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Motherhood Penalty in Labour Supply during COVID-19 Shock: Evidence from Cyprus

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Abstract

This paper examines the patterns of the child (motherhood) penalty in labour supply in Cyprus over the period 2018–2023, with a particular focus on the COVID-19 shock. Using EU–SILC longitudinal microdata and correlated random-effects models, we track employment probabilities and usual weekly hours for men and women, disaggregated by parental status. Our results reveal a persistent and sizable employment-driven child penalty of roughly 20 percentage points, concentrated on the extensive margin. The pandemic year 2020 amplified this gap, reflecting disproportionate employment disruptions among mothers, while hours among the employed remained comparatively stable. Although employment levels rebounded by 2023, the underlying penalty remains substantial. Policy priorities should therefore target the extensive margin: expanding affordable and geographically accessible childcare, extending and adequately compensating father-specific parental leave, and promoting flexible work arrangements. These measures are likely to reduce mothers' exposure to employment interruptions and narrow the structural child penalty in the Cypriot labour market.

Keywords: Motherhood penalty, labour supply, COVID-19 shock, gender gaps

1. Introduction

A large literature documents persistent gender gaps in labour-market outcomes following childbirth, often referred to as the 'child penalty'. Using administrative data from Denmark, Kleven et al. (2019b) demonstrate that the arrival of the first child explains the bulk of the gender earnings gap. This evidence has recently been expanded in the *Child Penalty Atlas* (Kleven et al., 2023), which harmonizes microdata from 134 countries covering over 95% of the world's population. The Atlas confirms that child penalties are a universal phenomenon, with magnitudes ranging from 20-25% in Nordic countries to over 50% in parts of Central Europe; for Cyprus, the estimated penalty is approximately 27% (CI: 20–34%), based on data for 2005–2020 period.

The COVID-19 pandemic created a unique quasi-experimental environment to examine the dynamics of the child penalty, as it simultaneously disrupted labour markets, reshaped work organisation through teleworking, and intensified the interaction between paid and unpaid work. Studies which explored the COVID-19 shock documented disproportionate reductions in mothers' labour supply relative to fathers (e.g., Alon et al. 2020; Collins et al. 2021; Del Boca et al. 2020; Andrew et al. 2020;

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Lyssiotou and Savćić, 2022), often linked to sectoral shutdowns and intensified childcare demands during school closures. EU-level analyses by Eurofound and EIGE (2020–2022) similarly report sharper drops in actual and usual working hours for mothers compared to fathers, particularly in Southern Europe where teleworking was less prevalent.

Translating these insights to the Cypriot context, the study exploits EU–SILC longitudinal microdata from 2018 to 2023, which follow the same individuals annually across the pre-pandemic, pandemic, and recovery periods. This design allows us to track differential changes in usual weekly hours and employment probabilities for men and women, disaggregated by marital and parental status, and to examine how exogenous shocks amplified or mitigated pre-existing gender inequalities. By focusing on within-person dynamics rather than cross-sectional snapshots, the data allow us to distinguish structural group differences from individual adjustments over time. To further strengthen identification, the analysis relies on correlated random-effects models, which explicitly account for unobserved, time-invariant heterogeneity that may be correlated with observed characteristics such as education or occupation. This framework offers a robust basis for identifying how mothers—particularly married women with children—adjusted their labour supply relative to fathers and other groups during COVID-19, and it clarifies whether the pandemic shock manifested primarily on the extensive margin of employment or the intensive margin of hours worked. While the analysis aims primarily to document these patterns, the results also speak directly to policy debates on work–family reconciliation in Cyprus, underscoring the importance of childcare availability, parental leave design, and teleworking infrastructures in shaping how small open economies weather labour-market disruptions.

In the remainder of the paper the discussion turns to a review of the international literature on child penalties and the emerging evidence from the pandemic, with particular emphasis on Cyprus in Section 2. Section 3 introduces the EU–SILC data and describes the construction of the main variables. Section 4 sets out the empirical strategy, focusing on correlated random-effects models that trace labour-supply dynamics across groups and over time. The results are presented in Section 5, highlighting how employment and working hours evolved before, during, and after the pandemic. Section 6 examines policy implications, considering the role of childcare, parental leave, and flexible work arrangements. Finally, Section 7 concludes by summarising the main insights and outlining directions for future research.

2. Existing Literature

2.1 Child Penalty Literature Pre-COVID

The foundational research on child penalties highlights that the arrival of a child is a key driver of gender inequality in the labour market. Using high-quality administrative records from Denmark, Kleven et al. (2019b) show that the first childbirth generates a sharp, persistent earnings gap between men and women, with little convergence over time. This work builds on earlier evidence from Sweden (Angelov et al., 2016), Germany (Gangl and Ziefle, 2009; Schönberg and Ludsteck, 2014), and the United States (Waldfogel, 1998; Budig and England, 2001), which documents similar long-term penalties across diverse institutional settings.

Cross-country evidence further highlights heterogeneity in the magnitude of child penalties. Kleven et al. (2019a) document that earnings penalties are largest in countries with more traditional gender norms and less supportive family policies, often exceeding 50% in Central Europe. In contrast, Nordic countries, with their more progressive policies and extensive

childcare systems, exhibit penalties closer to 20–25%. These results emphasize the interaction between labour market structures, family policies, and cultural norms.

The Child Penalty Atlas (Kleven et al., 2023) represents the most comprehensive effort to date, harmonizing microdata from 134 countries to build pseudo-event studies of the earnings and employment trajectories of men and women around childbirth. Cyprus is also included in this dataset, using data spanning 2005–2020, with an estimated employment penalty of roughly 27%. This makes the Atlas particularly relevant for contextualizing country-level analyses such as this study, which extends the focus from earnings and employment to intensive margins of labour supply, namely usual weekly hours worked.

A range of mechanisms—often mutually reinforcing—gives rise to the child penalty. First, there are non-linear returns to long, inflexible hours and to continuous tenure in many high-paying occupations, which disadvantage those taking career breaks or shifting to flexible/part-time roles after childbirth (Goldin, 2014). Second, there is a well- established part-time wage penalty, particularly in systems where part-time jobs are concentrated in lower-wage tracks (Manning and Petrongolo, 2008). Third, interrupted experience accumulation and slower career progression during and after parental leave contribute to persistent gaps (Blau and Kahn, 2017). Fourth, family policy and tax–benefit design can shape incentives at the household margin, especially for second earners (often mothers), influencing whether the adjustment occurs on employment, hours, or job quality (OECD, 2022). Meta-analytic evidence confirms that motherhood penalties are widespread and statistically robust across study designs, though magnitudes vary with context and controls (Cukrowska-Torzewska and Matysiak, 2020).

Within Europe, evidence from Germany, Spain, Italy and the Nordic countries maps closely to the mechanisms above: childcare expansions raise maternal employment (Germany, Spain), while long leave or cash-for-care tend to reinforce traditional gender roles, with mothers remaining at home and fathers in paid work (Bauernschuster and Schlotter, 2015; Nollenberger and Rodríguez-Planas, 2015; Hardoy and Schøne, 2010; Olivetti and Petrongolo, 2017). In Asia, recent work for Japan and South Korea documents sizeable motherhood penalties, with heterogeneity by wage level and education; institutional context (working-time norms, childcare access) shapes both the size and the persistence of penalties (Dumauli, 2019; Jung, 2023). In Africa, data constraints are greater, but studies for South Africa report motherhood-related shortfalls in wages and employment probabilities consistent with a persistent penalty, interacting with high informal employment and care burdens (Mosomi, 2019; Torrington, 2022). Overall, the consensus is that child penalties are near-universal but differ in both level and composition (participation vs. hours vs. wage growth), depending on policy, prices (childcare), workplace practices, and social norms.

2.2 COVID-19 and Gender Gaps in Labour Supply

The COVID-19 pandemic introduced new dynamics to the child penalty literature. Early work by Alon et al. (2020) coined the term "she-cession", highlighting how sectoral composition (e.g., service industries) and childcare burdens combined to disproportionately affect women during lockdowns. These predictions were rapidly confirmed by empirical studies across multiple countries.

In the United States, Collins et al. (2021) used high-frequency panel data to show that mothers reduced their working hours 4–5 times more than fathers during the early stages of the pandemic, widening the gender gap in hours worked by roughly 20–50%. Similarly, Del Boca et al. (2020) found that Italian

mothers bore a disproportionate share of the additional childcare and domestic responsibilities while simultaneously experiencing greater reductions in paid work. Andrew et al. (2020) provided evidence from the United Kingdom showing that mothers' hours fell much more sharply than those of fathers during school closures, even when both partners were able to work from home. Lyssiotou and Savčić (2022) further document that UK parents' time allocation shifted markedly across different phases of the pandemic, with mothers consistently devoting more hours to childcare and housework, underscoring the persistence of gendered divisions of labour and their implications for post-pandemic gender equality.

At the European level, reports by Eurofound (2020, 2021) and EIGE (2022) documented sharp reductions in usual and actual hours worked for women, with mothers and women in Southern Europe facing the largest declines. These patterns were driven by both sectoral exposure—given the concentration of female employment in customer-facing industries—and limited access to telework in these regions. Importantly, these studies also highlight that recovery in hours worked was slower for women, suggesting that the COVID-19 shock may have exacerbated existing child penalties in many countries.

2.3 Cyprus-Specific Evidence

Research on gendered labour-market outcomes in Cyprus during the COVID-19 period is still limited. Eurofound country reports (Eurofound, 2021, 2020) provide useful descriptive evidence on the policy measures adopted, the prevalence of telework (mainly in the public sector), and sector-specific labour market disruptions. These reports underscore the limited telework infrastructure in Cyprus relative to Northern European countries, which likely intensified the labour-market impact on women with children.

Christofides and Mitsis (2024) document the evolution of the gender wage gap using Structure of Earnings Survey data from 2006 to 2018, showing that sizeable unexplained differentials persist despite gradual narrowing over time. Earlier work by Christofides and Pashardes (2000) similarly identified a pronounced wage gap disadvantaging women.

Against this backdrop, the Friedrich-Ebert-Stiftung (Friedrich-Ebert-Stiftung (FES), 2023) report on "COVID and Gender in Cyprus" concludes that women experienced disproportionate pressures, with increased childcare responsibilities, higher unemployment rate, and heightened work-life balance challenges during lockdowns. Data from CYSTAT Labour Force Surveys (Cyprus Statistical Service, 2023) confirm that total hours worked dropped sharply in 2020 before gradually recovering in 2022–2023. IMF country reports (International Monetary Fund, 2021) highlight that while headline employment losses were relatively muted, the intensive margin (hours worked) experienced substantial adjustment. EIGE's Gender Equality Index (European Institute for Gender Equality, 2022) for Cyprus provides complementary evidence on structural gender gaps: Cyprus scores substantially below the EU average, with particular weaknesses in the domains of work, time, and power, indicating structural gender disparities that the pandemic likely exacerbated.

Overall, the literature shows that child penalties are a persistent feature of labour markets and that the COVID-19 pandemic deepened existing gender inequalities, particularly through increased care responsibilities and employment disruptions for mothers. What remains less well understood in the Cypriot case is how these dynamics played out across different phases of the pandemic and whether they manifested primarily in employment participation or in working hours. Using longitudinal EU-SILC microdata for 2018–2023, the present study addresses this gap, tracing labour supply outcomes

for men and women with and without children over the pre-pandemic, lockdown, and recovery periods. Clarifying these patterns is not only of academic interest but also of practical importance, as the findings speak directly to ongoing policy debates on work–family reconciliation in Cyprus, highlighting the role of childcare availability, parental leave design, and flexible work arrangements in shaping how parents weather labour-market disruptions.

3. Data Used

We analyse annual EU–SILC longitudinal data for Cyprus from 2018 to 2023. The working sample is restricted to the individuals aged 20 to 64 for whom the complete set of observations is available in a given year. To keep definitions comparable across the 2020 questionnaire change, education is consolidated into four buckets—No/Primary, Lower Secondary, Upper Secondary/Post-Secondary Non-Tertiary, and Tertiary—and, where available, occupation is grouped into five harmonised ISCO bundles (1–2, 3, 4–5, 6–7, 8– 9). Employment is a binary indicator equal to one for people classified as employed after harmonising the pre-2021 and post-2021 labour-status items. Weekly hours are defined as the usual hours worked per week; when an individual is not employed, weekly hours are set to zero.[1]

TABLE 3.1
Employment rates by group and year

Year	Men, no child	Fathers	Women, no child	Mothers
2018	0.573	0.882	0.570	0.687
2019	0.611	0.889	0.593	0.707
2020	0.636	0.897	0.598	0.689
2021	0.655	0.896	0.623	0.708
2022	0.671	0.926	0.630	0.748
2023	0.691	0.915	0.647	0.750

Notes: Employment is the mean of the harmonized employment indicator in the working-age sample (ages 20–64).
Full descriptives are provided in Appendix Table B.2.

Within this working-age sample, outcomes differ systematically by gender and parenthood status. Fathers combine the highest employment rates with the longest weeks among the employed (about 40–41 hours), followed by men without children (just under 40 hours). Among women, mothers work fewer hours than childless women (around 36–37 versus 38–39) yet have higher employment incidence; women without children display the lowest employment rates overall. These patterns are broadly stable across years, with a modest dip in hours around 2021 and a recovery by 2023, alongside a gradual rise in employment across all four groups from 2018 to 2023.[2]

[1] See Appendix A for precise variable definitions and construction procedures
[2] Detailed descriptive statistics are reported in Appendix B.

TABLE 3.2
Average weekly hours among the employed, by group and year

Year	Men, no child	Fathers	Women, no child	Mothers
2018	39.05	40.46	37.76	36.54
2019	38.95	40.56	38.35	36.31
2020	39.11	40.43	38.14	36.52
2021	38.87	39.78	37.75	36.20
2022	39.30	39.79	38.52	36.80
2023	40.26	40.69	38.90	37.08

Notes: Hours refer to mean usual weekly hours among employed respondents. Full descriptives are provided in Appendix Table B.4.

4. Estimation strategy

While Kleven et al. (2019b, 2023) exploit high-frequency administrative registers to estimate event-study models centred on childbirth, such an approach is not feasible in the Cypriot EU–SILC data, which are annual and lack precise fertility events. Our objective is different: to document how mothers and fathers already in the labour force adjusted their employment and hours during an exogenous macro shock. For this purpose, our panel data model with group–year interactions is more appropriate, as it accounts for unobserved heterogeneity while allowing us to disentangle structural differences between groups from within-person adjustments over the pre-pandemic, pandemic, and recovery phases.

To this end, we estimate pooled correlated random effects (CRE) models following Wooldridge's formulation for unbalanced panels (Wooldridge, 2019). For each equation – employment, hours including zeros, and hours conditional on employment – we define an equation-specific availability flag that equals one exactly in the person–years where all variables required by that equation are observed. For any time-varying regressor x_{it} entering equation q ∈ {E, A, I}, we include the contemporaneous value x_{it} and the equation-specific person mean

$$\bar{x}_i^{(q)} = \frac{1}{T_i^{(q)}} \sum_{t:S_{it}^{(q)}=1} x_{it} \ , \qquad T_i^{(q)} \equiv \sum_t S_{it}^{(q)} \ ,$$

so the mean is computed only over waves used in that equation's estimation sample. This Mundlak augmentation delivers CRE estimates that are robust to correlation between time-invariant unobserved heterogeneity and the regressors within each unbalanced sample. We allow fully flexible group-by-year paths through saturated interactions of year indicators with four demographic groups (men without children, fathers, women without children, mothers). Education enters as three dummies (No/Primary omitted), and – when available for the employed-hours equation – occupation enters as four dummies (Managers and Professionals omitted); in each case, the corresponding equation-specific person means are included alongside the contemporaneous terms.

Individuals are indexed by i and calendar years by $t \in \{2018, \ldots, 2023\}$. We use y to index the year indicators and g to index demographic groups. Gi denotes individual i's group (men without children, fathers, women without children, mothers). $1\{\cdot\}$ is an indicator function that equals one when the statement holds and zero otherwise. For equation $q \in \{E, A, I\}$ (employment, hours including zeros, hours conditional on employment), $S_{it}^{(q)} \in \{0, 1\}$ flags availability of all variables required by that equation in person–year (i, t) and $T_i^{(q)} \equiv \sum_t S_{it}^{(q)}$ is the number of usable waves for i in equation q.

Overlines denote equation-specific person means computed only over $\left\{t: S_{it}^{(q)} = 1\right\}$, $e.g\ \bar{x}_i^{(q)} \equiv T_i^{(q)-1} \sum_{t:S_{it}^{(q)}} x_{it}$. $\boldsymbol{Z_{it}}$ collects education dummies (No/Primary omitted) and, when applicable, $\boldsymbol{O_{it}}$ collects occupation dummies (Managers and Professionals omitted). $\Lambda(\cdot)$ is the logistic link. We use $E_{it} \in \{0,1\}$ for employment, H_{it}^{all} for usual weekly hours including zeros, and H_{it}^{emp} for usual weekly hours among the employed. X_{it} denotes the full set of regressors in the relevant equation.

Employment (extensive margin). Let $E_{it} \in \{0,1\}$ denote employment. The logistic CRE model with group–year interactions and availability-weighted person means is

$$\Pr(E_{it} = 1 \mid X_{it}) = \Lambda(\alpha + \sum_{y,g} \delta_{yg} 1\{t = y\} 1\{G_i = g\} + \beta\, age_{it} + \gamma^T \boldsymbol{Z_{it}} + \bar{\beta}^{(E)}\, \overline{age_i}^{(E)} + \bar{\gamma}^{(E)T}\, \bar{\boldsymbol{Z}}_{\boldsymbol{i}}^{(E)}), \quad (1)$$

where $\Lambda(\cdot)$ is the logistic link and the superscript (E) indicates that the person means are computed only over years used by the employment equation. Coefficients on contemporaneous regressors (e.g. β on age_{it}) can be interpreted as within-person effects, conditional on the corresponding person means.

Hours including zeros (combined extensive + intensive margin). Let H_{it}^{all} be usual weekly hours with zeros for the non-employed. The linear CRE model is

$$H_{it}^{all} = \alpha + \sum_{y,g} \delta_{yg} 1\{t = y\} 1\{G_i = g\} + \beta\, age_{it} + \gamma^T \boldsymbol{Z_{it}} + \bar{\beta}^{(A)}\, \overline{age_i}^{(A)} + \bar{\gamma}^{(A)T}\, \bar{\boldsymbol{Z}}_{\boldsymbol{i}}^{(A)} + e_{it} \quad (2)$$

where (A) denotes means based on the hours-including-zeros sample. Because zeros are retained, this captures movements on both the extensive and intensive margins in a single hours-per-week outcome.

Hours conditional on employment (intensive margin). Restricting to $E_{it} = 1$, let H_{it}^{emp} denote usual weekly hours. Where occupation can be harmonised, we add its contemporaneous dummies and the corresponding availability-weighted means:

$$H_{it}^{all} = \alpha + \sum_{y,g} \delta_{yg} 1\{t = y\} 1\{G_i = g\} + \beta\, age_{it} + \boldsymbol{\gamma}^T \boldsymbol{Z_{it}} + \boldsymbol{\theta}^T \boldsymbol{O_{it}} + \bar{\beta}^{(I)}\, \overline{age_i}^{(I)} + \bar{\boldsymbol{\gamma}}^{(I)T}\, \bar{\boldsymbol{Z}}_{\boldsymbol{i}}^{(I)} + \bar{\boldsymbol{\theta}}^{(I)T}\, \bar{\boldsymbol{O}}_{\boldsymbol{i}}^{(I)} + e_{it,} \quad (3)$$

with (*I*) indicating that means are computed over the set of person-years usable for the employed-hours equation.

Event-study contrasts (year-by-year). The interactions $1\{t = y\} \cdot 1\{Gi = g\}$ trace each group's time path. We report adjusted, model-based means by group and year. For employment these are adjusted probabilities; for hours they are adjusted averages in hours per week.

Adjusted motherhood gaps and inference. The motherhood gap in year y is the difference between the adjusted mean for mothers and that for fathers,

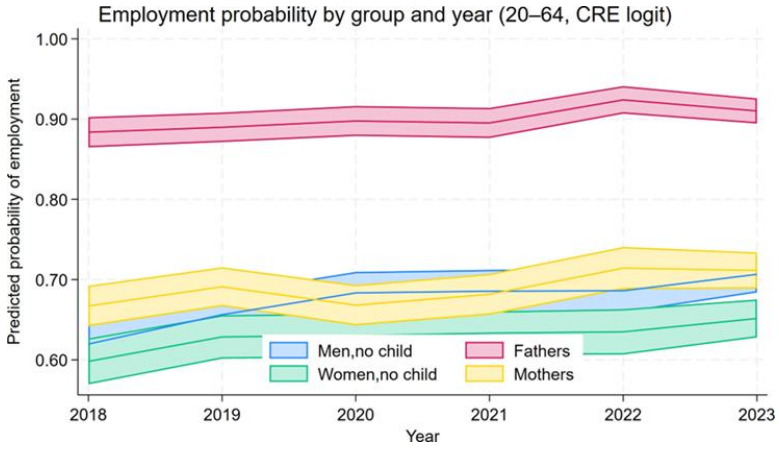
$$\Delta_y = m_{Mothers}(y) - m_{Fathers}(y),$$

with standard errors obtained via the delta method from the clustered variance–covariance matrix. Standard errors are clustered by individual to account for arbitrary within-person correlation and heteroskedasticity across years. The inclusion of contemporaneous regressors together with their availability-weighted person means implements Wooldridge's CRE in unbalanced panels, thereby controlling for time-invariant confounding correlated with the regressors while preserving a simple pooled estimator.

5. Results

Predicted employment rises for all four gender–parenthood groups between 2018 and 2023 (Figure 1). Men without children increase from about 0.62 to 0.71, fathers remain highest at roughly 0.88 to 0.91, women without children move from about 0.60 to 0.65, and mothers from about 0.67 to 0.71. The hours series echo these improvements. On the combined margin (hours including zeros), average weekly hours trend up with a small softening around 2021 and a clear rebound by 2023 (Figure 2): men without children rise from about 24.0 to 28.4 hours, fathers from 35.7 to 36.8, women without children from 22.7 to 25.3, and mothers from 24.5 to 26.5. Intensive-margin hours (employed only) are comparatively stable, with modest increases by 2023 (Figure 3): men without children from 39.1 to 40.3, fathers from 40.3 to 40.6, women without children from 37.9 to 38.9, and mothers from 36.6 to 37.2. 3 Full coefficient tables are reported in Appendix C.

FIGURE 1
Predicted probability of employment by group and year
(CRE logit; clustered at the individual level)



Motherhood (child) penalty with a focus on 2020. Figure 4 traces the adjusted motherhood penalty in employment, defined as the difference in predicted employment between mothers and fathers in each year. The penalty is large and fairly stable, but it widens in 2020 : from about −19.9 percentage points in 2019 to about −23.0 points in 2020, before easing to roughly −21.3 in 2021 and −19.9 in 2023. On the combined hours margin (Figure 5), the gap also becomes more negative in 2020 (around −11.7 hours/week, versus −10.9 in 2019), then narrows to roughly −10.2 to −10.3 hours by 2022–2023. In contrast, the intensive-margin gap among the employed (Figure 6) changes little in 2020 (about −3.7 hours/week, from −4.1 in 2019), suggesting that the 2020 deterioration in mothers' overall hours worked arose primarily through the extensive margin (employment incidence) rather than shorter workweeks conditional on employment. Appendix C reports the full sets of estimates underlying these figures.

[3] As a robustness check for the intensive margin, we augment the CRE model with earnings/wage controls, decomposed into within- and between-person components. Results are statistically identical to the baseline specification.

FIGURE 2
Usual weekly hours including zeros by group and year
(CRE OLS; clustered at the individual level)

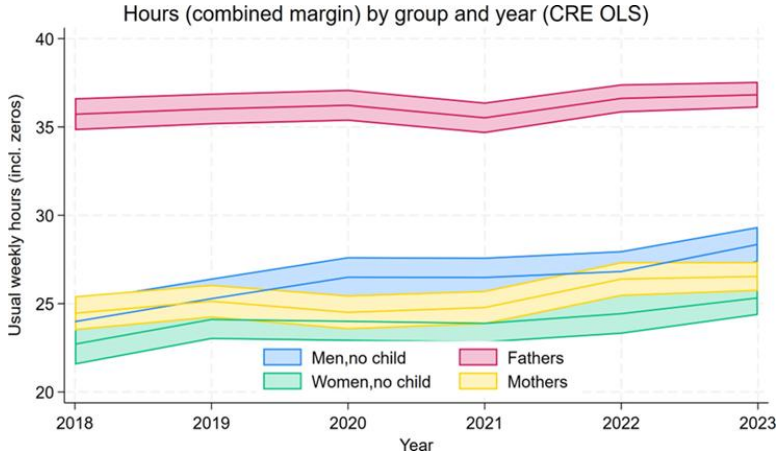


FIGURE 3
Usual weekly hours among the employed by group and year
(CRE OLS; clustered at the individual level)

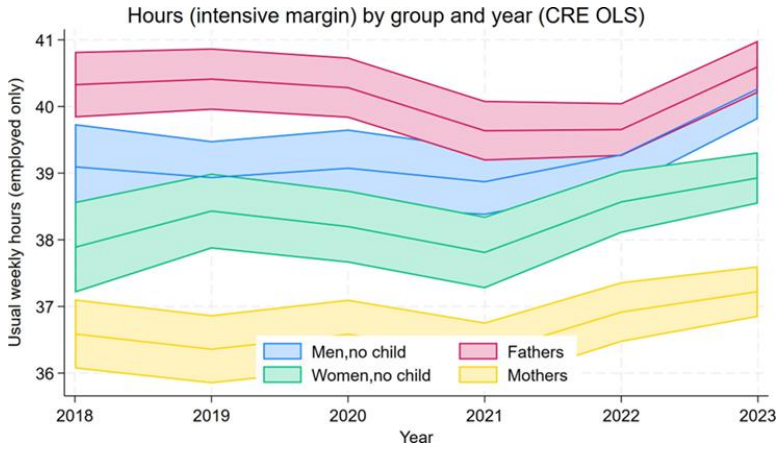


FIGURE 4
Adjusted motherhood employment penalty (mothers minus fathers, p.p) by year

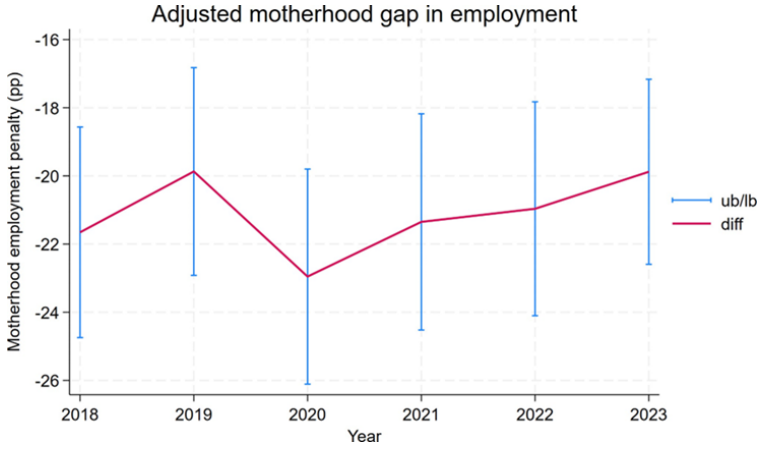


FIGURE 5
Adjusted motherhood employment penalty (including zeros, hours/week) by year

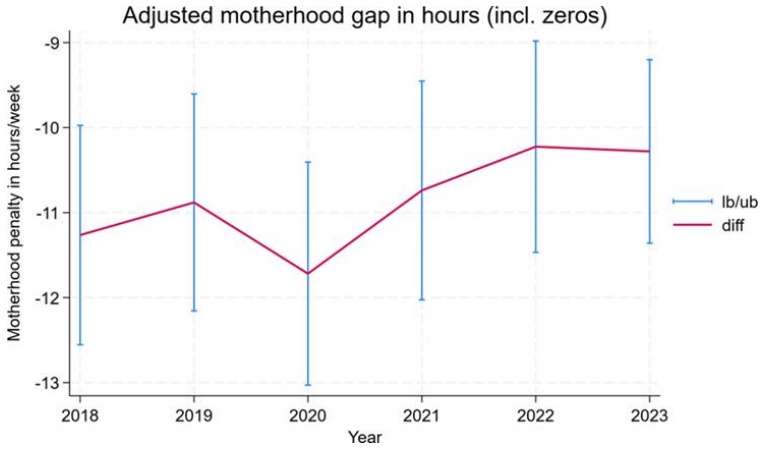
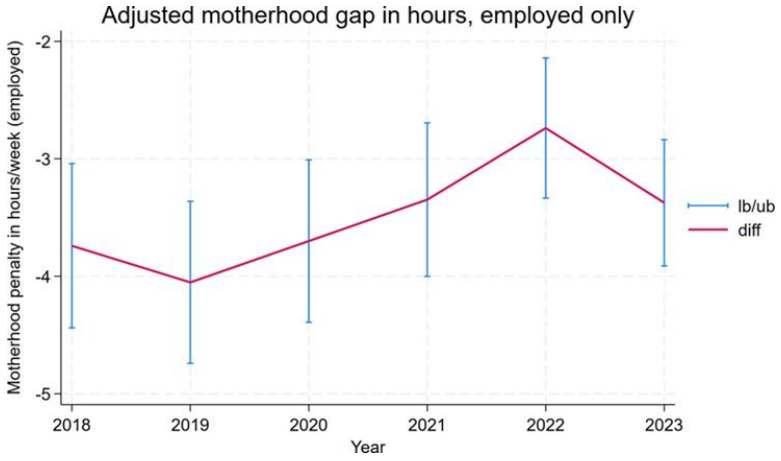


FIGURE 6
Adjusted motherhood hours penalty among the employed (including zeros, hours/week) by year



6. Policy Recommendations

Our results point to the extensive margin as the binding constraint: mothers' employment probabilities lag fathers' in every year, with the short, identifiable dip in 2020 and a swift recovery thereafter. Hours among the employed are comparatively stable across groups. In line with the literature, the most promising levers are those that (i) lift constraints on childcare supply and affordability; (ii) protect job attachment around birth; and (iii) nudge within-household time allocation.

First, priority should be given to expanding capacity and ensuring durable funding for early childcare. Cyprus has introduced a tuition-and-feeding subsidy for young children (covering up to ~80% of fees within caps, targeted by age, hours, and income), which lowers out-of-pocket prices but does not by itself create places; waiting lists and geographic gaps can leave the extensive margin unchanged for

rationed families.[4] [5]. Attention should be directed to (a) adding places (public and licensed private) in undersupplied municipalities; (b) maintaining/raising per-child subsidy ceilings where fees exceed caps; and (c) simplifying take-up and continuity of support, so mothers can accept jobs when offers arrive. These steps complement the quasi-experimental evidence that childcare expansion increases maternal employment and agreed hours in capacity-constrained settings (Bauernschuster and Schlotter, 2015; Nollenberger and Rodríguez-Planas, 2015).

Second, a more refined leave design could maintain labour-market attachment while avoiding extended career interruptions and fostering shared caregiving via father-specific measures. Cyprus provides maternity leave and short paternity leave (two weeks, paid via social insurance), with parental leave largely unpaid.[6] [7] International reviews find that job-protected but not excessively long paid leave sustains attachment, while father-targeted quotas increase paternal care time; both effects operate primarily through the extensive margin (Olivetti and Petrongolo, 2017; Rege and Solli, 2013; Cools et al., 2015). On this margin, extending and adequately compensating the father-reserved portion of leave (beyond the current two-week paternity leave) and introducing at least a modestly paid, non-transferable parental-leave quota for each parent would better align incentives with the objective of shared care and faster return to work.

Finally, the normalisation of flexible work organisation should be pursued as a complement – not a substitute – to child-care and leave. Cyprus has transposed the EU Work-Life Balance Directive, giving parents of young children a right to request flexible working arrangements; the binding constraint now is practice.[8] Our estimates show stable within-job hours but persistent employment gaps: this is exactly the margin where predictable schedules, part-time path- ways back to full-time, and output-based performance evaluation sustain attachment without depressing hours for those already employed (Goldin, 2014). The policy task is enforcement and diffusion (e.g., guidance to employers, public-sector exemplars, and transparency around acceptance rates), not new legislation.

In short, given Cyprus's current baseline – individual taxation, a targeted childcare-fee subsidy, short paternity leave, and a right to request flexible work – the highest-return moves are to add childcare places; modestly pay and reserve more parental leave for fathers; and embed flexible work in day-to-day practice. These target precisely the extensive margin where our CRE estimates locate the child penalty, while avoiding blunt instruments that the country already has or does not need.

7. Conclusion

Drawing on EU–SILC longitudinal data for Cyprus from 2018 to 2023 and pooled correlated random-effects models with individual–clustered standard errors, we assessed the child (motherhood) penalty on both the extensive margin of employment and the intensive margin of usual weekly hours.

Two broad patterns emerge. First, employment probabilities rise over the window for the population as a whole, and hours among those employed are remarkably stable. Fathers are consistently the most

[4] Welfare Benefits Administration Service (Deputy Ministry of Social Welfare) programme pages for childcare tuition/feeding subsidies: Subsidy Scheme for Children aged 4 and over (current cohort)

[5] https://www.gov.cy/en/service/participation-in-the-tuition-subsidy-scheme-for-children-over-the-age-of-4-and-up-to-the-limit-of-free-compulsory-pre-primary-education-application-submission-by-parents/

[6] Social Insurance Services (Ministry of Labour) statistical publications documenting the introduction and operation of the paternity allowance (from 1 Aug 2017): Social Insurance Services: Statistical Report 2021.

[7] Annual Report 2017.

[8] See the Department of Labour Relations page for the national implementation details and employer/employee guidance: Work–Life Balance for parents and carers.

attached to the labour market, followed by men without children. Mothers and women without children trail behind, with women without children generally at the bottom of the employment ranking. Second, when non-employment is counted as zero hours, group differences in total weekly hours mirror the employment ordering, indicating that much of the cross-group dispersion in hours is due to movements on the extensive margin.

The pandemic year 2020 stands out in the employment results. In the period specification, the interaction for $covid(2020) \times Mothers$ is negative and statistically significant, while the corresponding interactions for fathers and for women without children are not.

The predictive margins show that 2020 coincides with a dip in mothers' employment relative to their pre-trend, whereas the other groups rise or remain broadly stable. This pattern aligns with a temporary widening of the motherhood penalty concentrated on the extensive margin during the peak disruption. In contrast, conditional workweeks for those who remain employed change little across years for all groups, and differences between mothers and other groups among the employed are comparatively modest and stable. Together, these facts point to an employment-driven penalty in 2020 rather than a general compression of hours among employed mothers.

Several limitations remain. Annual data smooth within-year shocks, and EU–SILC does not measure school closures or childcare disruptions at high frequency. Heterogeneity by the age of the youngest child, sectoral teleworkability, and occupation could be explored further with additional data. Comparative work with structurally similar EU economies would also help benchmark magnitudes and persistence.

Overall, the concentration of the 2020 penalty on the extensive margin suggests that interventions that stabilise maternal employment during crises – reliable childcare and school-contingency provision, flexible scheduling, and policies that encourage a more equal sharing of childcare responsibilities, such as longer and better-compensated paternity leave – are likely to be more effective than measures focused solely on adjusting hours for those already employed. The gradual narrowing of the gap in 2021–2023 as services reopened is encouraging, but the fact that differences persist by 2023 indicates scope for durable support that reduces mothers' exposure to employment interruptions when shocks recur.

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Appendix A: Data and Variables

Population, time frame, and analytic views

We focus on the working-age population, restricting to individuals aged 20–64. To fa- cilitate interpretation around the pandemic and subsequent rebound, calendar years are grouped into three non-overlapping phases: a pre-pandemic period (2018–2019), the acute COVID year (2020), and a recovery phase (2021–2023). In addition, outcomes are pre- sented by a four-way "group" variable that crosses

sex with parental status: men without children, fathers, women without children, and mothers. These groupings are derived from harmonized indicators of sex and a parental-status flag available in the panel.

Outcome variables and harmonization across waves

Employment. The binary employment indicator is harmonized to accommodate EU– SILC questionnaire changes. From 2021 onward, we classify respondents as employed when PL032 equals 1 and as not employed otherwise (values 2–8). For 2020 and earlier, we use PL031, treating codes 1–4 as employed and all other observed codes as not employed. When this primary logic leaves the employment status missing, we adopt two transparent fallbacks: we set employment to one if the job-status variable PL035 indicates current work, or if a positive value is recorded for the usual-hours field; any remaining missing values are set to zero. This rule preserves a consistent employed/not-employed partition while avoiding spurious missingness created by instrument rotation across waves.

Usual weekly hours. We construct two measures. The *combined* hours variable equals the harmonized usual weekly hours when observed and is set to zero for non-employed observations, yielding an outcome that mixes the extensive and intensive margins and can be analyzed with OLS without dropping zeros. The *intensive* hours variable is the same harmonized usual-hours measure but is only used among employed respondents. At the raw-data level, EU–SILC rotated the hours instrument around the pandemic; in the harmonized extract, this is reconciled (e.g. PL060 in earlier years versus PL073 in later years), so that a single field is available for analysis.

Controls and transformations

Age enters the models via the correlated random effects (Mundlak) decomposition: for each person we compute the time average of age and subtract it from the observed value to obtain a within-person deviation. This produces a between component (the individual mean) and a within component (the deviation), allowing us to separate cross-sectional from longitudinal variation in a pooled framework.

Education is coded into four ordered categories—No/Primary, Lower Secondary, Upper or post-secondary non-tertiary, and Tertiary. For the CRE specification, we form indicator variables for the three upper categories (leaving No/Primary as the reference) and compute their person-specific means to serve as between-person controls.

Appendix B: Descriptive Statistics

In the employment sample (ages 20–64), the average employment probability rises from 67.6% in 2018 to 74.7% in 2023. Benchmarking mothers against fathers, the raw mother- hood employment gap is 19.5 percentage points in 2018 (68.7% for mothers versus 88.2% for fathers) and 16.5 percentage points in 2023 (75.0% versus 91.5%), with intermediate-

year gaps of 18.2 pp (2019), 20.8 pp (2020), 18.8 pp (2021), and 17.8 pp (2022). Thus, while aggregate employment drifts upward for all groups, the mother–father differential remains large and only gradually contracts after 2020. For context, men without chil- dren and women without children sit at the lower end of the employment distribution throughout (e.g., 2018: 57.3% and 57.0%; 2023: 69.1% and 64.7%), indicating a siz- able fatherhood premium and showing that mothers' employment rates exceed those of childless women in these data.

Among the employed, usual weekly hours are high and stable in levels, with a mild dip in 2021 and a

rebound thereafter: 38.48 (2018), 38.54 (2019), 38.56 (2020), 38.14 (2021), 38.57 (2022), and 39.19 (2023). The motherhood hours gap relative to fathers is sizeable and persistent, at 3.9 hours/week in 2018 (36.54 for mothers vs. 40.46 for fathers) and 3.6 hours/week in 2023 (37.08 vs. 40.69), ranging between about 3 and 4.3 hours over the window (4.25 in 2019; 3.91 in 2020; 3.58 in 2021; 2.99 in 2022). Compared with women without children, mothers also work fewer hours on average (e.g., 1.22 hours less in 2018 and 1.82 hours less in 2023), reinforcing the intensive-margin component of the motherhood penalty despite the overall recovery in hours.

In the employment sample, mean age inches up from 42.49 to 43.21 years and the female share hovers just above parity (52.9% to 53.4%), while the share of parents re- mains close to one half (51.8% to 50.6%). In the employed-only hours sample, average age similarly rises (43.06 to 43.87), the female share stays near 50%, and parental status declines moderately (59.2% to 55.8%). Educational attainment shifts toward tertiary degrees among the employed (from 48.9% to 53.3%), with a corresponding decline in no/primary education (from 7.1% to 5.2%), and modest changes in the middle categories. Taken together, the raw gaps indicate a persistent and quantitatively meaningful motherhood shortfall relative to fathers on both the extensive and intensive margins, alongside a gradual post-2020 catch-up in employment.

TABLE B.1: Employment descriptives per year

Year	N	Unique	Age	Female	Has child	Employed
2018	4717	4717	42.49	0.529	0.518	0.676
2019	4701	4701	42.73	0.535	0.508	0.697
2020	4552	4552	42.58	0.533	0.494	0.698
2021	4455	4455	42.91	0.536	0.502	0.716
2022	4141	4141	43.14	0.531	0.501	0.739
2023	5944	5944	43.21	0.534	0.506	0.747

Notes: Shares are means in [0,1].
Employed is the mean of the harmonized employment indicator in the employment sample (ages 20–64).

TABLE B.2: Employment descriptives per year × group

Year	Group	N	Employed	Female	Has child
2018	Men, no child	1128	0.573	0.000	0.000
	Fathers	1092	0.882	0.000	1.000
	Women, no child	1147	0.570	1.000	0.000
	Mothers	1350	0.687	1.000	1.000
2019	Men, no child	1113	0.611	0.000	0.000
	Fathers	1072	0.889	0.000	1.000
	Women, no child	1198	0.593	1.000	0.000
	Mothers	1318	0.707	1.000	1.000
2020	Men, no child	1132	0.636	0.000	0.000
	Fathers	995	0.897	0.000	1.000
	Women, no child	1170	0.598	1.000	0.000
	Mothers	1255	0.689	1.000	1.000

TABLE B.2 continued

Year	Group	N	Employed	Female	Has child
2021	Men, no child	1064	0.655	0.000	0.000
	Fathers	1002	0.896	0.000	1.000
	Women, no child	1153	0.623	1.000	0.000
	Mothers	1236	0.708	1.000	1.000
2022	Men, no child	1012	0.671	0.000	0.000
	Fathers	930	0.926	0.000	1.000
	Women, no child	1054	0.630	1.000	0.000
	Mothers	1145	0.748	1.000	1.000
2023	Men, no child	1423	0.691	0.000	0.000
	Fathers	1347	0.915	0.000	1.000
	Women, no child	1511	0.647	1.000	0.000
	Mothers	1663	0.750	1.000	1.000

Notes: Shares are means in [0, 1].
Employed is the mean of the harmonized employment indicator in the employment sample (ages 20–64).
Groups: Men (no child), Fathers, Women (no child), Mothers.

TABLE B.3: Employed-only descriptives per year

Year	N	Unique	Age	Female	Has child	Hours	ed1	ed2	ed3	ed4
2018	3190	3190	43.06	0.496	0.592	38.48	0.071	0.071	0.369	0.489
2019	3275	3275	43.08	0.501	0.576	38.54	0.070	0.075	0.379	0.476
2020	3178	3178	43.22	0.492	0.553	38.56	0.067	0.071	0.386	0.476
2021	3188	3188	43.61	0.500	0.556	38.14	0.064	0.068	0.379	0.489
2022	3060	3060	43.83	0.497	0.561	38.57	0.057	0.067	0.361	0.515
2023	4442	4442	43.87	0.501	0.558	39.19	0.052	0.066	0.349	0.533

Notes: Shares are means in [0,1].
Hours is mean usual weekly hours among employed.
Education shares (ed1–ed4) correspond to No/Primary, Lower Secondary, Upper/PSNT, and Tertiary.

TABLE B.4: Employed-only descriptives per year × group

Year	Group	N	Hours	Female	Has child
2018	Men, no child	646	39.05	0.000	0.000
	Fathers	963	40.46	0.000	1.000
	Women, no child	654	37.76	1.000	0.000
	Mothers	927	36.54	1.000	1.000
2019	Men, no child	680	38.95	0.000	0.000
	Fathers	953	40.56	0.000	1.000
	Women, no child	710	38.35	1.000	0.000
	Mothers	932	36.31	1.000	1.000
2020	Men, no child	720	39.11	0.000	0.000
	Fathers	893	40.43	0.000	1.000
	Women, no child	700	38.14	1.000	0.000
	Mothers	865	36.52	1.000	1.000
2021	Men, no child	697	38.87	0.000	0.000
	Fathers	898	39.78	0.000	1.000
	Women, no child	718	37.75	1.000	0.000
	Mothers	875	36.20	1.000	1.000
2022	Men, no child	679	39.30	0.000	0.000
	Fathers	861	39.79	0.000	1.000
	Women, no child	664	38.52	1.000	0.000
	Mothers	856	36.80	1.000	1.000
2023	Men, no child	984	40.26	0.000	0.000
	Fathers	1232	40.69	0.000	1.000
	Women, no child	978	38.90	1.000	0.000
	Mothers	1248	37.08	1.000	1.000

Notes: Shares are means in $[0, 1]$.
Hours is mean usual weekly hours among employed.
Groups: Men (no child), Fathers, Women (no child), Mothers.

Appendix C: Estimation Tables

This appendix reports the full set of coefficients for the year-by-year and period-by- period models. All standard errors are robust and clustered at the individual level. Education dummies use No/Primary as the omitted category; group dummies use Men without children as the base; year 2018 is the base year (for period models the base is pre= 2018–2019). Person-mean terms implement Wooldridge's CRE in unbalanced panels using equation-specific availability (see main text).

In the employment models, coefficients are in log-odds units; probability effects are shown in the figures and can be recovered via margins. In the hours models (OLS), coefficients are in hours/week. For any indicator D (group or year), the main effect captures the difference in the base year/base group; the interaction $D \times year$ (or $D \times period$) shows how that difference changes in that year (or period). CRE "person means" are included to control for correlation between time-invariant unobservables and

regressors; they aid identification of the within-person effects and are not a substantive outcome of interest.

The motherhood penalty in year t for employment is the difference between mothers and women without children in that year:

$$\Delta_t^{mom} = [\beta_{Mothers} + \beta_{t*Mothers}] - [\beta_{Women,no\ child} + \beta_{t*Women,no\ child}],$$

We report the associated standard errors and confidence intervals in the figures; tables list the underlying components.

Key patterns in the estimates. (i) Employment (CRE logit). Year coefficients are positive, indicating rising employment over 2018–2023 for the base group (men without children). Mothers have a persistently lower probability of employment than women with- out children in every year. The period interactions isolate 2020: the $covid(2020) \times Mothers$ term is negative and statistically significant (–0.272, $p < 0.01$), while the corresponding terms for fathers and women without children are smaller in magnitude and not significant. Consistent with the margins, the estimated motherhood employment gap is about –20.7 p.p. in pre, widens to –23.0 p.p. in 2020, and narrows to –20.7 p.p. in the recovery period (see the plotted contrasts).

(ii) Hours including zeros (CRE OLS). For total weekly hours (treating the non- employed as zero hours), the 2020 interactions for mothers are negative and significant (–2.46 hours in 2020), with further negative deviations in 2021 and 2023. The year- specific motherhood gap in total hours is large throughout (about –11.3 hours in 2018), widens in 2020 (–11.7 hours), and remains around –10.3 hours by 2023. These movements line up with the employment results, indicating that the 2020 dip in mothers' total hours operates mainly through the extensive margin (employment).

(iii) Hours among the employed (CRE OLS). Conditional on employment, year and interaction coefficients are small and mostly imprecisely estimated. The 2020 interaction for mothers is near zero and not significant (0.02 hours), and the period results show a stable motherhood gap among the employed of roughly –3.9 hours (pre), –3.7 hours (2020), and –3.2 hours (recovery). Taken together with (ii), this reinforces that the 2020 child penalty shows up primarily through reduced employment rather than shorter workweeks among those who stay employed.

In the employment models, tertiary attainment is strongly associated with higher employment (e.g., coefficient ≈ 2.14), and the positive person-mean terms for education indicate selection on time-invariant traits correlated with higher employment. In hours models, tertiary attainment is associated with higher total hours when zeros are included; among the employed, education effects are modest and imprecise once CRE terms are included. Coefficients on person means should not be over-interpreted: they serve to purge bias in the "within" estimates.

Across specifications, (a) employment rises over time for all groups, (b) mothers lag behind women without children by ~20–23 p.p. in employment, with the largest gap in 2020, and (c) conditional workweeks are relatively stable across groups and over time, so the child penalty in total hours is driven by the extensive margin.

TABLE C.1: Employment and Hours (CRE; clustered at individual level)

	Employment	Hours (incl. zeros)	Hours (employed only)
Year (base: 2018)			
2019.year	0.171**	1.298**	-0.161
	(0.067)	(0.604)	(0.328)
2020.year	0.304***	2.511***	-0.020
	(0.083)	(0.747)	(0.405)
2021.year	0.315***	2.496***	-0.223
	(0.093)	(0.831)	(0.411)
2022.year	0.317***	2.834***	0.179
	(0.096)	(0.850)	(0.417)
2023.year	0.421***	4.370***	1.171***
	(0.090)	(0.796)	(0.401)
Group (base: Men, no child)			
Fathers	1.630***	11.736***	1.233***
	(0.115)	(0.752)	(0.409)
Women, no child	-0.099	-1.275	-1.207***
	(0.090)	(0.822)	(0.468)
Mothers	0.223**	0.472	-2.507***
	(0.089)	(0.767)	(0.416)
Year × Group			
2019 × Fathers	-0.108	-1.001	0.244
	(0.121)	(0.758)	(0.410)
2019 × Women, no child	-0.032	0.097	0.705
	(0.095)	(0.847)	(0.488)
2019 × Mothers	-0.053	-0.617	-0.068
	(0.089)	(0.756)	(0.427)
2020 × Fathers	-0.155	-2.006**	-0.024
	(0.155)	(0.935)	(0.501)
2020 × Women, no child	-0.156	-1.219	0.331
	(0.118)	(1.051)	(0.571)
2020 × Mothers	-0.299***	-2.460**	0.016
	(0.113)	(0.956)	(0.525)
2021 × Fathers	-0.193	-2.698***	-0.468
	(0.169)	(1.034)	(0.527)
2021 × Women, no child	-0.153	-1.320	0.147
	(0.129)	(1.145)	(0.597)
2021 × Mothers	-0.243*	-2.173**	-0.075
	(0.127)	(1.063)	(0.537)
2022 × Fathers	0.166	-1.939*	-0.853*
	(0.185)	(1.028)	(0.518)
2022 × Women, no child	-0.148	-1.110	0.502
	(0.131)	(1.165)	(0.582)
2022 × Mothers	-0.079	-0.899	0.149
	(0.131)	(1.074)	(0.533)
2023 × Fathers	-0.124	-3.269***	-0.902*
	(0.163)	(0.964)	(0.502)
2023 × Women, no child	-0.174	-1.755	-0.130
	(0.121)	(1.077)	(0.555)
2023 × Mothers	-0.198*	-2.285**	-0.536
	(0.120)	(0.993)	(0.505)

TABLE C.1 (continued)

	Employment	Hours (incl. zeros)	Hours (employed only)
Age	-0.037**	-0.247**	0.023
	(0.016)	(0.112)	(0.060)
Lower secondary	-0.028	-0.618	-0.329
	(0.085)	(1.740)	(1.971)
Upper sec./post-sec.	0.433	3.697	-2.191
	(0.807)	(6.582)	(1.997)
Tertiary	2.136***	18.243***	2.005
	(0.823)	(6.692)	(2.483)
Constant	-0.880***	13.316***	38.953***
	(0.122)	(1.030)	(0.525)
Observations	28303	28303	20333
Wald chi2 / F	1517.04		
R2 (OLS)		0.113	0.048
Pseudo R2 (logit)	0.1072		
Log pseudolikelihood	-15021	-120969	-68850

Standard errors in parentheses; clustered at the individual level.
*, **, *** denote significance at the 10%, 5%, and 1% levels.