The Effects of Public Childcare Expansion on Child Penalties - Evidence From West Germany*

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Abstract

This paper examines the effects of public childcare expansion on child penalties for mothers, exploiting extensive childcare policy reforms implemented in Germany. Through a series of reforms, the German government has substantially expanded subsidized public childcare for children under the age of three since the mid-2000s. By exploiting the regional variation in the timing and magnitude of public childcare expansion at the county level in West Germany and using social security administrative data, we identify the causal effects of public childcare provision on child penalties for mothers, specifically in terms of labor supply, wage growth, and job mobility. Employing event study analyses and generalized difference-in-difference estimation, we present the following findings. First, we observe a decrease in the child penalty for mothers in West Germany in terms of earnings, employment, days worked, working full-time, and daily wages since the 2000s. Second, our estimates suggest that a 10 percentage point increase in early public childcare coverage rate reduces mothers' child penalty in earnings by 1.4 percentage points for the five years following childbirth. Third, we find that expanding public childcare primarily reduces mothers' child penalty in earnings through increased days worked, higher daily wages, and a reduced likelihood of transitioning to low-paying firms. Lastly, we find that the positive effects of public childcare expansion on mothers' earnings, daily wages, and firm mobility last up to 7 years after childbirth.

1   Introduction

Despite the steady convergence in education and the economic roles between men and women in society, there is still significant gender inequality in labor markets worldwide. One critical source of the remaining gender inequality is the child penalties existing only for women. A large body of literature documents that women experience a significant drop in labor supply and earnings following childbirth, while men do not (e.g., Bertrand et al. 2010; Angelov et al. 2016; Kleven et al. 2019b). This suggests that designing family policies to reduce women's childcare burden is crucial for improving gender equality in labor markets and households.

Providing universal childcare is one such policy. Numerous countries have expanded public or publicly subsidized childcare to encourage mothers to return to work after giving birth. Consequently, there has been a growing body of literature on the effects of public childcare provision on maternal labor supply.[1] However, the overall evidence is mixed, depending on the countries and ages of children eligible for public childcare (Andresen and Havnes, 2019; Müller and Wrohlich, 2020). Moreover, very little is known about the impact of public childcare expansion on other labor market outcomes for mothers, such as wage growth, promotion, or mobility across firms.

In this paper, we examine the effects of public childcare expansion on child penalties by exploiting public childcare policy reforms implemented in Germany. Through multiple reforms, the German government has expanded subsidized public childcare for children under three since 2005. As a result, the public childcare coverage rate has substantially increased over time, particularly in West Germany, which is well-known for its low maternal labor force participation among developed countries. By exploiting the reform-induced variation in public childcare expansion across counties and years in West Germany, we investigate how expanding public childcare to very young children affects child penalties for mothers in the short and long run in terms of a wide range of labor market outcomes.

This paper first documents the trend of child penalties for mothers in West Germany. Using the event study methodology proposed by Kleven et al. (2019b) and utilizing German administrative data, we estimate the child penalty in terms of earnings, employment, days worked, daily wage, working full-time, and firm mobility for mothers who gave birth during different time periods. The event study results reveal a decrease in the overall child penalty for mothers in West Germany since the 2000s.

Motivated by this finding, we proceed to analyze the causal effects of public childcare expansion on mothers' child penalties. To establish identification, we employ an event study analysis and generalized difference-in-difference estimation, leveraging the regional and temporal variation in public childcare expansion at the county level in West Germany. In the event study analysis, we

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[1]See the literature review part for more details.

categorize counties into two groups: 1) counties that experienced a large sudden increase in public childcare (treated) and 2) counties that did not (control). By comparing mothers who gave birth in these two groups of counties during the periods 1-3 years before and 4-6 years before the public childcare expansion occurred, we examine the effects of increased public childcare on mothers' child penalties. For robustness checks, we examine pre-trends in variables that may be correlated with public childcare expansion and find very similar or parallel pre-trends between treated and control counties.

To obtain more straightforward and practical estimates for the effects of public childcare expansion on mothers' child penalties, we also utilize all available variation in public childcare at the county-year level and conduct a generalized difference-in-difference estimation. To verify causality, we present multiple pieces of evidence indicating that the heterogeneous timing of public childcare expansion across counties was primarily driven by local supply shocks that are exogenous to mothers' labor market outcomes (Müller and Wrohlich, 2020; Stürmer-Heiber, 2022).

Our event study analysis results indicate that public childcare expansion reduces child penalties for mothers in terms of earnings, employment, and days worked. Our estimates suggest that a 5 percentage point increase in public childcare coverage rate leads to average reductions of 0.7, 1, and 1.2 percentage points in child penalties for earnings, employment, and days worked, respectively, over a five-year period following childbirth.

Our generalized difference-in-difference estimation yields consistent findings. The estimate indicates that a 10 percentage point increase in public childcare coverage rate decreases mothers' child penalty in earnings by 1.4 percentage points over the five years following childbirth. Considering that the public childcare coverage rate in West Germany increased by an average of 20 percentage points during the reform period (2007-2014), this implies that the childcare expansion resulting from the reforms reduced the child penalty in earnings by approximately three percentage points, which accounts for 4 percent of the total child penalty in earnings.

Expanding public childcare reduces mothers' child penalty in earnings through various channels. Specifically, it leads to higher labor force participation, more days worked, higher daily wages, and fewer transitions to low-paying firms for mothers. This suggests that increased public childcare provision can enhance maternal labor supply both at the extensive and intensive margins. Furthermore, it can improve mothers' labor market outcomes by enabling them to earn higher wages and maintain employment in higher-paying firms. Additionally, we find that while the impact on labor supply is relatively short-term, the effects on earnings and daily wages persist for up to seven years following childbirth.

This paper contributes to the literature in several ways. First, it provides additional evidence on the positive effects of public childcare expansion on maternal labor supply. While an increasing number of studies have examined the impact of public (or publicly subsidized) childcare provision

on mothers' labor supply, the findings have been mixed. For instance, in terms of the impact of preschool expansion for children aged 3-6, Gelbach (2002) Baker et al. (2008) and Bauernschuster and Schlotter (2015) find sizable positive effects on maternal labor supply in the United States, Canada, and Germany, respectively. On the other hand, Fitzpatrick (2010), Havnes and Mogstad (2011), Nollenberger and Rodríguez-Planas (2015) find small or no effects in the United States, Norway, and Spain, respectively. Regarding the impact of expanding childcare to younger children under three on maternal labor supply, which is the primary focus of this paper, Carta and Rizzica (2018); Andresen and Havnes (2019) and Müller and Wrohlich (2020) find significant positive effects for Italy, Norway, and Germany, respectively, while Kleven et al. (2020), Attanasio et al. (2022) and Rabaté and Rellstab (2022) find small or no effects in Austria, Brazil, and the Netherlands, respectively.[2] This paper adds to this extensive literature by investigating the impact of expanding public childcare to toddlers on mothers' child penalties in terms of labor supply. We examine various labor market outcomes, including earnings, days worked, daily wage, working full-time, as well as employment.

Second, this paper not only quantifies the impact of public childcare expansion on mothers' labor supply but also examines its effects on wage growth and job mobility. Most existing studies that examine the effects of public childcare provision primarily focus on its impact on mothers' employment or working hours. In terms of the identification strategy and context, this paper is closely related to Müller and Wrohlich (2020) and Huber and Rolvering (2023). Müller and Wrohlich (2020) find positive effects on part-time employment (working 20-35 hours per week) using a household panel data set. Huber and Rolvering (2023) also find positive effects of public childcare on maternal employment and earnings using a 2 percent random sample of German social security data.[3] In this paper, we investigate the effects of public childcare expansion on mothers' wage

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[2]Some studies have found mixed results when examining different subgroups. Goux and Maurin (2010) find positive effects on maternal employment for single mothers but no significant effect on mothers in two-parent households in response to the availability of public schools for 2-3-year-old children in France. Kunze and Liu (2019) reveal an overall positive impact on maternal labor supply from a nationwide reform in Norway that expanded childcare for 1-2-year-olds, but the results are largely heterogeneous across different subgroups.

[3]Huber and Rolvering (2023) investigates the impact of public childcare expansion on mothers' labor market outcomes using a similar identification strategy and dataset to ours. However, there are several distinctions between our study and Huber and Rolvering (2023). First, we employ regional and temporal variation in childcare expansion differently for identification. While Huber and Rolvering (2023) considers counties with an above-median increase in public childcare coverage from 2002 to 2009, which corresponds to the early phase of the childcare reform, as "high expansion" counties (treated group), we define treated counties as those experiencing a sudden large increase in public childcare within a single year throughout the entire reform period, focusing on variation driven by supply shocks. Moreover, our generalized difference-in-difference estimation incorporates all available variation in public childcare expansion at the county-year level from 2007 to 2014, providing a direct measure of the elasticity of mothers' child penalty in response to public childcare expansion. Additionally, we utilize the whole sample of mothers in administrative data directly drawn from the Integrated Employment Biographies (IEB), enabling us to precisely estimate child penalties at the county level. Lastly, while Huber and Rolvering (2023) focuses on specific labor market outcomes of mothers, our analysis explores different labor market outcomes, including daily wage and the likelihood of transitioning to low-paying firms measured by firm wage.

growth and their mobility across firms, which, to our knowledge, have received little attention.

Third, this paper examines both short- and long-term effects of childcare supply on mothers' labor market outcomes. While many studies have explored the short-term effects of public childcare supply on maternal labor outcomes, evidence on the long-term impact is limited. Lefebvre et al. (2009) find positive effects of childcare subsidies on maternal labor supply lasting for 5-6 years following the reform implemented in Québec between 1997 and 2000, but only for less educated mothers. Haeck et al. (2015), using more extended data sets, examine the impact for 11 years after the reform and find long-lasting positive effects on mothers' labor force participation and weeks worked, but only when full-time kindergarten is combined with the low-fee daycare program. Kunze and Liu (2019) examines how the 2002 reform expanding childcare to toddlers in Norway affected mothers with the youngest child aged 2 in 2002-2004 and 2005-2009. However, these studies examine the long-term effects of the reform on new mothers who had a child a few years after the reform implementation, not the long-term labor market outcomes, such as earnings trajectory, of mothers directly affected during the reform period.

Recent studies have investigated the impacts of having children on parents' labor market outcomes even with a very long-term time frame (e.g., for 20 years following childbirth) by conducting event study analyses (Kleven et al., 2019a,b; Kleven, 2022). Employing the child penalty estimates obtained from the event study analysis as outcome variables, we analyze how childcare expansion affects mothers' labor market performance in the relatively longer term as in Kleven et al. (2020) and Rabaté and Rellstab (2022). While they find no significant effects of public childcare expansion on mothers' child penalties either in the short- or long-run following childbirth for Austria and the Netherlands, we find that the effects persist until seven years following birth in West Germany.

2   Background and Data

2.1   Public Childcare in Germany

The childcare market consists of two main types: public and private. In Germany, public childcare dominates the market, with only a small portion of childcare facilities operated by private for-profit organizations.[4] Germany provides public childcare at two levels depending on the age of eligible children. Kindergarten is available for children aged 3-6, while daycare (*Krippe*) is provided for children under three. These childcare facilities are primarily operated by municipalities or non-profit organizations, both religious and non-religious, and receive substantial subsidies from federal and local governments. The operational procedures, including funding allocation to local

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[4]For example, approximately only 3% of the childcare market was covered by for-profit providers in 2014 in Germany (StatistischesBundesamt, 2014).

childcare providers, are managed by youth welfare offices in each county (Müller and Wrohlich, 2020). Being heavily subsidized, parents have to pay €250 per month on average for a public childcare slot. The fee schedule is progressive based on household income and regressive based on the number of siblings. The quality of facilities is heavily regulated by the government, ensuring a high level of homogeneity (Felfe and Lalive, 2018; Stürmer-Heiber, 2022).

2.2 Childcare Policy Reforms in Germany

After reunification, the German government implemented several public childcare policy reforms. In 1996, legislation was enacted to grant children aged 3-6 the legal right to a place in kindergarten. This reform resulted in a sharp increase in childcare attendance for 3-6-year-olds, particularly 3-4-year-olds (Bauernschuster and Schlotter, 2015). As a result, the public childcare coverage rate for this age group reached almost 90% in the early 2000s. However, until the mid-2000s, public childcare for younger children aged 0-2 was very limited, especially in West Germany. In 2002, for example, the public childcare enrollment rate for children below the age of three in West Germany was only about 2% (Stürmer-Heiber, 2022).

To address the growing demand for childcare and increase maternal labor supply and fertility rates (Bauernschuster et al., 2016; Müller and Wrohlich, 2020), the German government embarked on a series of reforms to expand public childcare for children under the age of three starting from the mid-2000s.[5] In 2005, the federal daycare expansion law (Tagesbetreuungsausbaugesetz) was introduced, aiming to create 230,000 additional childcare slots for 0-2-year-olds and achieve a coverage rate of 17% by 2010 in West Germany. In 2007, the federal and local governments agreed to further increase the coverage rate to 35% by 2013. In 2008, the federal law to promote children (Kinderförderungsgesetz) was enacted, establishing a phased introduction of the legal right to childcare slots for children aged 1-2 by 2013.[6] Following the introduction of this legal claim, the reform-induced expansion of childcare was concluded in 2014.

These reforms led to a significant increase in the public childcare coverage rate for children under three in Germany. The impact was particularly pronounced in West Germany, where public

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[5]In 2007, the German government also introduced the Parental Allowance and Parental Leave Act, which implemented two significant reforms. Firstly, parents became eligible for benefits equal to two-thirds of their average net earnings from the previous year, with a minimum of 300 euros and a maximum of 1800 euros, for a duration of 12 months. Prior to 2007, benefits were means-tested and capped at 300 euros for 24 months. Secondly, two months of paid parental leave were exclusively designated for fathers, otherwise, the leave would be forfeited. Since this act was simultaneously implemented across all regions in Germany, it is unlikely to confound the estimation results when controlling for year and county fixed effects, unless its effects systematically vary across counties over time. To address this concern, we control for the share of highly educated and high-income women who are most affected by the reform (Raute, 2014; Welteke and Wrohlich, 2019) and fathers' uptake of parental leave at the county-year level in our generalized difference-in-differences estimation. Reassuringly, we find little change in our estimation results.

[6]Working parents became eligible for the slot from October 2010 and all parents became eligible from August 2013.

childcare for toddlers was less developed before the reforms. Between 2002 and 2014, the coverage rate for 0-2-year-olds in West Germany increased from 2% to 27%, while the increase in East Germany during the same period was relatively smaller (Stürmer-Heiber, 2022). Figure 1 illustrates the striking contrast in public childcare coverage and its change between East and West Germany.

West Germany has long been recognized for its lower maternal labor force participation compared to East Germany and other developed countries. Historical institutions in West Germany, such as the male-breadwinner model, reinforced traditional gender roles, while East Germany pursued more gender-egalitarian policies that encouraged women's participation in the labor market under the socialist regime. Consequently, the prevailing gender norm in West Germany that mothers should stay at home to care for their children led to low maternal labor supply even after reunification, and this trend has persisted until recent years (Campa and Serafinelli, 2019; Lippmann et al., 2020). Given this context, West Germany provides a unique setting to examine the effects of public childcare provision when maternal labor supply is low and private childcare alternatives are limited.[7]

2.3 Data

Our study relies on data from multiple sources. Firstly, we primarily utilize the Integrated Employment Biographies (IEB), which is a German administrative social security data set provided by the Institute for Employment Research (IAB). The IEB is a longitudinal data set encompassing employment records of all German employees covered by social security, excluding public and self-employed workers. It comprises complete employment histories from 1975 to 2021 and includes information on daily wages, part-time employment, firm identifiers, and detailed occupation codes. To incorporate employer characteristics, we merge various firm-level variables from the Establishment History Panel (BHP) with the IEB using the firm identifier associated with each employment spell. By utilizing these firm identifiers and firm-level characteristics, such as the average wage level of full-time workers, we can track the movements of workers across different firms and analyze the underlying patterns.

Regarding information on the public childcare coverage rate, we utilize data provided by the German Statistical Office. Using the number of children aged 0-2 and the number of children enrolled in public childcare within that age range, we construct a measure for public childcare at the county-year level.

Although the childcare reform was implemented between 2005 and 2014, we consider the

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[7]Instead of formal childcare (public or private), informal childcare provided by grandparents could serve as an important alternative. According to Jappens and Van Bavel (2012), Germany demonstrates an average level of reliance on grandparental childcare compared to other European countries.

sample period from 2007 to 2014 for several reasons. First, data on public childcare coverage rates at the county level are only available from 2007. Second, excluding the years 2005 and 2006 ensures greater consistency in the sample period due to changes in the parental leave regime in 2007. Additionally, it is plausible that the expansion of childcare resulting from the reforms was initially slow due to a lack of preparedness.

3 Trend of Child Penalties for Mothers in West Germany

Recent literature on child penalties has shown that the extent of gender inequality in earnings related to having children has not decreased over time in several countries, such as Denmark (Kleven et al., 2019b), Austria (Kleven et al., 2020), and the United States (Cortés and Pan, 2020). In this section, we aim to investigate whether a similar trend exists in Germany.

To examine the trend of child penalties in West Germany, we estimate the child penalties for mothers who gave birth during different time periods. To do this, we employ the method proposed by Müller and Strauch (2017) to identify mothers in the administrative data who have given birth. By utilizing information on work interruptions, including the duration and reason for the interruption, we can identify female workers who took maternity leave and predict the date of each birth.

To obtain more accurate estimates of child penalties using an event study analysis, we narrow down the sample to include only mothers who were employed for at least two years prior to giving birth. Additionally, we focus on the first birth identified as an event for each mother. Our sample consists of approximately 150,000 mothers who gave birth for the first time each year between 2001 and 2014.[8] Furthermore, we restrict our sample to mothers who do not move to other counties within three years after giving birth to mitigate any potential endogeneity issues arising from worker migration.

For our sample of mothers, we estimate child penalties using an event study methodology proposed by Kleven et al. (2019b). The estimation equation is given by:

$$Y_{ist} = \sum_{j \neq -1} \alpha_j \cdot \mathbf{I}[t = j] + \sum_k \beta_k \cdot \mathbf{I}[age_{is} = k] + \sum_y \gamma_y \cdot \mathbf{I}[s = y] + \nu_{ist} \tag{1}$$

where Y_{ist} represents the labor market outcome of interest for individual i in calendar year s and at event time t. The event time $t = 0$ corresponds to the year of childbirth, and we consider event

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[8]It is important to note that since we can only identify mothers who were attached to the labor market in the private sector before giving birth, some of the births identified in our data set may not represent their actual first births. However, we find that the age distribution of mothers identified as having their first birth in this data set closely resembles the actual age distribution of mothers at their first childbirth reported by federal statistics. Therefore, we define the birth identified for the first time for a worker in this data set as their first birth.

times ranging from -3 to 5 for our main analysis. As in Kleven et al. (2019b), we omit the event time dummy at $t = -1$ to capture the impact of having a child relative to the year just before childbirth. We include a full set of age and calendar year dummies to account for life-cycle and time trends.

Since the child penalty for fathers is generally close to zero in many countries, including Germany (Kleven et al., 2019a), we focus on estimating the child penalty specifically for mothers in this study. We define the child penalty as $P_t \equiv \hat{\alpha}_t / E[\tilde{Y}_{ist}|t]$, where $\tilde{Y}_{ist} \equiv \sum_k \hat{\beta}_k \cdot \mathbf{I}[age_{is} = k] + \sum_y \hat{\gamma}_y \cdot \mathbf{I}[s = y]$ represents the predicted outcome in the absence of a child.

We estimate the regression in equation (1) separately for mothers who gave birth in the periods 2003-2006, 2007-2010, and 2011-2014. The child penalties are estimated for various labor market outcomes, including earnings, employment, days worked, daily wage, full-time employment, and firm wage level.[9] For earnings and days worked, the child penalties are estimated without conditioning on employment status (i.e., earnings and days worked are set to zero for individuals not employed), while for other outcomes, the child penalties are estimated conditional on being employed.

Our findings in Figure 2 suggest that child penalties for mothers in West Germany have decreased since the 2000s in various aspects, including earnings, employment, days worked, daily wage, and working full-time. Panel (a) illustrates a decrease in the child penalty in earnings, particularly noticeable two or more years after childbirth. This reduction in the child penalty in earnings can be attributed to three margins: increased employment, more days worked, and a higher daily wage. Panels (b)-(d) of Figure 2 demonstrate that all three factors play a role. The decline in child penalties in employment and days worked indicates an increase in maternal labor supply, both in terms of the number of working mothers and the intensity of their work. The decrease in the child penalty in daily wage suggests that it could be a result of increased working hours or an improvement in hourly wage rates for mothers. However, due to limited information on working hours in the IEB data, we examine the child penalty in terms of working full-time instead. Panel (e) shows that the child penalty has also decreased in terms of working full-time, suggesting more mothers have been returning to the full-time positions after childbirth.[10] To investigate whether mothers' likelihood of transitioning to low-paying firms after having a child has changed over time, we estimate the child penalty based on the average wage level of the firms where mothers work. Panel (f) indicates no decreasing trend in this regard. Given the German government's efforts to expand

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[9]Earnings represent annual earnings, employment is an indicator set to one if an individual is employed for at least 30 days per year, days worked represent the number of days worked per year, and the firm wage represents the mean wage of full-time workers at the firm where an individual works.

[10]There was a significant change in the part-time variable (*teilzeit*) in the IEB in 2011 as employers have been required to report their workers' part-time status more precisely since 2011. We used the imputation method proposed by Fitzenberger and Seidlitz (2020) to ensure consistency of the part-time variable over time.

public childcare facilities for children under the age of three since 2005, our findings in Figure 2 raise the question of whether and how the expansion of public childcare has contributed to reducing child penalties for mothers in West Germany.

4 The Effects of Public Childcare Expansion on Child Penalties for Mothers

4.1 Identification Strategy

During the period of childcare reform in Germany, there was variation in the expansion of early childcare facilities across counties, both in terms of timing and intensity. We leverage this regional variation to identify the impact of public childcare expansion on child penalties for mothers. In our event study analysis, we compare the child penalties of mothers in two groups of counties: those that experienced a significant and sudden increase in public childcare in a single year (treated group) and those that did not (control group). To obtain more practical and straightforward estimates of the effects of public childcare expansion on child penalties, we also conduct a generalized difference-in-difference estimation.

For causal identification, it is crucial that the source of variation in childcare expansion is exogenous to other determinants of mothers' labor market outcomes. Multiple government reports and studies provide evidence that the heterogeneous timing and magnitude of childcare provision across counties were primarily driven by local supply shocks that were exogenous to mothers' labor market outcomes (Müller and Wrohlich, 2020; Stürmer-Heiber, 2022). Firstly, shortages of suitable construction sites and qualified staff posed challenges in meeting the demand for public childcare in various years (BMFSFJ, 2011, 2012, 2013). Even in inner cities with higher demand, local childcare providers struggled to recruit staff promptly due to the high cost of living, which was unattractive to low-paid childminders. As a result, municipalities and other local childcare providers often faced difficulties in developing suitable proposals for childcare funding (Stürmer-Heiber, 2022).

Secondly, idiosyncratic errors in local demand and population projections contributed to heterogeneity in the approval probability for childcare funding (Hüsken, 2010, 2011). In Germany, youth welfare offices at the county level are responsible for allocating childcare funding to municipalities and other local childcare providers. The annual allocation of funding depends on factors such as the existing supply of childcare, projected demand, and the quality of proposals submitted by providers (Felfe and Lalive, 2018). These processes often involved errors in local projections of childcare demand, resulting in an inadequate supply of childcare to meet the demand.

Thirdly, significant frictions in public childcare provision arose due to lengthy approval pro-

cesses at different administrative levels (Stoy, 2015). Additionally, if the applications for expanding childcare exceeded the available budget, the recipients of funding in the current and subsequent years were determined through lotteries or waiting lists (Felfe and Lalive, 2018). These findings suggest that a large portion of the regional variation in public childcare expansion was driven by supply shocks that were exogenous to mothers' labor market outcomes.

However, despite the significant role of supply shocks in creating heterogeneity in the timing of childcare expansion across counties, there could still be demand-driven factors contributing to the variation. For instance, if mothers in certain counties were more willing to return to work after giving birth, leading to a more timely recruitment of staff or search for construction sites, the supply shocks could be related to the demand and therefore endogenous. To address these concerns, we further examine the pre-trends of variables that could predict public childcare expansion in our event study analysis. Moreover, we control for various county-year-specific characteristics related to the demand for childcare, such as the ratio of young women, fertility rate, and the employment share of young women, in our generalized difference-in-difference estimation.

4.2 Event Study Analysis

As mentioned earlier, while evidence suggests that the timing and magnitude of childcare expansion across counties were largely driven by exogenous local supply shocks, there may still be factors related to mothers' preferences or labor supply decisions that could contribute to the regional variation. To address these concerns, we follow the approach of Kleven et al. (2020) and focus on episodes where a county experiences a significant and sudden increase in public childcare in a single year. This approach allows us to isolate expansions that are more likely driven by supply shocks rather than demand shocks. We define our event as a case where the public childcare coverage rate of a county increases by more than 5 percentage points in a single year, which corresponds to the top 5 percent of changes in public childcare coverage rate at the county level between 2007 and 2014 (see Appendix Figure 1).

4.2.1 Constructing a Control Group of Counties

For our event study analysis, we define counties that ever experienced a sudden and large expansion in public childcare as our treated group. Among 324 counties in West Germany, 109 counties experienced the childcare expansion event at some point during the reform period between 2007 and 2014. We consider the year when the event happened as the baseline year ($p = 0$) of each treated county.[11] Among all other counties that have never experienced the childcare expansion

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[11] Among 109 treated counties, 98 counties experienced the childcare expansion event only once during the reform period. For counties that experienced the event twice during the reform period, we consider the year of the first event

event, we choose a control county for each treated county using propensity score matching to obtain a comparable control group of counties. For each treated county, we find a control county matched in terms of fertility rate, female employment rate, and public childcare coverage rate in years $p-1$ and $p-2$ within the same urban/rural status.

Figure 3 demonstrates that the two groups of counties had the almost same trend in public childcare coverage rate before the expansion event, but only the treated group experienced a substantial increase in public childcare in a single year. Panel (a)-(d) of Figure 4 present the pre-trends of variables that could be potentially correlated with public childcare expansion. Panel (a) and (b) demonstrate that the pre-trends of public childcare coverage rate for children aged 3-5 (i.e. kindergarten coverage rate) and fertility rate are highly similar between treated and control counties. Panel (c) and (d) display parallel pre-trends of female employment rate and the population share of young women, respectively, between treated and control counties. These pre-trends suggest that the sudden increase in public childcare in treated counties is unlikely to be driven by demand shocks.

4.2.2 Descriptive Results

For our descriptive analysis, our main sample consists of mothers who gave birth between 1-3 years before the public childcare expansion took place. In other words, we focus on estimating the child penalty for mothers whose first child was eligible for public childcare at the time of the expansion. We conduct separate regressions using equation (1) for mothers in both the treated and control groups of counties and compare their child penalties over time following childbirth. To facilitate a better comparison, we also include a placebo group consisting of mothers who gave birth between 4-6 years before the public childcare expansion event. These mothers serve as a placebo group because their first child was not eligible for public childcare when the childcare expansion occurred. We estimate their child penalties separately for both the treated and control groups of counties.

Figure 5 presents the child penalties of mothers in four different groups. The solid lines represent the child penalties of the main sample, consisting of mothers who had their first child 1-3 years before the public childcare expansion, while the dotted lines depict the child penalties of the placebo group, composed of mothers who had their first child 4-6 years before the expansion. The red lines represent mothers in treated counties, while the blue lines represent mothers in control counties.

In panel (a) of Figure 5, the solid lines demonstrate that mothers in the main sample from treated counties have lower child penalties in earnings compared to those in control counties for

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as the baseline year of them.

a period of three to five years after childbirth. Conversely, the placebo group of mothers shows no difference in child penalties in earnings between treated and control counties. Panels (b), (c) and (e) reveal also a pronounced difference in child penalties for the main sample of mothers between treated and control counties in terms of employment and days worked. Although the child penalties in employment, days worked and working full-time are smaller in treated counties even for the placebo group of mothers, as depicted by the dotted lines in panels (b), (c) and (e), the gap is smaller than that observed for the main sample of mothers. The smaller child penalty in treated counties for the placebo group could be attributed to different availability of public childcare for their second or third child in the two groups of counties. Panel (d) suggests that the child penalties in daily wage are quite similar between treated and control counties for the main sample of mothers, while they are larger in treated counties for the placebo group of mothers. Although panel (f) shows that the child penalties in firm wage are larger in treated counties for both the main and placebo group of mothers, the gap diverges more substantially for the placebo group of mothers.

4.2.3 Regression Results

To estimate the effect of public childcare expansion on mothers' child penalties, we employ a difference-in-difference design in conjunction with the event study analysis for child penalties. The specific regression model used is as follows:

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Y_{ist} = \sum_{j=-3}^{5} \alpha_j \cdot \mathbf{I}[E_t = j] + \sum_{j=-3}^{5} \beta_j \cdot \mathbf{I}[E_t = j] * After + \sum_{j=-3}^{5} \gamma_j \cdot \mathbf{I}[E_t = j] * Treat
$$
$$
+ \sum_{j=-3(\neq -1)}^{5} \delta_j \cdot \mathbf{I}[E_t = j] * After * Treat + \sum_k \lambda_k \cdot \mathbf{I}[age_{is} = k] + \sum_y \kappa_y \cdot \mathbf{I}[s = y] + \nu_{ist}
$$

(2)

where Y_{ist} represents the labor market outcomes of individual i in calendar year s and at event time t (which corresponds to childbirth in this context). We define the variable $After$ as 1 for mothers whose child was between 0-2 years old after the childcare expansion occurred (i.e., $After$ is 0 for mothers who gave birth in period B in Figure 3). $Treat$ is set to 1 for mothers who gave birth in the treated counties. In this setup, $\hat{\delta}$ captures the effects of childcare expansion on mothers' child penalties, following the approach of Rabaté and Rellstab (2022). To obtain consistent estimates of child penalties, we normalize $\hat{\delta}$ with respect to the counterfactual outcomes as follows:

$$
Effect_t \equiv \frac{\hat{\delta}_t}{E[\tilde{Y}_{ist}|t]}
$$

(3)

where $\tilde{Y}_{ist} \equiv \sum_k \hat{\lambda}_k \cdot \mathbf{I}[age_{is} = k] + \sum_y \hat{\kappa}_y \cdot \mathbf{I}[s = y]$ is the predicted outcome when excluding the

effects of the event dummies. Then, $Effect_t$ estimates the impact of a sudden increase in public childcare coverage rate of 5 percentage point on mothers' child penalties in t years following childbirth, represented as a percentage change in mothers' labor market outcomes relative to the outcomes observed one year prior to childbirth.

Figure 6 plots the normalized effects of a sudden 5 percentage point increase in public childcare coverage rate on child penalties for mothers. This is represented by $Effect_t$ in equation (3), where t indicates the number of years after childbirth. The estimates presented in Figure 5 indicate that mothers who gave birth in treated counties just prior to the public childcare expansion had smaller child penalties in terms of earnings, employment, days worked, daily wage, working full-time and firm mobility. Since the child penalties are estimated as negative, positive coefficients of $Effect_t$ indicate a reduction in child penalties. The magnitude of the estimates suggests that a 5-percentage-point increase in public childcare reduces the child penalty three years after childbirth by 1.2%, 0.2%, 0.4%, 1.5%, 0.6%, and 0.5% for earnings, employment, days worked, daily wage, working full-time, and firm wage, respectively. In other words, relative to the pre-childbirth outcomes, a 5-percentage-point increase in public childcare coverage rate leads to approximately a 1.2%, 0.2%, 0.4%, 1.5%, 0.6%, and 0.5% smaller reduction in earnings, employment, days worked, daily wage, working full-time, and firm wage, respectively. Figure 6 suggests that this effect persists for up to five years after childbirth.

4.3 Generalized Difference-in-Difference

4.3.1 Methodology

Event study analysis provides the advantage of examining pre-trends in variables of interest. It is also more rigorous as it focuses solely on episodes of a sudden and large increase in public child-care as the treatment event. However, this strength can also be a weakness as it does not utilize all available variations. Given that childcare policy reforms generally resulted in gradual expansion of public childcare within and across counties, focusing solely on episodes of sudden jumps in public childcare may not provide a practical estimate for the actual effect of public childcare expansion on mothers' child penalties. Therefore, to complement our event study analysis, we conduct a generalized difference-in-difference estimation.

In our generalized difference-in-difference estimation, we exploit the variation in public child-care expansion across counties and over time. To accomplish this, we estimate child penalties at the county level, building on the approach of Kleven (2022), as follows:

$$Y_{isec} = \sum_z \sum_{j \neq -1} \alpha_c^e \cdot \mathbf{I}[e=j] \cdot \mathbf{I}[c=z] + \sum_z \beta_c \cdot \mathbf{I}[c=z] + \sum_b \sum_y \delta_y \cdot \mathbf{I}[s=y] \cdot \mathbf{I}[g=b]$$
$$+ \sum_b \sum_k \gamma_k \cdot \mathbf{I}[age_{is}=k] \cdot \mathbf{I}[g=b] + \nu_{istc} \tag{4}$$

where Y_{isec} represents the labor market outcome of interest for individual i in county c, at event time e, and in calendar year s. In this specification, the event time dummies in equation (1) are interacted with county dummies. Following the approach of Kleven (2022), we also interact state (g) dummies with age and calendar year dummies to account for life-cycle and time trends at the state level. The event time $e = 0$ corresponds to the birth year, and we consider event times ranging from years -3 to 7.

The child penalty for mothers in county c at event time e (i.e., e years after having a child) is defined as:

$$P_c^e \equiv \frac{\hat{\alpha}_c^e}{E[\tilde{Y}_{isec}|e]} \tag{5}$$

where $\tilde{Y}_{isec} \equiv \hat{\beta}_c + \sum_k \hat{\gamma}_k \cdot \mathbf{I}[k=age_{is}] + \sum_y \hat{\delta}_y \cdot \mathbf{I}[y=s]$ is the predicted outcome in the absence of a child. To estimate the child penalty for each year t in the sample period 2007-2014, we run the regression in equation 2 separately for mothers who gave birth between years $t-3$ and t for each t. In other words, we estimate the child penalty for mothers whose child is 0-2 years old in year t where $t = 2007, ..., 2014$, and P_{ct}^e measures the child penalty in the e-th year after childbirth for mothers who gave birth between year $t-3$ and t in county c.

Using the child penalty estimates at the county-year level obtained above, we conduct a generalized difference-in-difference estimation as follows:

$$CP_{ct} = \alpha + \beta PCC_{ct} + \gamma Z_{ct} + Year_t + County_c + \epsilon_{ct} \tag{6}$$

where CP_{ct} is the average child penalty for five years ($\overline{P}_{ct} \equiv \frac{1}{5} \sum_{e=1}^5 P_{ct}^e$) or the child penalty in the e-th year (P_{ct}^e) after childbirth for mothers in county c whose child is 0-2years old in year t. PCC_{ct} denotes the public childcare coverage rate in county c and year t, Z_{ct} represents a set of county-year specific characteristics, including the average age of population, the ratio of female, college graduates and women aged between 25 and 40, the employment share of each industry, population density, fertility rate, and unemployment rate. $Year_t$ and $County_c$ are year and county fixed effects, respectively.

4.3.2 Results

As the reform-induced public childcare expansion mainly occurred during 2007-2014, we limit the sample to mothers who had a child aged 0-2 during this period. For mothers who had a child in 2014, we can estimate their child penalties for up to seven years following the birth due to data availability.[12]

Table 1 provides summary statistics for the variables used in the main specification of equation (6). The main outcome variables include the average child penalty for five years after childbirth ($\overline{P}ct \equiv \frac{1}{5}\sum e = 1^5 P_{ct}^e$) in terms of earnings, employment, days worked, daily wage, working full-time, and firm wage. The mean values of the child penalty estimates are all negative, indicating that mothers face significant penalties across all these labor market outcomes.

Panel A of Table 2 presents the main results. The coefficients of the public childcare coverage rate are positive and statistically significant for most of the outcomes. Given that the child penalty estimates are negative, this implies that an increase in public childcare reduces the child penalties. Column (1) of Panel A suggests that a 1 percentage point increase in the public childcare coverage rate decreases the child penalty in earnings by 0.14 percentage points. In other words, if the public childcare coverage rate increases from 0% to 100%, it would reduce the child penalty in earnings by 14 percentage points. This reduction corresponds to approximately 20% of the total child penalty in earnings, given that its mean value is -0.71.

Expanding public childcare can decrease the child penalty in earnings through multiple channels. Columns (2)-(6) of Panel A demonstrate that expanding public childcare reduces the child penalty in terms of employment, days worked, daily wage, working full-time, and firm wage. This indicates that an increase in public childcare leads more mothers to return to work, work more days and full-time, earn higher daily wages, and remain with higher-paying firms. In other words, increased public childcare availability stimulates maternal labor supply both at the extensive and intensive margins. Moreover, it enables mothers to earn higher wage rates or increases their likelihood of remaining with higher-paying firms.

Panel B of Table 2 provides insights into the effects of public childcare expansion on the child penalty for each year following childbirth, up to seven years later. Column (1) of Panel B shows that public childcare expansion reduces the child penalty in earnings consistently over the seven-year period after childbirth. The magnitude of the coefficients suggests that it has the most significant effect on mothers during the first three years following birth. Columns (1) and (4) indicate that public childcare expansion has long-lasting effects on mothers' earnings and daily wages. On the other hand, columns (2)-(5) demonstrate that the increase in public childcare positively affects maternal labor supply (employment, days worked, and working full-time) in the relatively shorter

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[12]The IEB data set covers the period from 1975 to 2021.

term. This result could be attributed to the possibility that mothers in counties with more significant public childcare expansion are more likely to have a second child, resulting in another employment interruption thereafter.

5   Conclusion

In this paper, we study the effects of expanding public childcare to 0-2-year-old children on mothers' child penalties. West Germany has long been known for its low maternal labor supply and traditional gender norms attributed to family and labor policies adopted during the division. Consequently, the child penalty in (West) Germany has been larger and more persistent compared to other developed countries (Kleven et al., 2019a). In an effort to improve overall gender equality and achieve better family-and-work reconciliation of parents, the German government has implemented several family policy reforms since the mid-2000s, including the expansion of public childcare to toddlers. Encouragingly, our findings indicate a decrease in the child penalty for mothers in West Germany since the 2000s.

Motivated by this finding, we examine the causal effects of public childcare expansion on mothers' child penalties, leveraging regional and temporal variation in childcare expansion at the county level in West Germany. Our main estimation result suggests that a ten percentage point increase in public childcare coverage rate reduces mothers' child penalty in earnings by approximately three percentage points for the five years following birth. This reduction in the child penalty in earnings arises from various channels. Expanding public childcare to toddlers increases the likelihood of mothers returning to work after childbirth. Furthermore, providing more public childcare results in mothers working more days per year, earning higher daily wages, and being less likely to switch to low-paying firms once they return to work. These effects persist until seven years after childbirth.

As of 2020, the public childcare coverage rate for children under the age of three in West Germany was around 31%.[13] This implies that there is still room for further expanding public childcare and reducing the child penalty for mothers[14]. Considering the long-lasting impact of public childcare on mothers' labor market outcomes, the overall effects of public childcare expansion would be more significant than estimated in our paper if we consider a longer time span in the future. It could potentially affect mothers' career advancement in the long run, including promotion to managerial positions, and have a broader impact on firm culture and overall gender inequality.

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[13]Source: German statistical office (22543).

[14]According to some articles, the demand for public childcare still exceeds the supply in West Germany. See, for example, https://www.iamexpat.de/expat-info/german-expat-news/germanys-childcare-system-lacks-staff

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Figures

Figure 1: Expansion of Public Childcare for Children Aged 0-2


(a) 2007

(b) 2014
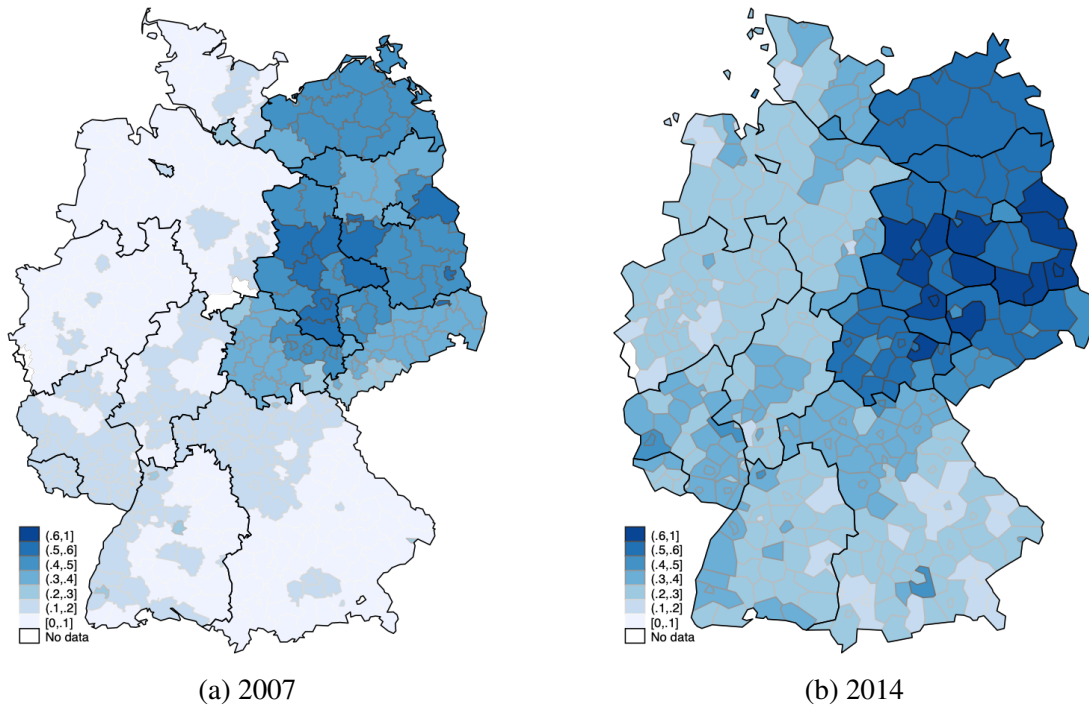
Note. This figure illustrates the public childcare coverage rate for children aged 0-2 across counties in Germany in 2007 and 2014. The coverage rate is calculated as the proportion of children enrolled in public childcare out of the total number of children aged 0-2 in each county for a specific year (Source: German statistical office).

Figure 2: Trend of Child Penalties for Mothers in West Germany
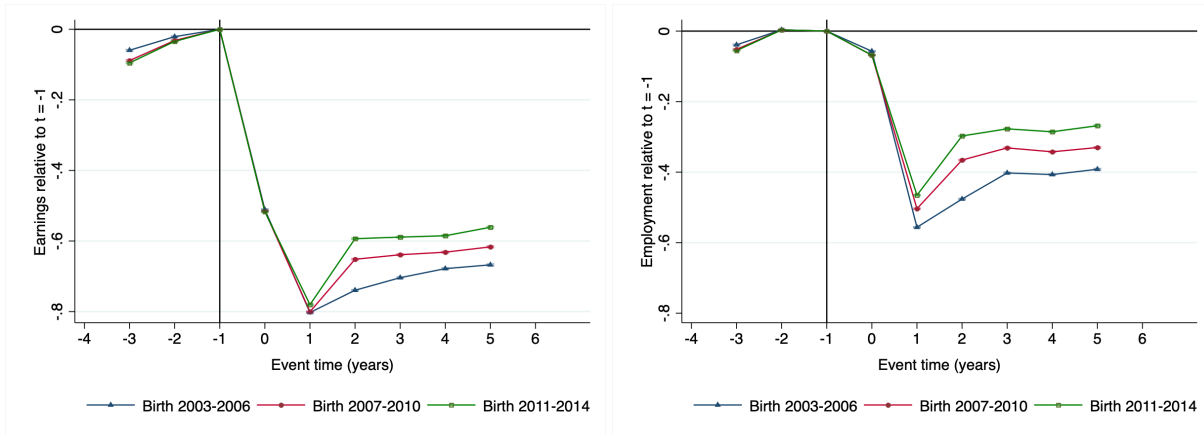
(a) Earnings

(b) Employment
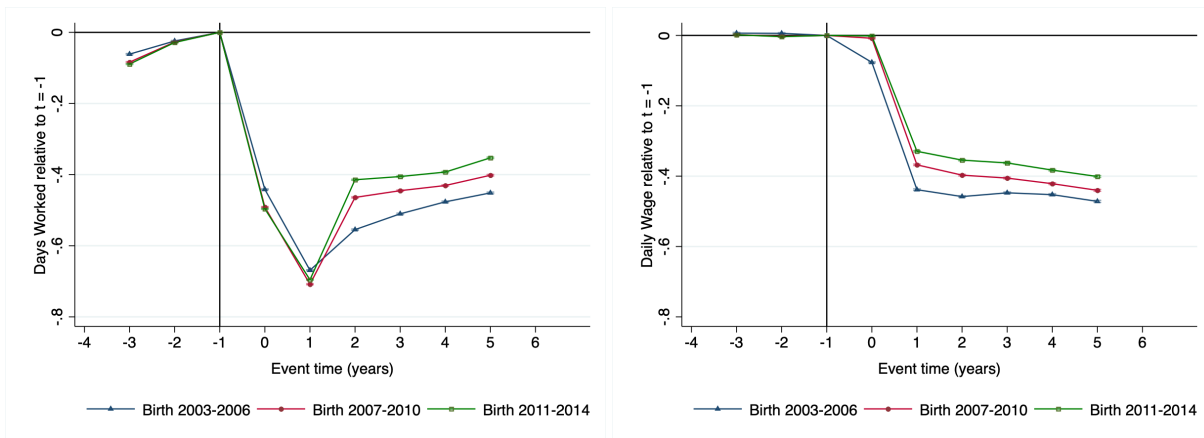
(c) Days Worked

(d) Daily Wage
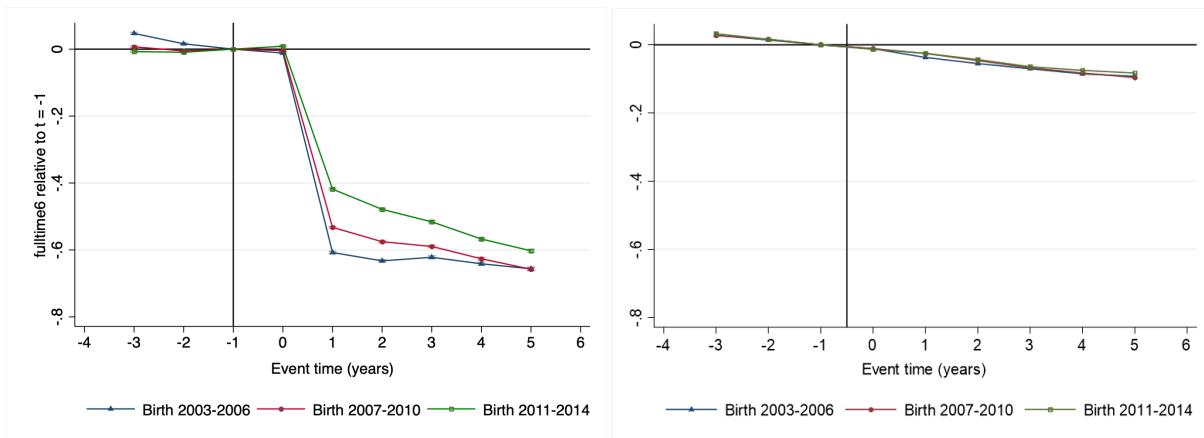
(e) Working Full-time

(f) Firm Wage Level

Note. The figure displays the estimated child penalties for different outcomes experienced by mothers in West Germany who gave birth in the periods 2003-2006, 2007-2010, and 2011-2014. For earnings and days worked, the child penalties are estimated without conditioning on employment status, meaning that earnings and days worked are assumed to be zero for those who are not employed. For other outcomes, the child penalties are estimated conditional on being employed. Earnings are measured as annual earnings, employment is represented by a binary indicator that equals one if an individual is employed for at least 30 days per year, days worked indicates the number of days worked per year, and the firm wage reflects the average wage of full-time workers in the firm where an individual is employed. Event time = 0 indicates the (calendar) year of giving birth.

Figure 3: Public Childcare Coverage Rate in Treated and Control Counties
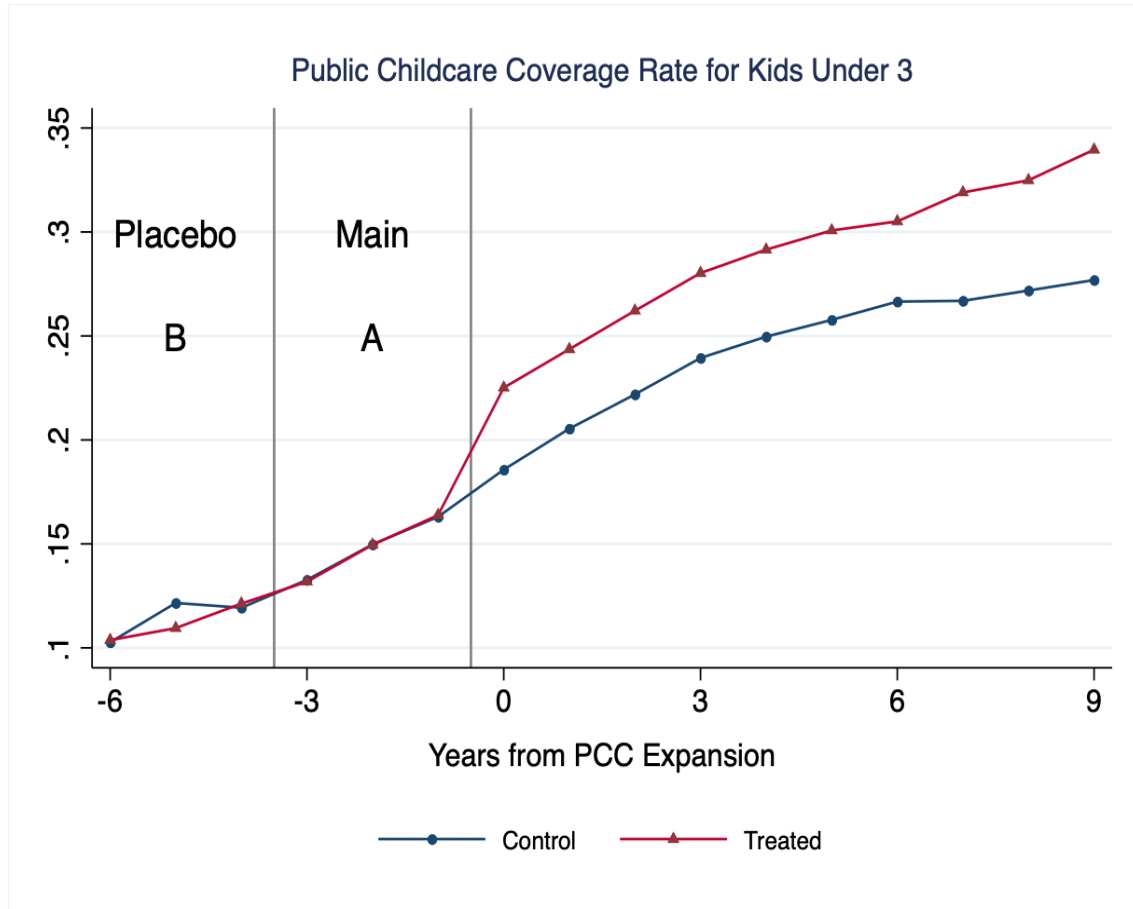
Note. This figure describes the changes in public childcare coverage rates in treated and control counties. In our event study analysis, counties that experienced a sudden and significant increase in public childcare coverage rate (more than 5 percentage points) within a single year are classified as treated. For the treated counties, the year of the expansion (referred to as "event year = 0" or "expansion year") indicates the year when the childcare expansion occurred. For each treated county, one county is chosen among never-treated counties as a control group matched in terms of urban status, fertility rate, female employment rate, and public childcare coverage rate for two years before the baseline year using the propensity score matching. For both groups of counties, we focus on two samples of mothers: those who gave birth 1-3 years before the public childcare expansion (our main sample) and those who gave birth 4-6 years before the expansion (the placebo group).

Figure 4: Pre-trends of Variables Potentially Relevant to Public Childcare Expansion
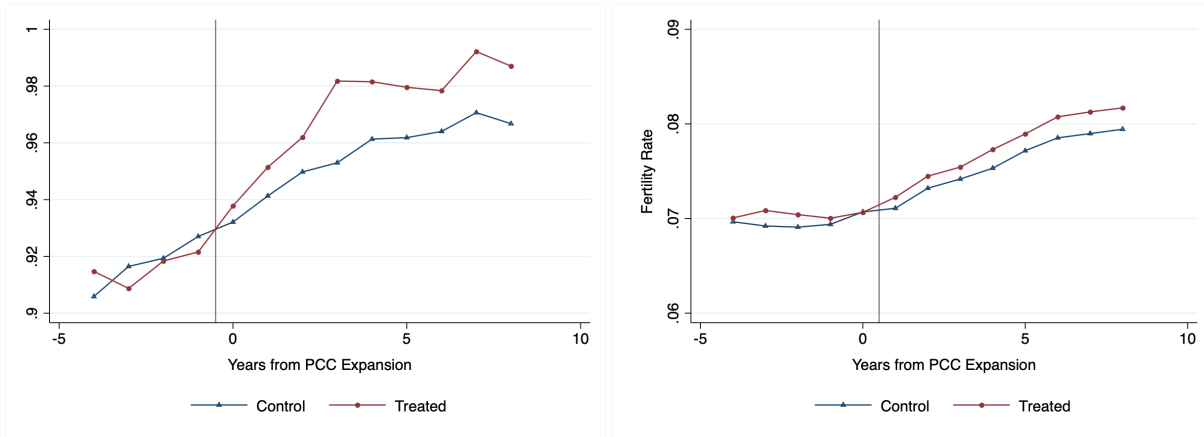
(a) PCC Rate for Kids Aged 3-5

(b) Fertility Rate
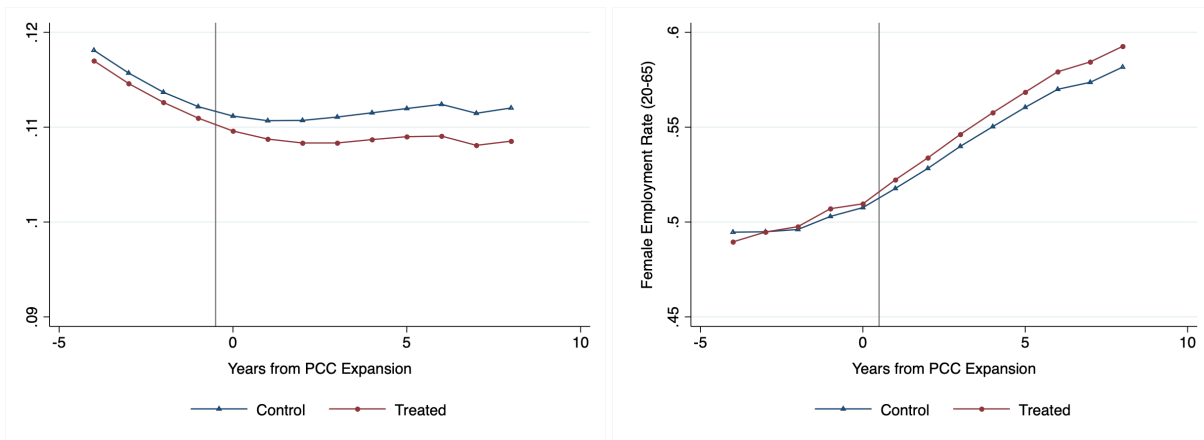
(c) Population Share of Women Aged 20-40

(d) Female Employment Rate

Note. This figure illustrates the pre-trends of variables that may be correlated with public childcare expansion for treated and control group of counties. Panels (a)-(d) compare the pre-trends of kindergarten coverage rate for kids aged 3-5, fertility rate, population share of young women, and female employment rate between the treated and control group counties.
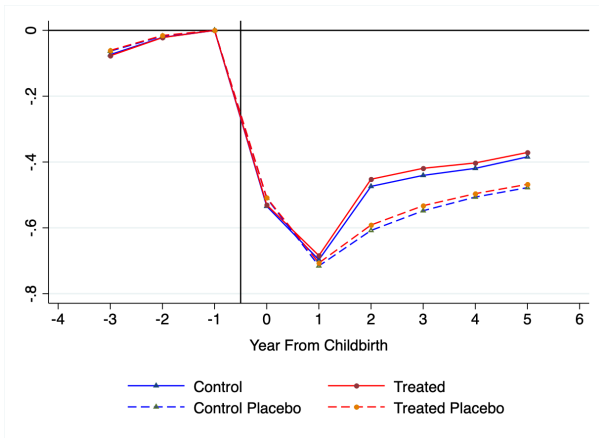
24

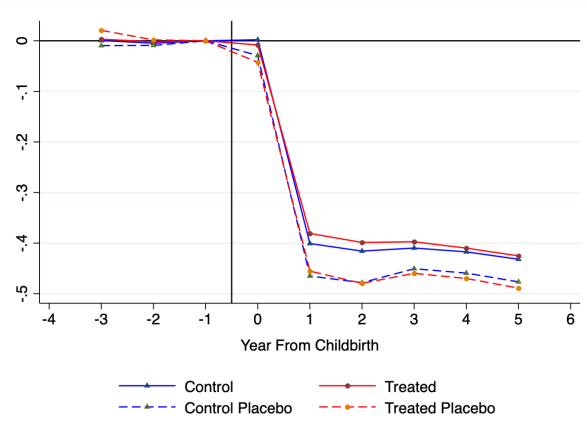Figure 5: Child Penalties for Mothers in Treated vs. Control Counties
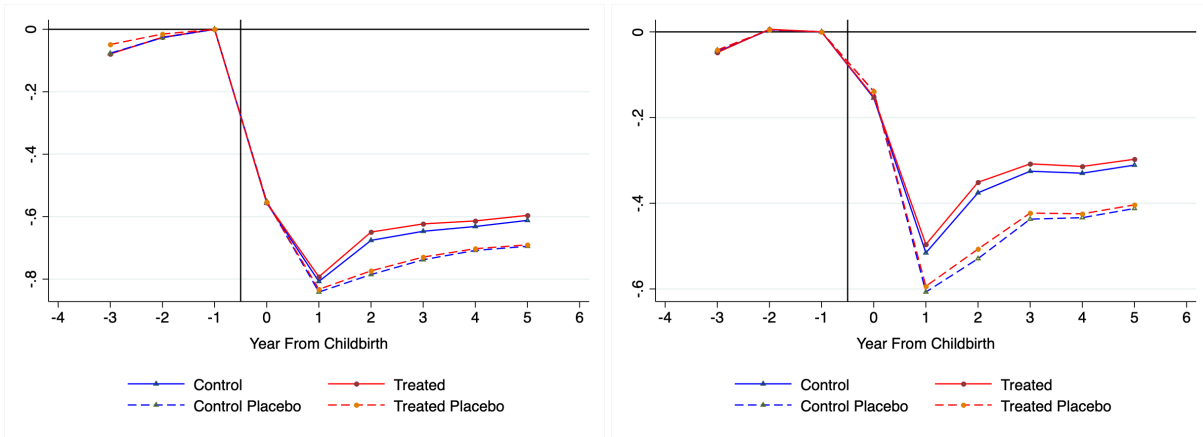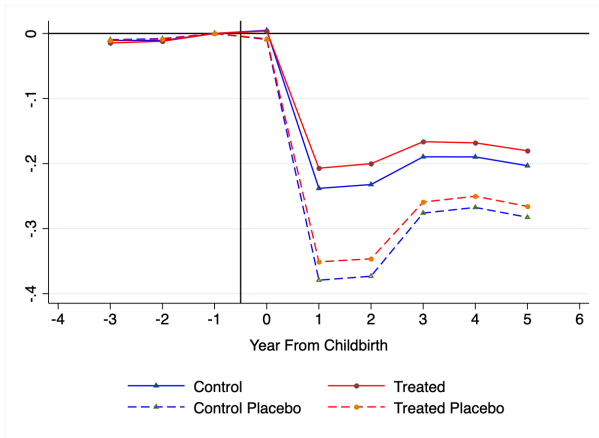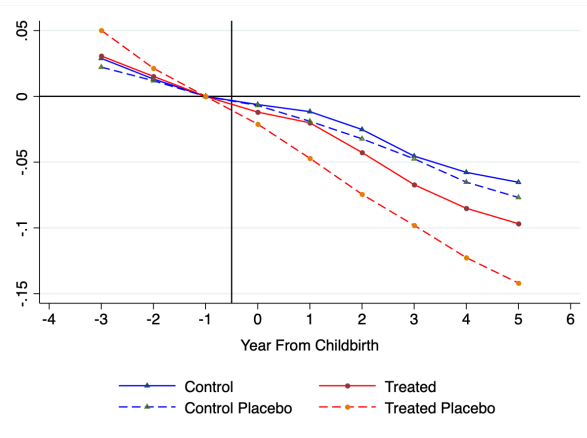
(a) Earnings
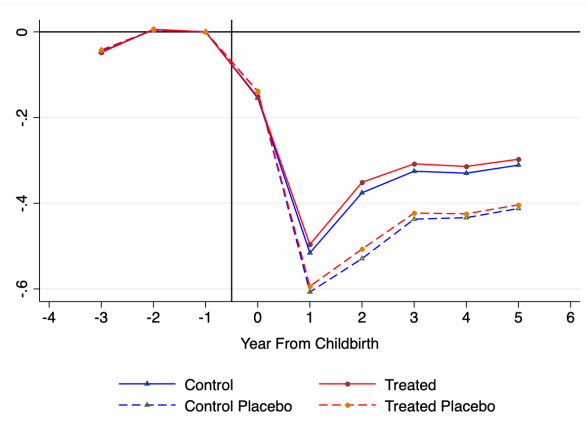
(b) Employment

(c) Days Worked

(d) Daily Wage

(e) Working Full-time

(f) Firm Wage

Note. This figure displays the child penalties for mothers in treated and control group of counties. The solid lines represent the child penalties of the main sample of mothers who had their first child 1-3 years before the public childcare expansion, while the dotted lines represent the child penalties of the placebo group of mothers who had their first child 4-6 years before the expansion. The red lines correspond to mothers in treated counties, while the blue lines correspond to mothers in control counties.

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Figure 6: The Effects of a Sudden Increase in Public Childcare on Mothers' Child Penalties
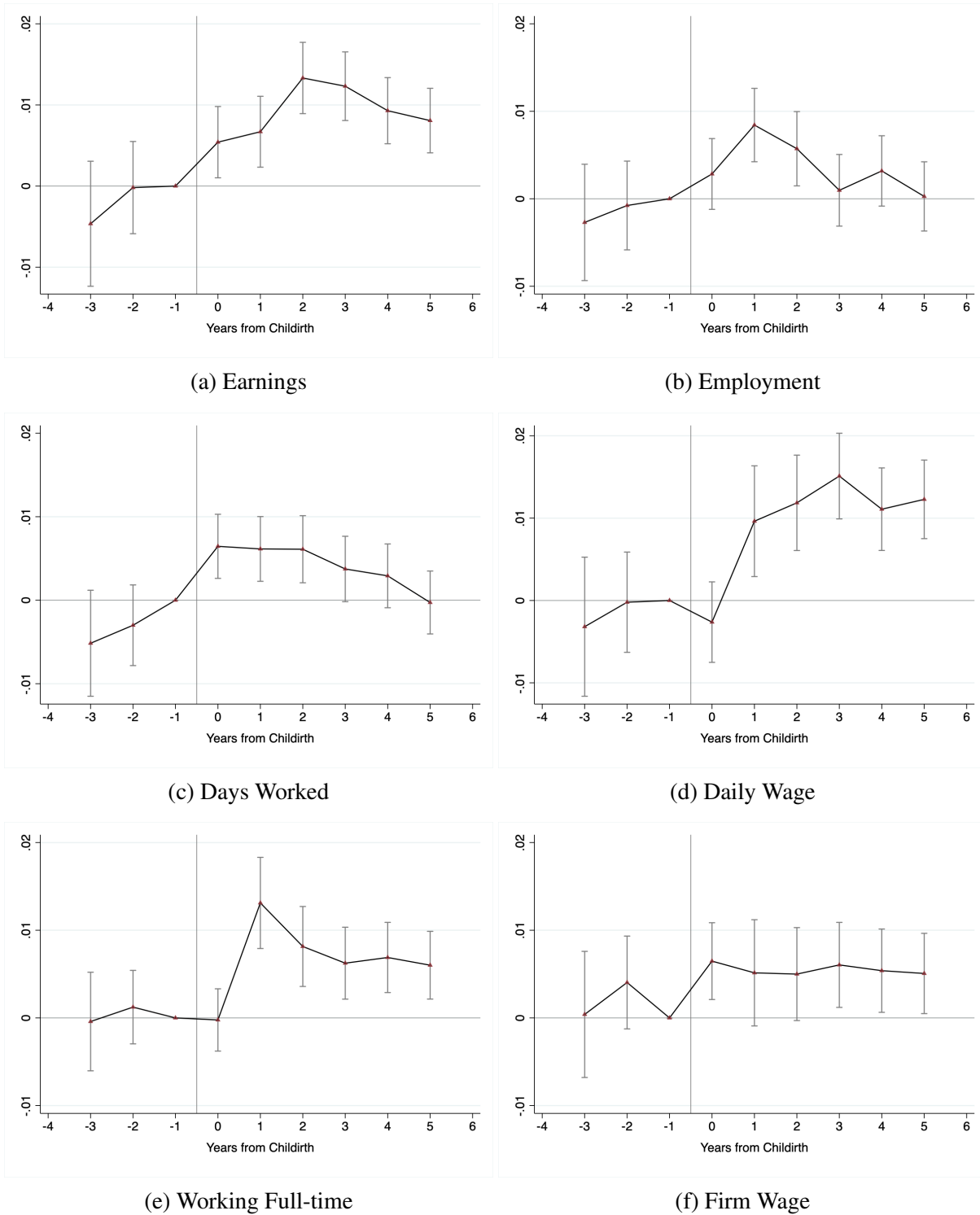

(a) Earnings

(b) Employment

(c) Days Worked

(d) Daily Wage

(e) Working Full-time

(f) Firm Wage

Note. This figure illustrates the normalized effects of a sudden 5 pp increase in public childcare coverage rate on child penalties for mothers. It represents $Effect_t$ as defined in equation (3), with t denoting the number of years from childbirth. That is, the x-axis of the graph corresponds to the event time in terms of childbirth.

Tables

Table 1: Summary Statistics

Variable	Mean	SD	Min	Max	N
Public Childcare Coverage rate	0.18	0.08	0.02	0.44	2592
Child Penalty (Earnings)	-0.71	0.05	-0.84	-0.53	2592
Child Penalty (Employed)	-0.42	0.06	-0.61	-0.26	2592
Child Penalty (Days Worked)	-0.56	0.04	-0.72	-0.43	2592
Child Penalty (Daily Wage)	-0.40	0.07	-0.56	-0.19	2592
Child Penalty (Full-time)	-0.52	0.06	-0.70	-0.27	2592
Child Penalty (Firm Wage)	-0.03	0.02	-0.10	0.07	2592
Age	40.7	0.96	37.1	43.9	2592
Female Ratio	0.49	0.02	0.41	0.55	2592
Ratio of Women Aged 25-40	0.32	0.04	0.22	0.45	2592
Ratio of College Graduate	0.08	0.05	0.01	0.35	2592
Employment Share of Manufacturing	0.23	0.08	0.05	0.52	2592
Employment Share of Public, Edu, Health	0.20	0.04	0.11	0.36	2592
Employment Share of IT	0.05	0.02	0.01	0.16	2592
Population Density	564.4	691.6	39.9	4601.2	2592
Fertility Rate	0.07	0.01	0.004	0.09	2592
Unemployment Rate	6.0	2.6	1.2	18.5	2592

Notes. This table presents a summary of the statistics for the variables used in the main generalized difference-in-difference estimation. The public childcare coverage rate is calculated as the percentage of children enrolled in public childcare among children aged 0-2 in each county and year. The child penalty represents the average penalty for each labor market outcome over a five-year period after giving birth ($\overline{P}ct \equiv \frac{1}{5}\sum e = 1^5 P_{ct}^e$). Population density indicates the number of people per square kilometer. The fertility rate is calculated as the number of new-born babies per women aged between 20 and 40. The analysis includes 324 counties in West Germany, and the sample period spans from 2007 to 2014, resulting in a total of 2592 observations ($= 324 \times 8$).

Table 2: The Effects of Public Childcare Expansion on Child Penalties of Mothers

Panel A — Dependent Variable: $\overline{CP}_{ct}$ (The average child penalty for 5 years after giving birth)

Outcomes of Interest:		Earnings (1)	Employment (2)	Days Worked (3)	Daily Wage (4)	Full-time (5)	Firm Wage (6)
Public Childcare Coverage		0.14***	0.15***	0.13***	0.09***	0.09*	0.02*
		(0.02)	(0.03)	(0.02)	(0.03)	(0.05)	(0.01)
X_{ct}		Yes	Yes	Yes	Yes	Yes	Yes
Year FE		Yes	Yes	Yes	Yes	Yes	Yes
County FE		Yes	Yes	Yes	Yes	Yes	Yes
Mean of Dep. Var.		-0.71	-0.42	-0.56	-0.40	-0.52	-0.03
N		2592	2592	2592	2592	2592	2592

Panel B — Dependent Variable: CP_{ct}^e (Child penalty of e-th year after giving birth)

Outcomes of Interest:		Earnings (1)	Employment (2)	Days Worked (3)	Daily Wage (4)	Full-time (5)	Firm Wage (6)
Public Childcare Coverage	$e=1$	0.13***	0.21***	0.12***	0.12***	0.08	0.01
		(0.02)	(0.03)	(0.02)	(0.03)	(0.05)	(0.03)
	$e=2$	0.18***	0.15***	0.19***	0.07***	0.05	0.01
		(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.02)
	$e=3$	0.11***	0.09***	0.09***	0.09***	0.13**	0.04*
		(0.02)	(0.03)	(0.03)	(0.02)	(0.06)	(0.02)
	$e=4$	0.09***	0.09***	0.06**	0.10***	0.09*	0.05*
		(0.02)	(0.02)	(0.02)	(0.03)	(0.05)	(0.03)
	$e=5$	0.07***	0.05**	0.04	0.05	0.13***	0.04
		(0.02)	(0.02)	(0.03)	(0.04)	(0.05)	(0.03)
	$e=6$	0.06***	0.01	0.02	0.05**	0.06	-0.02
		(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.03)
	$e=7$	0.06***	0.01	0.01	0.06***	0.08	0.06*
		(0.02)	(0.02)	(0.02)	(0.02)	(0.05)	(0.03)
X_{ct}		Yes	Yes	Yes	Yes	Yes	Yes
Year FE		Yes	Yes	Yes	Yes	Yes	Yes
County FE		Yes	Yes	Yes	Yes	Yes	Yes
N		2592	2592	2592	2592	2592	2592

Notes. Panel A of this table displays the estimates for the impact of public childcare provision on the average child penalty over a five-year period after giving birth. In contrast, Panel B provides the estimates for the effect on the child penalty for each individual year after giving birth. The models include a comprehensive set of county-year specific controls denoted as X_{ct}, as presented in Table 1. Standard errors are clustered at the county level and are reported in parentheses (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$). The regressions are weighted using the employment size of each county in the year 2007.

Appendix

Figure A.1: Distribution of Changes in Public Childcare Coverage Rate
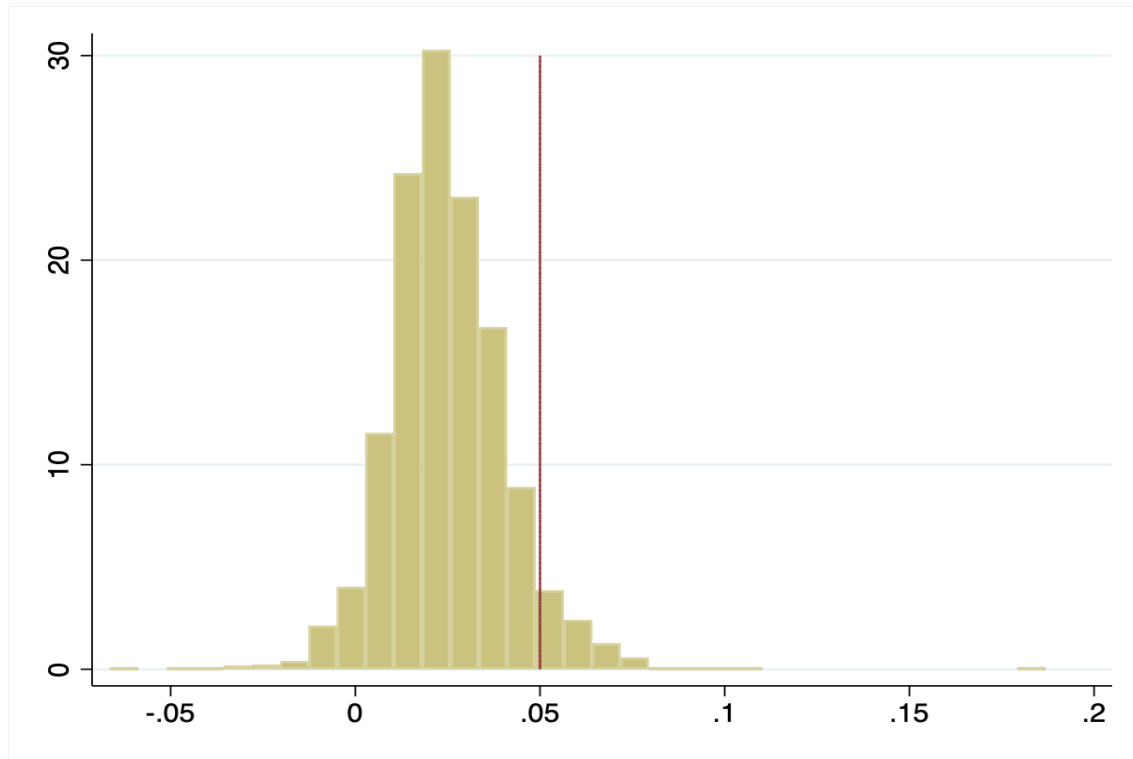
Note. This figure illustrates the distribution of annual changes in the public childcare coverage rate for 324 counties in West Germany during the period between 2007 and 2014. A 5 percentage point increase represents the top 5 percent of the distribution, with 132 cases out of 2268 exceeding this threshold. This cutoff value is used to define the public childcare expansion event.

Figure A.2: The Number of Cases of Public Childcare Expansion Event
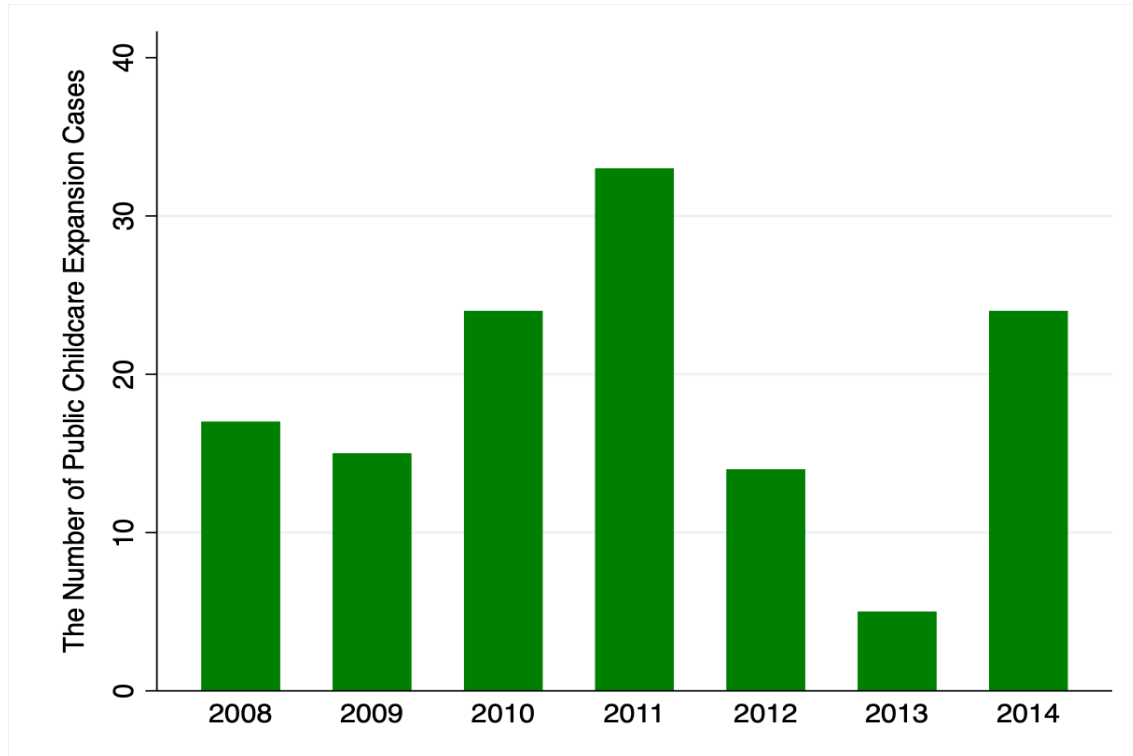
Note. This figure displays the number of public childcare expansion events that occurred across different years. An expansion event is defined as a county experiencing an annual increase in the public childcare coverage rate of more than 5 percentage points. In other words, if a county had a single-year increase in public childcare coverage rate exceeding 5pp, it is categorized as a treated county.