertility might be conditional on the characteristics of the newly generated jobs. Uncertainty would be reduced the most – particularly for women – if the new jobs offered stable income or allowed for combining paid work and having a family. Overall, the relationship between job creation, job destruction, and fertility is likely gendered, as these processes may have different outcomes for men's and women's childbearing decisions.

This study contributes to the literature on the labour market and fertility by providing a dynamic and nuanced picture of the association between labour market processes and total fertility rates at a regional level. With the inclusion of gender-specific job creation and destruction, it also aims to add new evidence of gender differences in the employment–fertility nexus.

2. Background

2.1 Labour market and fertility

A large body of research has demonstrated that adverse labour market conditions such as high unemployment or an increasing share of precarious employment are associated with lower fertility across developed countries (Adserà 2011; Alderotti et al. 2021; Cazzola, Pasquini, and Angeli 2016; Sobotka, Skirbekk, and Philipov 2011). The association is also evident at an individual level: a worker's unemployment (Adserà 2005; Bono, Weber, and Winter-Ebmer 2015; Özcan, Mayer, and Luedicke 2010) or precarious employment (Scherer 2009; Schmitt 2021; Vignoli, Tocchioni, and Mattei 2020) is negatively linked with childbearing. Importantly, the association between employment and fertility is moderated by one's socioeconomic characteristics, primarily gender and education (Kreyenfeld and Andersson 2014; Matysiak and Vignoli 2013; Özcan, Mayer, and Luedicke 2010; Schmitt 2012).

Gender has traditionally been at the core of the work–fertility nexus. Economic theories on household decision-making argue that an increase in female labour force participation raises the opportunity cost of having children and lowers fertility (Becker 1981; Willis 1974). However, women now play a more significant role in the labour market than ever before (Engelhardt and Prskawetz 2004; Oppenheimer 1994) and the historical negative association between female employment and fertility has been weakening (Adserà 2004), along with women's labour market attachment becoming increasingly important for family formation (Scherer and Brini 2023).

Most literature agrees that unemployment among men is detrimental to individual childbearing, which is reflected in a reduction in total fertility rates (Cazzola, Pasquini, and Angeli 2016; Kravdal 2002; Pailhé and Solaz 2012), though there are exceptions (Inanc 2015). Research on the implications of female unemployment points to major heterogeneities. While a majority of studies have reported a negative relationship between female unemployment and fertility (Adserà 2004; Currie and Schwandt 2014; Huttunen and Kellokumpu 2016; Luci-Greulich and Thévenon 2014), insignificant and positive associations have also been found (Andersen and Özcan 2021; Özcan, Mayer, and Luedicke 2010). Overall, the effect of female unemployment on fertility is largely context-dependent. First, there is a socioeconomic gradient in the association between unemployment or labour market uncertainty and fertility (Kreyenfeld and Andersson 2014). Lower-educated women tend to respond to low job security by becoming pregnant and higher-educated women by postponing parenthood (Kreyenfeld 2010). Second, macro-level conditions moderate the association between unemployment and fertility. Female job loss during an economic downturn is more detrimental to first-birth rates than job loss during a period of economic growth, which does not have a significant effect (Hofmann, Kreyenfeld, and Uhlendorff 2017).

A couple perspective offers additional insights into the interplay between labour market and gendered family dynamics, showing that female job loss in the couple has a detrimental effect on fertility rates through its long-term negative influence on women's careers (Di Nallo and Lipps 2023). Furthermore, the scarring effect of job loss is particularly relevant for women and affects multiple domains of their lives, including family stability and wellbeing (Blom and Perelli-Harris 2021; Di Nallo and Lipps 2023).

2.2 The role of job characteristics

Despite being more attached to the labour market than before, women still take on more childbearing responsibilities (Killewald and García-Manglano 2016) and have more influence on the couple’s fertility decisions (Doepke et al. 2023). Women are more likely to have children if their jobs favour work–family compatibility (Adserà 2011; Begall and Mills 2013), such as offering stable employment and providing access to maternity leave and flexible working hours (Dribe and Stanfors 2010; Martín García 2010). These ‘family-friendly’ jobs lower the personal costs of childbearing by allowing combining paid work and family obligations. However, these jobs also tend to have unique characteristics beyond employment conditions, and these characteristics might be independently associated with childbearing. Begall and Mills (2013) argue that occupations related to caring, such as healthcare, welfare, or education, may promote childbearing not only because of the family-friendly working conditions but also due to the ‘nurturing’ nature of the occupational tasks. It needs to be noted that there is a potentially reverse causal relationship too: if a woman is family-oriented and wants to have (more) children, she will choose a job that enables her to fulfil her fertility plan (Cortes and Pan 2018). Overall, working in healthcare, welfare, education, or other public sector jobs has been associated with higher fertility in various European countries, lower levels of childlessness, and a lower impact of economic uncertainty on fertility (Begall and Mills 2013; Dribe and Stanfors 2010; Hellstrand, Nisén, and Myrskylä 2024).

Family-friendly jobs do not usually offer a steep career progression, so women focused on occupational achievement or economic power might have less interest in them. A possible alternative for them is a career in a more competitive work environment. Such careers offer steep progression to high-achievers (Den Dulk and Peper 2007) but often penalize childbearing. In these jobs it is more difficult to balance paid work and family life. Furthermore, in such jobs, career interruptions lead to the erosion of human capital (Walker 1995) through missing out on and failing to keep up with what is happening in the given field.

Other types of potentially ‘family-unfriendly’ occupations are those in which it is difficult to become established in the labour market and which come with high employment uncertainty, such as jobs related to the arts and humanities. These occupations have lower fertility rates and higher rates of childlessness (Hellstrand, Nisén, and Myrskylä 2024). As in the case of family-friendly jobs, work conditions, intrinsic task characteristics, and self-selection are the likely mechanisms behind these trends (Neyer, Hoem, and Andersson 2017). It needs to be emphasized that self-selection into occupations does not undermine the argument that job characteristics remain pivotal to investigating the employment–fertility nexus for women. In fact, there is evidence that certain job characteristics might reinforce preferences that have contributed to individuals selecting into these jobs (Anni, Vainik, and Mõttus 2024).

The association between job characteristics and fertility likely matters less for men, though there are caveats. Men do not face as high opportunity costs of childbearing as women, so the ease of combining work and family is less of a priority in their fertility decisions. Nonetheless, they are susceptible to labour demand shocks (Kearney and Wilson 2018). The key factors for male union formation and fertility are whether the job pays well enough (Kaufman and Bernhardt 2012) and whether the labour market prospects are promising (Giuntella, Rotunno, and Stella 2021). Not having stable financial resources is one of the main mechanisms behind the negative association between unemployment and fertility (Becker 1960; Oppenheimer 1994; Vignoli, Tocchioni, and Mattei 2020). Likewise, working in declining sectors, such as those affected by automation, has been linked with worse prospects for family formation and fertility among men (Autor, Dorn, and Hanson 2019).

2.3 Gendered effects of job creation and job destruction on fertility

The present study proposes that job destruction is associated with lower fertility, which is in line with earlier research on unemployment and fertility. However, there are several conditions and substantial heterogeneities in the expected effects. First, the type of job being cut may be important, particularly for women. On the one hand, the effect of job destruction on female fertility could be stronger if family-friendly jobs are the ones to be cut. On the other hand, these jobs might be selected by family-oriented women, and if that is the case these women could use the spell of unemployment to have a child (Adserà 2005). In the latter case, the loss of jobs into which women self-select would have no effect on fertility. Conversely, if women decided to have a child predominantly because of the family-friendly nature of the job and the lower childbearing costs of such jobs, they might delay becoming pregnant if such jobs were cut.

Similar heterogeneous effects are expected in the link between job creation and fertility. Jobs created in sectors such as healthcare, welfare, or education could lead to more women deciding to have a child, for two reasons. First, women seeking employment opportunities that align with their childbearing plans have a greater chance to realize their plans. It is worth noting that men are also more likely to have a child if their female partner has a job that allows her to combine work and family (Kaufman and Bernhardt 2012). Second, women who take up jobs in these areas are more likely to be surrounded by mothers, due to the lower childlessness rates in these sectors (Hellstrand, Nisén, and Myrskylä 2024). In professional surroundings where having children is common, a workplace culture may exist that normalises childbearing, thus lowering its social or professional costs for the mother. Jobs created in these sectors may therefore show a stronger positive association with fertility than jobs created in other sectors.

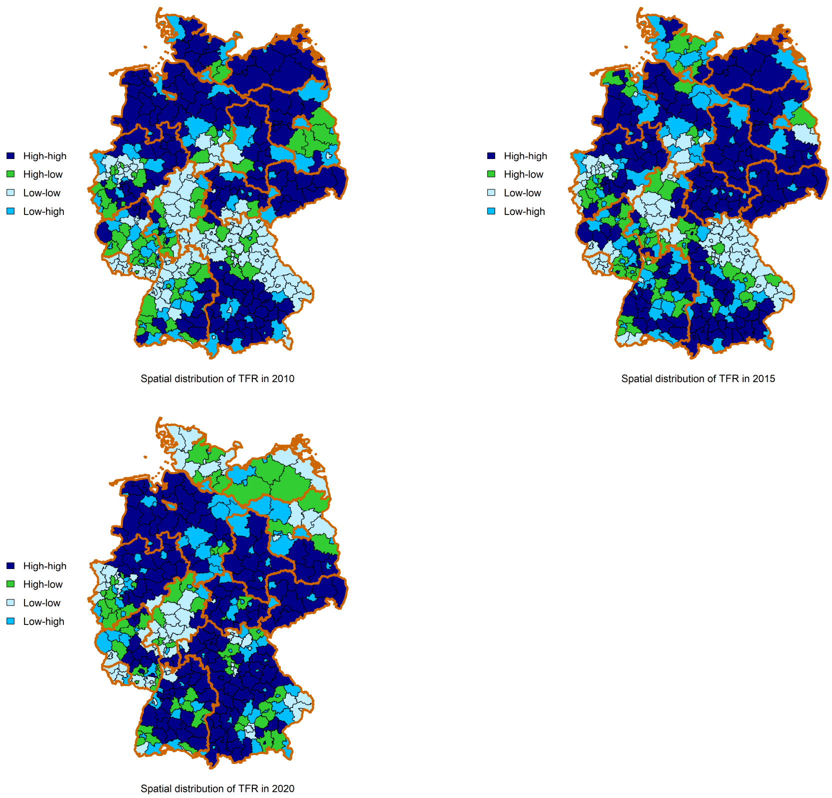
As regards male employment and fertility, labour demand shocks have more negative effects on men than on women (Anelli, Giuntella, and Stella 2019; Autor, Dorn, and Hanson 2019). In particular, job loss affecting male-dominated industries has been shown to lower male workers' value in the mating market and reduce their fertility (Autor, Dorn, and Hanson 2019). Conversely, local sector-specific positive economic shocks are associated with higher fertility rates among men working in these sectors, including low-skilled workers (Kearney and Wilson 2018). However, evidence from Germany shows that while lower-educated and married men working in sectors which benefit from increased international exports have higher fertility, low-skilled labourers, such as those working in traditionally male-dominated industries like manufacturing, are also less likely to move across sectors and are thus more affected by any systemic changes (Giuntella, Rotunno, and Stella 2021). While lower-educated men might be more affected by economic shocks, higher-educated men are more likely than women to work in sectors with higher added value and in more cognitively demanding occupations. Such jobs provide better earning opportunities and greater job security (Matysiak, Hardy, and Van der Velde 2023), which create favourable conditions for having children.

2.4 The German context

The degree of the relationship between macro-level labour market conditions and individuals' fertility decisions depends on the institutional settings and social norms in the country (Baizan, Arpino, and Delclòs 2016; McDonald 2000). Germany is a country with a conservative welfare regime (Mills and Blossfeld 2013), a heavily regulated labour market (Moser, Urban, and di Mauro 2010), and generous unemployment benefits (Mills and Blossfeld 2013).

Two important reforms happened just before our observation period began. First, the Hartz Reforms (2003–2005) marked a shift towards a system that incentivizes recipients of unemployment benefits to seek employment opportunities (Hofmann and Hohmeyer 2013). Second, in 2007 parental leave reform introduced an earnings-based parental-leave benefit scheme (Trappe, Pollmann-Schult, and Schmitt 2015) where maternity leave payments became based on previous earnings, making the woman's job more valuable for couples for whom income is a key determinant of childbearing. Before the 2007 reform, family policy encouraged new mothers to remain at home for a longer period (Brewster and Rindfuss 2000). However, the current system has transitioned to an earnings-based parental-leave benefit scheme, attracting new mothers to return to work within one year of giving birth (Huebener et al. 2022). This could have implications for the association between job creation and fertility. As it incentivizes women's attachment to the labour market, women who want to have children might be more eager to seek employment in the sectors that allow combining work and family. Creating such work opportunities could therefore contribute to higher fertility.

Figure 1: Spatial distribution of the regional TFR in Germany, 2010, 2015, and 2020



Note: High–high: High TFR regions surrounded by high TFR regions; High–low: High TFR regions surrounded by low TFR regions; Low–high: Low TFR regions surrounded by high TFR regions; Low–low: Low TFR regions surrounded by low TFR regions.

Since 2007 Germany has experienced a fluctuating but generally increasing trend of fertility. At the national level, the total fertility rate (TFR) increased from 1.33 in 2006 to above 1.5 after 2015, and this level was maintained until 2021 (World Bank 2024). In our data the regional TFR in Germany shows a geographical pattern (Supplementary materials, Figure 2). Figure 1 visualises the clusters of high and low fertility regions in

Germany for the years 2010, 2015, and 2020 using a Moran scatterplot.[3] Some regions (e.g., Saxony and most of Hesse) exhibit a consistent clustering of high or low fertility. By contrast, TFR in other regions (e.g., the Upper Palatinate, Bavaria) underwent substantial changes throughout the observation period.

3. Data and methods

3.1 Labour market dynamics

We use the data on the total number of employees subject to social security contribution by level 2 German classification of economic activities (WZ2008) from the Federal Employment Agency of Germany. In Germany, employees subject to social security contributions include most wage and salary workers but exclude the self-employed, those engaged in mini-jobs, civil servants, judges, soldiers, and unpaid family members who assist in a business. Although the data does not encompass the entire labour force, it effectively captures positions most influenced by market fluctuations and employment trends. The WZ2008 classification system is the German version of the Statistical Classification of Economic Activities in the European Community (NACE). It provides a standardized framework for categorizing 89 sectors[4] in total, including agriculture, manufacturing, services, and the public sector. We analyse labour market dynamics for 400 NUTS 3 statistical regions in Germany from 2008 to 2019,[5] the longest available period since the implementation of the current version of WZ2008.

We calculate job creation and job destruction following the approach by Davis and Haltiwanger (1998). Due to the different research goals, we measure job creation and destruction by industry for each region, whereas the original work focused on firm-level

[3] The Moran scatterplot illustrates the spatial clustering of high and low TFR regions based on standardized TFR values. Regions are categorised as high surrounded by high TFR, high surrounded by low TFR, low surrounded by low TFR, and low surrounded by low TFR. High TFR regions are those with a regional TFR equal to or greater than the mean regional TFR for the year, while low TFR regions are those with a regional TFR below the mean. For each county, the TFR of its neighbouring regions is represented by the average standardized TFR of all adjacent regions sharing a common border.

[4] Due to the data protection rules in Germany, records in the datasets are replaced with missing values mainly when the number of workers in a region is one or two in an industry. In the dataset that pools male and female workers the share of missing values is 4%, whereas in the datasets of male and female workers separately the shares are 7.7% and 5.9% respectively. To avoid over-smoothing the dynamics, this study imputes the missing values primarily using the ‘weighted moving average’ approach, instead of replacing them with mean values or zero.

[5] This study uses a map based on the administrative regions after 2011. In 2016 and 2021 one county disappeared and two counties merged into one. We replace the values of variables for these three counties by means of the year. For the administrative regions that underwent changes in and before 2011, the missing value is imputed using linear interpolation.

employment changes. For a given region, job creation is defined as the total number of job gains summed across all expanding industries. Job destruction represents the total job losses aggregated from all contracting industries. These measures are based on the change in employment levels between the current year (t) and the previous year (t−1). They are standardised by the average aggregate regional employment over these two years. The two measures are calculated as shown in Equations 1a and 1b:

$$JC_{jt} = \sum_i \frac{E_{ijt}-E_{ij(t-1)}}{(E_{jt}+E_{j(t-1)})/2} \text{ for all } E_{ijt} - E_{ij(t-1)} > 0 \tag{1a}$$

$$JD_{jt} = \sum_i \frac{|E_{ijt}-E_{ij(t-1)}|}{(E_{jt}+E_{j(t-1)})/2} \text{ for all } E_{ijt} - E_{ij(t-1)} < 0 \tag{1b}$$

where JC_{jt} and JD_{jt} stand for job creation (JC) and job destruction (JD) in region j at time t. The index i represents industry and E denotes the number of workers. Job creation and destruction are calculated in separate equations as they represent opposite types of employment change. However, both measures are standardized in the same way to capture changes relative to the size of the local labour market.

The gender-specific labour market dynamics take into account changes in male and female employment separately but are also standardised by the total employment of a given region. The calculations are as follows:

$$JC_{mjt} = \sum_i \frac{E_{mijt}-E_{mij(t-1)}}{(E_{jt}+E_{j(t-1)})/2}, \text{ for all } E_{mijt} - E_{mij(t-1)} > 0 \tag{2a}$$

$$JD_{mjt} = \sum_i \frac{|E_{mijt}-E_{mij(t-1)}|}{(E_{jt}+E_{j(t-1)})/2}, \text{ for all } E_{mijt} - E_{mij(t-1)} < 0 \tag{2b}$$

$$JC_{fjt} = \sum_i \frac{E_{fijt}-E_{fij(t-1)}}{(E_{jt}+E_{j(t-1)})/2}, \text{ for all } E_{fijt} - E_{fij(t-1)} > 0 \tag{3a}$$

$$JD_{fjt} = \sum_i \frac{|E_{fijt}-E_{fij(t-1)}|}{(E_{jt}+E_{j(t-1)})/2}, \text{ for all } E_{fijt} - E_{fij(t-1)} < 0 \tag{3b}$$

Equations 2a, 2b, 3a, and 3b examine the job creation and destruction rate for male and female workers independently. However, these measures only indicate lower bounds of real job creation and destruction rates. For example, it is not possible to identify when an industry in a region loses some jobs with others at the same level emerging within a year (Davis and Haltiwanger 1998).

In addition to the pooled and gender-specific samples, we include subsamples of male workers in male-dominated industries and female workers in female-dominated industries. These industries serve as proxies for gendered job characteristics. For comparison, we add subsamples excluding those industries. Female-dominated and male-dominated industries are defined as industries where the share of female and male workers, respectively, exceed 60% of the total workforce, based on the average number of workers over the entire observation period. A threshold of 60% is chosen to ensure that the subsamples have sufficient variation for analysis. The list of the 10 biggest industries per gender is given in Table 1 (the complete list of all industries is provided in the Supplementary Materials, Tables 1A and 1B). In the calculation of job creation and destruction in female-dominated industries we include female workers from 17 industries that collectively employ approximately 58% of the female labour force. Male workers are distributed more evenly across industries in Germany. In total, 47 male-dominated industries, accounting for 64% of the male labour force, are included in subsample of male-dominated industries.

Table 1: Industries ordered by the share of female and male workers in Germany

	Female-dominated industries	Male-dominated industries
1	Veterinary activities	Mining of coal and lignite
2	Households as employers of domestic personnel	Civil engineering
3	Human health activities	Mining of metal ores
4	Residential care activities	Mining support service activities
5	Legal and accounting activities	Manufacture of basic metals
6	Other personal service activities	Other mining and quarrying
7	Manufacture of apparel	Construction of buildings
8	Travel agency and tour operator activities	Specialised construction activities
9	Retail trade, except motor vehicles	Manufacture of other transport equipment
10	Education	Land transport and transport via pipelines

3.2 Variables

The main dependent variable is the regional-level total fertility rate (TFR). Data on regional TFR and any variables other than labour market dynamics were derived from the Regional Database Germany. To calculate regional TFR we collected data on annual total live births by the age group of mothers and the number of women of reproductive age by age group. The formula is as follows:

$$\mathrm{TFR}_{jt} = 5 * \sum ASFR_{jt} \tag{4}$$

where $ASFR_{jt}$ represents the age-specific fertility rate in region j at time t. The age-specific fertility rate is calculated as the number of births to women in a specific age group divided by the number of women in that age group in region j at time t. We use the following age groups: 15–19, 20–24, 25–29, 30–34, 35–39, and 40–44. To obtain the overall fertility rate, the sum of the age-specific fertility rates is multiplied by five.

To account for the time of pregnancy, all control variables except for job creation and job destruction have a two-year lag. The labour market dynamics variables have only a one-year lag. However, as shown in Equations (1a) and (1b), job creation and job destruction at year t capture the change between year $t-1$ and year t, and are standardized by the two-year average total employment per region.

To account for the economic development of regions, we control for real GDP per capita for each year in the constant price of 2015 in logarithm form. We also include the share of non-German nationals, and the share of employed women for females between 20 and 29 years old to measure how difficult it is for young women to enter the labour market. Population density, an indicator of urbanisation, is a potential confounder that may influence both regional employment and regional TFR. To account for this, we control for population density by calculating the number of individuals in thousands per square kilometre. Descriptive statistics for all variables are given in Table 2.

Table 2: Descriptive statistics

Variable	Mean	Std dev	Year
TFR	1.54	0.15	2010–2020
Labour market dynamics			
Job creation (all)	2.84%	0.89%	2009–2019
Job destruction (all)	1.34%	0.91%	2009–2019
Job creation (female)	1.40%	0.39%	2009–2019
Job destruction (female)	0.58%	0.35%	2009–2019
Job creation (male)	1.65%	0.60%	2009–2019
Job destruction (male)	0.97%	0.67%	2009–2019
Job creation (female in female-dominated industries)	0.70%	0.26%	2009–2019
Job destruction (female in female-dominated industries)	0.15%	0.19%	2009–2019
Job creation (male in male-dominated industries)	0.99%	0.49%	2009–2019
Job destruction (male in male-dominated industries)	0.68%	0.58%	2009–2019
Job creation (female in non-female-dominated industries)	0.70%	0.27%	2009–2019
Job destruction (female in non-female-dominated industries)	0.42%	0.26%	2009–2019
Job creation (male in non-male-dominated industries)	0.65%	0.33%	2009–2019
Job destruction (male in non-male-dominated industries)	0.29%	0.24%	2009–2019
Control variables			
GDP per capita	33611	14830	2008–2018
Share of women in the labour force aged 20–29	58.34%	7.97%	2008–2018
Share of non-German nationals	12.30%	6.72%	2008–2018
Population density (1000 per square kilometer)	0.53	0.68	2008–2018
Sample Size		4,433	

Note: GDP stands for gross domestic product; Std dev stands for standard deviation

To provide additional context, it is worth noting the significant variation in labour force size across Germany, ranging during the observation period between approximately

12,000 workers in Zweibrücken and over 115,000 in Berlin. Overall, the average number of workers per county is 74,886, with more than half of the counties in Germany employing fewer than 56,000 workers during this period. Since job creation and destruction are calculated relative to labour market size across all samples, the average job creation rate for all workers of 2.84% implies the creation of around 340 jobs in smaller counties and over 3,260 jobs in larger counties.

3.3 Spatial panel data modelling

We use Moran's I test to quantify the geographical relationship of TFRs in neighbouring regions. Moran's I is the most widely used measure of spatial dependence between observations. It is specified as follows:

$$I = \frac{N}{\sum_{j=1}^{N}\sum_{k\neq j}^{N} w_{jk}} \frac{\sum_{j=1}^{N}\sum_{k\neq j}^{N} w_{jk}(y_j-\bar{y})(y_k-\bar{y})}{\sum_{j=1}^{N}(y_j-\bar{y})^2} \tag{5}$$

where y is the variable of interest, j and k index the counties (j, k =1, …N), $\bar{y}$ is the sample mean, and N is the number of counties. In spatial econometrics, w_{jk} represents the spatial weights matrix that defines the neighbourhood structure (Kopczewska 2020). This study selects the contiguity matrix which recognizes regions sharing a common border as a neighbourhood. Similar to other correlation measures, the Moran's I ranges between –1 and 1, indicating perfect negative spatial autocorrelation to perfect positive spatial autocorrelation respectively (Moran 1950). For our data, the Moran's I statistics of the TFR are significantly different from 0 every year,[6] with a yearly average value of 0.15, implying that the TFR is correlated in neighbouring counties. Consequently, using conventional panel data modelling would produce biased parameter estimates. For this reason we use a spatial lag model, also referred to as a spatial autoregressive model (SAR), to account for spatial dependence in the dependent variable. The generalised form of this model is the following:

$$y_{jt} = \delta \sum_{k=1}^{N} w_{jk} y_{kt} + x_{jt}\beta + \mu_j + \varepsilon_{jt} \tag{6}$$

where j and k index the counties (j, k =1, …N) and t the time ($t = 1, \dots, T$). In this study, the dependent variable y_{jt} is the TFR for county j in year t, and y_{kt} is the TFR measured in county k (i.e., the neighbouring region of county j). δ is the parameter for

[6] Moran's I index of TFR is significant at 1% for most of the observation period, except for 2019 and 2020 when it is significant at the 5% and 10% levels respectively.

the spatial lag of the dependent variable. Thus, the first term on the right-hand side captures how the TFRs in the neighbouring counties are correlated with the TFR of county j. Additionally, x_{jt} is the vector of independent variables measured in county j, and β is the vector of parameters for independent variables, which aligns with the regular panel data modelling. Similar to conventional panel data models, we include μ_j as the county-specific error and ε_{jt} as the county- and year-specific error terms.

As there might also be unobserved regional similarities in the error terms, we perform the Moran's I test for the residuals after the spatial lag modelling. The Moran's I statistics decrease substantially in magnitude and in most years are not significantly different from 0. This confirms that the spatial lag model has effectively accounted for the spatial dependencies in the data.

In a conventional regression, the change in an explanatory variable is associated (or not) with the change in the dependent variable. In a spatial lag model, since the dependent variable in a region is also correlated with the dependent variables in its neighbouring regions, the change in an explanatory variable in that region should also be associated with the change in the dependent variable of the neighbouring region. Therefore, we calculate the direct effect, i.e., the local effect of change in the independent variable on the dependent variable of its own region, and the indirect effect, i.e., the effect on the dependent variables in other regions. The total effect is defined as the sum of direct and indirect effects in spatial econometrics (LeSage and Pace 2009). Consequently, a change in a given independent variable in county j is also associated with fertility in county j through an effect going from county j to neighbouring county k, and then back to j through spatial autocorrelation (δ) in fertility. Thus, the coefficient of an explanatory variable is not identical to the direct effect when δ does not equal 0.

In the analyses we use the spatial lag model for panel data with two-way fixed effects. The choice of fixed-effects modelling is based on the Hausman test for spatial panel data models (Millo and Piras 2012). The Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) are much lower in all specifications with two-way fixed effects compared to models with individual fixed effects.

4. Results

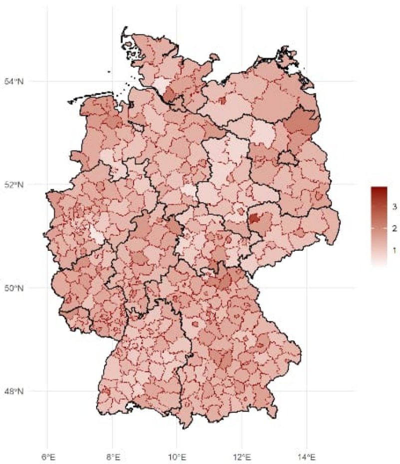
First, we compare regional changes in the level of job destruction and job creation for all workers between 2009 (the economic crisis) and 2019. As expected, job destruction was highest across the country in 2009, but between 2009 and 2019 its level decreased in almost all German regions (Supplementary Materials, Figure 1). This was accompanied by an increase in job creation rates, though only in the most westward regions of the country. East Germany showed similar rates of job creation as the West during the economic crisis. However, at that time the rate of job creation for female workers exceeded that of men in most counties, and male workers were more severely affected by the crisis than their female counterparts (Figure 2). This relationship reversed after the crisis, with an East–West gap in job creation rates emerging for both men and women. In 2019, women from East Germany experienced not only a relatively lower rate of job creation but also a higher rate of job destruction compared to women from West Germany. We also looked at the geographic distribution of the 2010 regional TFRs during the economic downturn, which predominantly reflected fertility decisions made in 2009. As anticipated, regional TFR in most counties was lower in 2010 than in 2020 (Supplementary Materials, Figure 2).

The estimation results using the spatial lag model are shown in Tables 3 and 4. For all workers together, job creation is positively associated with fertility (Table 3). A 1 percentage point increase in job creation in the given county predicts an increase in regional TFR of 0.0033 in that county (direct effect) and 0.0036 across all counties (total effect, including spill-over effects). Conversely, job destruction is negatively associated with regional TFR. A 1 percentage point increase in job destruction in a region is correlated with a decline in regional TFR of 0.0046 locally and a decline of 0.0050 for the whole country. The spatial lag of regional TFR δ suggests a positive spatial dependence.

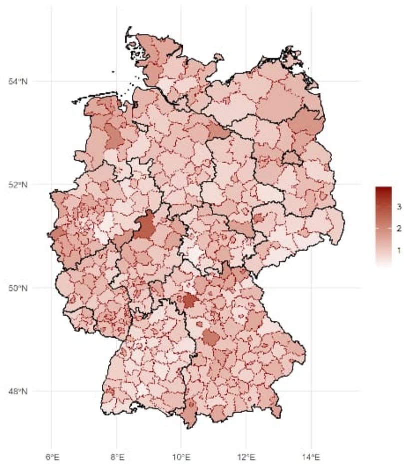
When the analyses are split by gender, substantial differences emerge. For women, job creation, but not job destruction, is positively associated with regional fertility. The results for male workers are somewhat the opposite: job creation is positive but not significantly associated with fertility, whereas job destruction has a negative association with regional TFR. These results suggest that it is job creation among female workers which primarily accounts for the positive relationship between job creation and regional TFR in the pooled sample, whereas the negative association between job destruction and regional TFR is primarily due to its negative effect on regional TFR among men.

Figure 2: Gender-specific labour market dynamics in Germany (%), 2009 and 2019

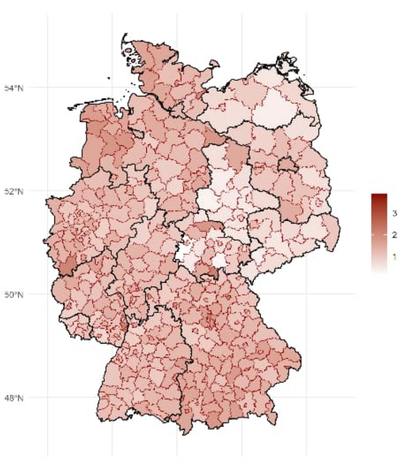
Job creation for female workers, 2009



Job creation for male workers, 2009



Job creation for female workers, 2019



Job creation for male workers, 2019

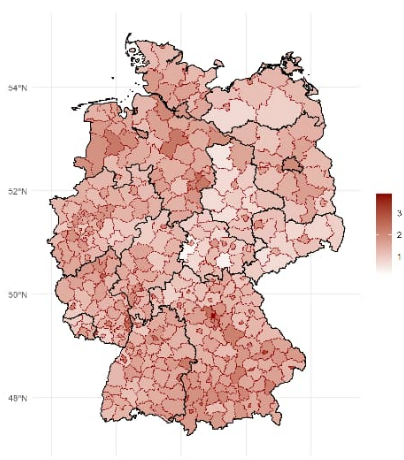
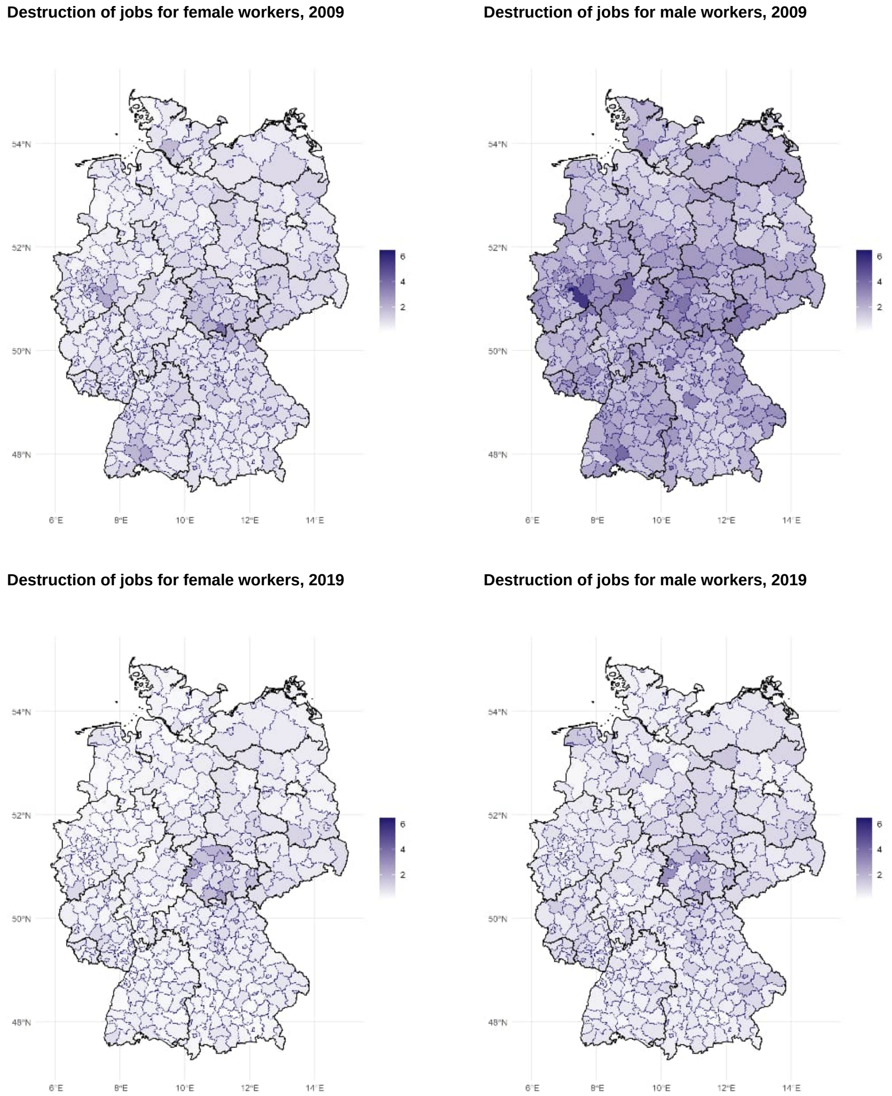


Figure 2: (Continued)



Note: The maps use longitude (°E) on the horizontal axis and latitude (°N) on the vertical axis.
Source: Authors' calculation based on data from the Regional Database Germany.

Table 3: Estimation results for all workers, female workers, and male workers

	Dependent Variable: TFR	β		Direct Effect		Indirect Effect		Total Effect	
		Coef.	s.e.	Coef.	s.e.	Coef.	s.e.	Coef.	s.e.
Pool Sample	Job Creation	0.0033	(0.0017)	0.0033	(0.0017)	0.0003	(0.0002)	0.0036	(0.0018)
	Job Destruction	–0.0046	(0.0018)	–0.0046	(0.0018)	–0.0004	(0.0002)	–0.0050	(0.0019)
	Controls								
	Log GDP per capita	0.1020	(0.0246)	0.1021	(0.0247)	0.0088	(0.0034)	0.1110	(0.0269)
	Female LFP (20–30)	0.0042	(0.0005)	0.0042	(0.0005)	0.0004	(0.0001)	0.0046	(0.0006)
	Share of non-German nationals	0.0044	(0.0009)	0.0044	(0.0009)	0.0004	(0.0001)	0.0047	(0.0010)
	Population density	–0.0767	(0.0188)	–0.0768	(0.0187)	–0.0067	(0.0026)	–0.0835	(0.0205)
	δ	0.0808	(0.0216)						
Female Sample	Job Creation	0.0081	(0.0036)	0.0081	(0.0036)	0.0007	(0.0004)	0.0088	(0.0039)
	Job Destruction	–0.0044	(0.0041)	–0.0045	(0.0041)	–0.0004	(0.0004)	–0.0048	(0.0045)
	Controls								
	Log GDP per capita	0.0983	(0.0246)	0.0984	(0.0246)	0.0085	(0.0033)	0.1069	(0.0269)
	Female LFP (20–30)	0.0042	(0.0005)	0.0043	(0.0005)	0.0004	(0.0001)	0.0046	(0.0006)
	Share of non-German nationals	0.0045	(0.0009)	0.0045	(0.0009)	0.0004	(0.0001)	0.0049	(0.0010)
	Population density	–0.0782	(0.0189)	–0.0783	(0.0189)	–0.0068	(0.0026)	–0.0851	(0.0207)
	δ	0.0808	(0.0216)						
Male Sample	Job Creation	0.0037	(0.0026)	0.0036	(0.0025)	0.0003	(0.0002)	0.0040	(0.0028)
	Job Destruction	–0.0083	(0.0026)	–0.0083	(0.0026)	–0.0007	(0.0003)	–0.0090	(0.0028)
	Controls								
	Log GDP per capita	0.1020	(0.0246)	0.1022	(0.0247)	0.0088	(0.0034)	0.1109	(0.0269)
	Female LFP (20–30)	0.0042	(0.0005)	0.0042	(0.0005)	0.0004	(0.0001)	0.0045	(0.0006)
	Share of non-German nationals	0.0043	(0.0009)	0.0044	(0.0009)	0.0004	(0.0001)	0.0047	(0.0010)
	Population density	–0.0758	(0.0189)	–0.0759	(0.0189)	–0.0065	(0.0025)	–0.0824	(0.0206)
	δ	0.0802	(0.0216)						

Note: LFP stands for labour force participation, GDP stands for gross domestic product, δ stands for the spatial lag of the dependent variable. Standard errors in parentheses.

Results split by industry (Table 4) also show differences in this dimension. A 1 percentage point increase in job creation in female-dominated industries is associated with a regional TFR increase of 0.0094 locally and 0.0102 across the counties. Regarding jobs outside female-dominated industries but occupied by women, the association between job creation and regional TFR is not significantly different from 0.

In the sample of male-dominated industries, the associations between job creation, job destruction, and regional TFR are quite similar to those observed in the full male sample. Conversely, the negative association between job destruction and fertility disappears in the subsample excluding male-dominated industries.

Table 4: Estimation results by type of industry

	Dependent Variable: TFR	β		Direct Effect		Indirect Effect		Total Effect	
		Coef.	s.e.	Coef.	s.e.	Coef.	s.e.	Coef.	s.e.
Female-dominated industries	Job Creation	0.0094	(0.0047)	0.0094	(0.0047)	0.0008	(0.0005)	0.0102	(0.0051)
	Job Destruction	–0.0052	(0.0060)	–0.0052	(0.0060)	–0.0004	(0.0006)	–0.0056	(0.0066)
	Controls								
	Log GDP per capita	0.0945	(0.0246)	0.0946	(0.0248)	0.0081	(0.0032)	0.1027	(0.0270)
	Female LFP (20–30)	0.0042	(0.0005)	0.0042	(0.0005)	0.0004	(0.0001)	0.0045	(0.0006)
	Share of non-German nationals	0.0045	(0.0009)	0.0045	(0.0009)	0.0004	(0.0001)	0.0049	(0.0010)
	Population density	–0.0778	(0.0189)	–0.0779	(0.0188)	–0.0067	(0.0026)	–0.0845	(0.0205)
	δ	0.0798	(0.0216)						
Non-female-dominated industries	Job Creation	0.0043	(0.0047)	0.0043	(0.0047)	0.0004	(0.0004)	0.0047	(0.0051)
	Job Destruction	–0.0071	(0.0051)	–0.0071	(0.0051)	–0.0006	(0.0005)	–0.0077	(0.0055)
	Controls								
	Log GDP per capita	0.0980	(0.0246)	0.0982	(0.0247)	0.0084	(0.0033)	0.1066	(0.0269)
	Female LFP (20–30)	0.0042	(0.0005)	0.0042	(0.0005)	0.0004	(0.0001)	0.0045	(0.0006)
	Share of non-German nationals	0.0045	(0.0009)	0.0045	(0.0009)	0.0004	(0.0001)	0.0049	(0.0010)
	Population density	–0.0790	(0.0189)	–0.0790	(0.0190)	–0.0068	(0.0026)	–0.0858	(0.0207)
	δ	0.0800	(0.0216)						
Male-dominated industries	Job Creation	0.0040	(0.0027)	0.0040	(0.0027)	0.0003	(0.0003)	0.0044	(0.0029)
	Job Destruction	–0.0097	(0.0026)	–0.0097	(0.0026)	–0.0008	(0.0003)	–0.0105	(0.0028)
	Controls								
	Log GDP per capita	0.1012	(0.0246)	0.1013	(0.0247)	0.0085	(0.0033)	0.1098	(0.0270)
	Female LFP (20–30)	0.0042	(0.0005)	0.0042	(0.0005)	0.0004	(0.0001)	0.0046	(0.0006)
	Share of non-German nationals	0.0043	(0.0009)	0.0043	(0.0009)	0.0004	(0.0001)	0.0047	(0.0010)
	Population density	–0.0781	(0.0188)	–0.0782	(0.0189)	–0.0065	(0.0025)	–0.0847	(0.0206)
	δ	0.0783	(0.0216)						
Non-male-dominated industries	Job Creation	–0.0046	(0.0037)	–0.0046	(0.0038)	–0.0004	(0.0004)	–0.0050	(0.0041)
	Job Destruction	0.0036	(0.0047)	0.0036	(0.0047)	0.0003	(0.0004)	0.0039	(0.0051)
	Controls								
	Log GDP per capita	0.0970	(0.0246)	0.0970	(0.0248)	0.0081	(0.0032)	0.1051	(0.0270)
	Female LFP (20–30)	0.0041	(0.0005)	0.0041	(0.0005)	0.0003	(0.0001)	0.0045	(0.0006)
	Share of non-German nationals	0.0045	(0.0009)	0.0045	(0.0009)	0.0004	(0.0001)	0.0049	(0.0010)
	Population density	–0.0797	(0.0188)	–0.0798	(0.0189)	–0.0067	(0.0026)	–0.0865	(0.0206)
	δ	0.0783	(0.0216)						

Note: LFP stands for labour force participation, GDP stands for gross domestic product, δ stands for the spatial lag of the dependent variable. Standard errors in parentheses.

The coefficients from the full sample suggest that a 1 percentage point increase in job creation rate predicts a 0.0036 increase in regional TFR. However, job creation that primarily benefits female employees in female-dominated industries is associated with a 0.01 increase in the regional TFR. While this may not seem like a significant change, regional TFR at the NUTS 3 level fluctuates marginally. During the observation period the median annual change in regional TFR was 0.018. Therefore, a 0.01 increase accounts for over half of the median annual change.

5. Robustness check

Specifications used in the main models do not account for the regional-level population structure. However, this structure could be altered by job creation or job destruction in the region attracting or pushing out some individuals. In particular, the regional sex ratio may be associated with both the gender-specific labour market dynamics and the regional TFR. To account for this, we added two control variables to capture the change in population structure: the proportion of women aged between 20 and 45 in the whole regional population, and the sex ratio (women to men) for the same age group (Supplementary Materials, Table 2). The coefficients are consistent with the main models for the full sample, and the female and male subsamples, respectively.

A major weakness of spatial modelling is that the spatial weights matrix is specified in advance, often without a solid theoretical foundation (Elhorst 2014; Leenders 2002). Since selecting a spatial weights matrix is essential for spatial modelling (Kopczewska 2020), it is necessary to investigate whether the results are robust to the choice of the spatial weights matrix. We re-run the main models based on the inverse distance matrix for the 10 nearest neighbours (Supplementary Materials, Table 2). The inverse distance matrix assigns the decreasing effects of further neighbours, based on the distances between the centroids of each county. Thus, the closer the two regions are, the stronger the spill-over effect between them. Changing the spatial weights matrix affects the magnitudes of coefficients of the variables' spatial lags, but the coefficients of the variables are consistent with those in the main models.

6. Discussion

This paper analyses the relationship between labour market dynamics and regional TFR in Germany. We examined the association between job creation, job destruction, and prospective fertility in 400 NUTS regions for the period 2008–2020. Our results suggest that job creation is positively associated with regional TFR, whereas the association between regional TFR and job destruction is negative, which is in line with the mechanisms proposed in existing studies on the relationship between unemployment, labour market uncertainty, and fertility. We went a step further, and by splitting the positive and negative changes in employment based on industry-level variation, showed that a positive association between job creation and regional TFR is driven by job creation in female-dominant sectors, whereas the negative association between job destruction and regional TFR can be attributed to job loss in male-dominated industries.

During our observation period job destruction was at its highest in 2009, at the time of the economic crisis, and subsequently declined across all regions. The male-dominated industries were more severely hit by the crisis, causing significant job losses for men (Annesley and Scheele 2011). A lower degree of job destruction was observed for women, though some studies argue this might be due to a reduction in working hours or other unfavourable changes, meaning that jobs are preserved but working conditions or income decline (Herzog-Stein and Zapf 2014). Additionally, men's higher labour force participation and their norm of full-time employment could also explain why throughout the observation period the job destruction rate was higher for men.

Job creation and job destruction in a region take place independently and do not necessarily balance each other out. In the pooled sample, the negative effect of job destruction on fertility is stronger than that of job creation. This finding implies that the positive effect of job creation on regional TFR is not sufficient to offset the negative effect of job destruction if they both increase at the same rate. It suggests that the positive relationship between unemployment decline and regional TFR may only be detected when the job creation rate is sufficiently higher than the job destruction rate. Throughout the observation period most German counties registered a substantially higher rate of job creation than job destruction. In over half of the observations the job creation rate exceeded the job destruction rate by at least a factor of two. The low job destruction rate could be attributed to the strong protection of workers provided by German labour market institutions (Moser, Urban, and di Mauro 2010). Consequently, the unemployment rate declined, followed by an increase in regional TFR.

An interesting result of this study concerns the combination of gender and industry effects and their association with regional TFR. The positive relationship between job creation and regional TFR is mainly driven by female workers, whereas the association between job destruction and regional TFR is primarily driven by male workers. What is particularly novel is that we observe that the positive association between job creation among female workers and regional TFR is driven by jobs created in specifically female-dominated industries. There are two possible reasons for this. First, job creation in female-dominated industries could be the driver of job creation among all women. In this situation the positive relationship between job creation and regional TFR in female-dominated industries essentially captures the association for all female workers. A second explanation is that some of the features of female-dominated industries which we outlined earlier can make jobs created in those areas more supportive of childbearing or more attractive to women who want to have children. To investigate these two possibilities, we analysed the correlation coefficients of job creation of the full female sample and the two subsamples. Job creation in female-dominated industries and in the remaining industries are highly correlated with the job creation of all female workers. The values are 0.73 and 0.76, respectively. This result is not sufficient to rule out the first possibility, but it implies that job creation in the subsample which excludes the female-dominated industries follows a similar pattern to that of the full female sample. Therefore, the non-significant relationship between job creation and regional TFR in this subsample could be attributed to factors other than solely the rate of job creation.

The earning-based maternity payment scheme introduced in 2007 has generated incentives for women to work for pay before childbearing. Jobs that are more compatible with childbearing should be the first choice for family-oriented women who have to work or are willing to work. In our data, these jobs are available in many of the female-dominated industries, including healthcare, child and elder care, education, service-related activities, and public administration. While our data do not provide information on specific employment conditions, existing literature on female-dominated industries suggests that in Germany these jobs are more secure but less well-paid (Bächmann 2023; Busch 2020). Firms operating within these industries are also more likely to endorse family-friendly policies (Bächmann et al. 2020; Kaufman and Petts 2022). However, studies have also found that working in these jobs means that female employees are less able to control their schedules (Chung 2019; Magda and Lipowska 2022). This may explain why the indirect effect, i.e., the spill-over effect of job creation, is not statistically significant. In other words, jobs created in female-dominated industries in the neighbouring regions may not promote childbearing decisions for women due to the combination of increased commuting time and fairly rigid schedules. Conversely, jobs created in male-dominated industries or other industries with no clear pattern of sex distribution may attract more career-oriented women, or be less supportive of childbearing. We observe that job creation for women in these industries is not significantly correlated with regional TFR.

While our findings provide evidence supporting the idea that access to family-friendly jobs matters for women's childbearing decisions, the question emerges of whether the mere fact of new jobs being created in female-dominated sectors could make women feel more confident about their future employment prospects and thus encourage them to (take the risk and) have children. Having a child entails a long-term commitment and generates significant future costs. Women may see the increasing availability of jobs in female-dominated industries as a reflection of a growing demand for certain skills or expansion of certain sectors, rather than just immediate employment opportunities. In other words, they could think of these jobs in terms of potential rather than actuality. Whether that happens is likely dependent on how sustained this demand is. Erratic and volatile job creation patterns would unlikely be factored into people's decisions regarding long-term commitments. However, in our sample, job creation in female-dominated sectors was fairly consistent across the observation period. It might be that this consistency in job creation is an additional factor behind the association between job creation and fertility, possibly providing some reassurance regarding not only immediate but also future employment opportunities.

The strong negative relationship between job destruction among male workers and regional TFR corresponds with earlier studies on the strong negative effect of male unemployment on fertility (Cazzola, Pasquini, and Angeli 2016; Pailhé and Solaz 2012). In Germany, women are still more likely to work part-time after childbirth and the gender pay gap remains large (Trappe, Pollmann-Schult, and Schmitt 2015). Under such circumstances, male employment remains a prerequisite for childbearing in terms of its contribution to household income, and in Germany job displacement negatively affects fertility in both male-breadwinner and dual-earner couples (Di Nallo and Lipps 2023).

Similar to the female sample, the negative relationship between job destruction and fertility is evident in male-dominated industries, but non-significant in the sample excluding these industries. The correlation coefficient of job destruction between the full male sample and the sample of male-dominated industries is 0.94, but only 0.51 for the other subsample. This indicates that job destruction in male-dominated industries is a reliable predictor of job destruction and uncertainty for all male workers. In Germany most male-dominated industries are in manufacturing. Thus, this finding is consistent with the studies showing that the decline in employment in manufacturing, particularly for men, is associated with overall fertility decline (Autor, Dorn, and Hanson 2019; Seltzer 2019).

6.1 Limitations

The scope of this study was restricted by data availability. We explored the mechanisms underlying the relationship between labour market dynamics and regional TFR by analysing subsamples of female- and male-dominated industries. However, within each industry, employees vary significantly in terms of skill level, seniority, and job positions. The share of skilled workers and the marriage/cohabitation rates are additional factors that affect regional TFR (Day 2015; Dorbritz 2008), but we lack the data to analyse them. In particular, data on the proportion of skilled and unskilled workers within each industry would provide further insight into how job creation and destruction for different workers affect regional TFR. When an industry expands or contracts, managers and production workers face distinctly different challenges and benefits, which our data does not capture. Individual-level research is needed to analyse the underlying mechanisms and heterogeneity within the processes we describe.

Next, this study focused on workers who were subject to social security contributions in Germany. Other types of employment such as the civil service, self-employment, and mini-jobs are not taken into account. These jobs constitute a minority within the German labour force but may exhibit a different relationship with fertility than the one we have observed.

Finally, as outlined earlier in this article, with the present data we cannot examine the actual causal mechanism linking job creation in female-dominated sectors to higher TFR. That is, we cannot tell whether women enter these jobs motivated by their fertility plans or, conversely, some characteristics of these jobs or work environments encourage women to have (more) children. These mechanisms are likely intertwined and they cannot be investigated using macro-level data. We also could not account for the availability of childcare services in the area, which is an independent factor influencing women's decisions related to work and childbearing (Haan and Wrohlich 2011).

6.2 Conclusions

This study adopts a nuanced view of the associations between dynamic labour market processes and regional TFR in Germany. It finds a positive association between jobs created for female workers and regional TFR. Conversely, job destruction, particularly for male workers, is a negative predictor of regional TFR. More detailed analyses suggest that particularly for women, job characteristics might be an important factor in the employment–fertility nexus.

The study also offers a novel explanation of the positive relationship between the employment rate and fertility in Germany since 2009, suggesting that the relatively high degree of job creation may have contributed to the increase in fertility.

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