External Safety Enforcement

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Introduction

Motivation

- Workplace injuries and illnesses are costly
  - An average of 4% of a country's GDP globally (Takala et al. 2014)
  - Annual economic loss of $250 billion in the US (Leigh 2011)
- Occupational safety and health (OSH) regulations as an essential solution (Lanoie 1992; ILO 2019; Johnson et al. 2024)
- A discrepancy between regulations and actual implementation due to imperfect *within-firm* enforcement (Brown et al. 2000; Robson et al. 2007; Fan et al. 2022)
  - Perceptions about OSH as an unnecessary burden (Viscusi 1979; Masi and Cagno 2015; EU-OSHA 2021)
  - Lower costs as economic incentives (Fan et al. 2022)
  - Meeting production demands (Brown et al. 2000; Pagell et al. 2020)
  - Dysfunctional safety monitoring and demanding (Pouliakas and Theodossiou 2013)
- Question about the effectiveness of *external* enforcement (Lindoe et al. 2001; Levine et al. 2012)
  - Causal evidence is important but very limited

Introduction

This research

- Evaluate *causal* effects of an external safety enforcement policy
  - Direct effects on worker health (injuries)
  - Spillover effects on spousal health (mental health problems)
- Norway provides a unique setting as a policy laboratory: Norwegian Regional Safety Representative Scheme (RVO)
  - The scheme was established to improve safety, health and working conditions at regulated sectors through regular external visits and checks
  - Quasi-experimental variation in exposure across industries and years
    - Regulated industries: Construction (first introduction in 1981); and catering, accommodation, cleaning (reform in 2011)
    - Unregulated industries: Other industries
  - This research focuses on catering (high-risk) and accommodation (low-risk) as treated industries
- High-quality administrative data with entire population registers (linked employer-employee, health, population, education)
- Employ the Synthetic Control Method (SCM) for estimating the counterfactual SC for a treated industry
  - Use a panel sample at the industry level (2006-2017)

Policy background

Norwegian Regional Safety Representative Scheme

- RVO is a compulsory tripartite arrangement in Norway aimed at improving health, safety, and working conditions in vulnerable, high-risk sectors (small and highly mobile workplaces without adequate safety representation)
- Purpose and mandate: All workplaces comply with the provisions of the Norwegian Working Environment Act
  - Gap filling: Targeting workplaces that do not have an elected in-house safety representative (verneombud) or where existing safety work is insufficient
  - Preventative work: Identifying risk factors, providing advice, and suggesting solutions to occupational health and safety problems
  - Enforcement powers: Where no in-house safety representative exists, the RVO has the same legal authority as one, including the right to halt work if they believe there is an immediate and serious danger to the life or health of employees
  - Mediation and reporting: RVOs point out deficiencies to the company's management and employees. If these identified deficiencies are not followed up, the RVO will notify the Norwegian Labour Inspection Authority

Policy background

Norwegian Regional Safety Representative Scheme

- Operations: The scheme operates independently of the Norwegian Labour Inspection Authority's general activities, functioning as a proactive safety body appointed by the social partners (trade unions)
  - Unannounced visits to worksites
  - RVOs are appointed by the relevant trade union federations representing workers in the specific industries
  - RVOs must typically have several years of practical experience in the industry they are appointed to cover, along with prior experience as an employee representative or safety representative
  - RVO scheme is financed primarily by annual fees levied on all covered businesses within the respective sectors. This fee is regulated and mandatory under the Working Environment Act.
- RVO differs the company's elected Safety Representative (Verneombud–VO)

Policy background

Norwegian Regional Safety Representative Scheme

- Scope and covered industries
  - Building and construction industry (1981): High risk of accidents, constantly changing work sites, and a transient workforce
  - Catering, accommodation, and cleaning industries (extended in 2011/2013): High risk of irregular working conditions, low union densities, and health hazards
- Compulsory participation for all businesses, including sole proprietorships (one-person businesses), that operate within these defined industries

Data

Population-wide administrative registers on Norwegian residents

- Norwegian State Register of Employers and Employees (2002-2017)
  - Complete information on all workers ages 15-75 working for all establishments
  - Statistics Norway's 2007 industry grouping classification (SN 2007) to construct 2-digit industry codes
- Norwegian Control and Distribution of Health Reimbursement Database Register (KUHR) (2006-2019)
  - Primary care services with specific types of medical consultations recorded by GPs
  - International Classification of Primary Care (ICPC-2) to construct health outcomes
- Other registers: Central Population Register, National Education Register
  - Demographic and socioeconomic information

Data

Sample restriction and variables of interest

- Sample restriction of individual workers and their spouses
  - Construct a panel sample of workers (ages 15-75) employed 2006-2017
    - Based on all individuals who are employed at least once during the pre-scheme period 2006-2010
    - Exclude all individuals who first enter employment in 2011-2017 to prevent selection into the treatment due to changes in the composition of new entrants
  - Spouses of these workers are used to construct a panel sample of spouses
    - Exclude spouses working in the same industry as workers
- Individual-level panel dataset is collapsed to create an industry-level balanced panel dataset (2006-2017) for the analysis
- Outcomes of interest
  - Worker health: Shares of worker injury
  - Spousal health: Shares of spousal psychological diagnosis

Methodology

Synthetic control method (SCM): Estimation

- SCM estimates treatment effects by constructing a counterfactual trajectory for a regulated industry as a weighted combination of untreated donor industries
- Y_{it} is the observed outcome for industry i at year t, with potential outcomes Y_{it}^N (no treatment) and Y_{it}^I (with treatment). The treatment effect for the treated industry $i =$ treated at time $t > T_0$ is

$$\tau_t = Y_{\text{treated},t}^I - Y_{\text{treated},t}^N \tag{1}$$

  - where T_0 is the last pre-treatment period
- $Y_{\text{treated},t}^N$ is unobserved after T_0,n and it is estimated as a SC

$$\hat{Y}_{\text{treated},t}^N = \sum_{j \in \mathcal{D}} w_j Y_{jt} \tag{2}$$

  - $\mathcal{D}$ is the set of donor units
  - $\mathbf{W} = (w_1, \ldots, w_{|\mathcal{D}|})$ is a vector of nonnegative weights ($w_j \geq 0$ and $\sum_{j \in \mathcal{D}} w_j = 1$)
- Estimated treatment effect at time $t > T_0$ is the post-treatment gap

$$\hat{\tau}_t = Y_{\text{treated},t} - \hat{Y}_{\text{treated},t}^N \tag{3}$$

Methodology

Synthetic control method (SCM): Inference

- Causal inference is based on placebo tests: the treatment is hypothetically reassigned to each unit in the donor pool to construct a reference distribution of treatment effects
- placebo *p*-value is measured as the fraction of placebo effects that are at least as large in absolute value as the estimated effect for the treated unit

$$p - value = \frac{1}{N} \sum_{j \in \mathcal{D}} \mathbf{1}\left(|\hat{\tau}_j| \geq |\hat{\tau}_{\text{treated}}| \right) \tag{4}$$

- Standardized *p*-value is used for causal inference and defined as

$$p - value^{\text{std}} = \frac{1}{N} \sum_{j \in \mathcal{D}} \mathbf{1}\left(\tilde{\tau}_j \geq \tilde{\tau}_{\text{treated}} \right) \tag{5}$$

  - Root mean squared prediction error in the pre-treatment period is used to adjust for the quality of the pre-treatment fit (Abadie et al. 2010, 2015) $\text{RMSPE}_i^{\text{pre}} = \sqrt{\frac{1}{T_0} \sum_{t=1}^{T_0} \left(Y_{it} - \hat{Y}_{it} \right)^2}$
  - Standardized treatment effect is then given by $\tilde{\tau}_i = \frac{|\hat{\tau}_i|}{\text{RMSPE}_i^{\text{pre}}}$

Methodology

Selection of industries

Industry	Industry
(a) Treated industries	
55 – Accommodation	56 – Catering
39/81.2 – Cleaning (including environmental cleaning)	
(b) Untreated industries	
01 – Crop, animal, hunting, related	50 – Water transport
02 – Forestry, logging	51 – Air transport
03 – Fishing, aquaculture	52 – Warehousing, transport support
05/06 – Coal, gas, petroleum extraction	53 – Postal, courier
07/08 – Metal ore, other mining	58 – Publishing
09 – Mining support	59 – Film, video, music publishing
10 – Food manufacturing	60 – Broadcasting
11/12 – Beverages, tobacco	61 – Telecommunications
13 – Textile manufacturing	62 – Information technology consultancy
14/15 – Clothing, leather	63 – Information services
16 – Wood manufacturing (except furniture)	64 – Financial services (excluding insurance)
17 – Paper manufacturing	65 – Insurance, pension funding
18 – Printing, media reproduction	66 – Financial, insurance support
19 – Coke, petroleum refining	68 – Real estate
20 – Chemical manufacturing	69/70 – Legal, accounting, headquarters consultancy
21 – Pharmaceutical manufacturing	71 – Architecture, engineering
22 – Rubber, plastic manufacturing	72 – Research, development
23 – Non-metallic mineral manufacturing	73 – Advertising, market research
24 – Basic metal manufacturing	74 – Professional, scientific, technical
25 – Fabricated metal (excluding machinery)	75 – Veterinary
26 – Computer, electronic, optical	77 – Rental, leasing
27 – Electrical equipment	78 – Employment services
28 – Machinery manufacturing	79/80 – Travel, security
29 – Motor vehicles, trailers	81 – Building, landscape services
30 – Other transport equipment	82 – Administrative, support services
31 – Furniture manufacturing	84 – Public administration, defense
32 – Other manufacturing	85 – Education
33 – Machinery repair, installation	86 – Human health
35 – Electricity, gas, air conditioning	87 – Residential care
36 – Water collection, treatment, supply	88 – Social work (no accommodation)
37 – Sewerage	90 – Arts, entertainment
38 – Waste collection, treatment, disposal	91 – Libraries, archives, museums, culture
41 – Building construction	92 – Gambling, betting
42 – Civil engineering	93 – Sports, recreation
43 – Specialized construction	94 – Membership organizations
45 – Motor vehicle sales, repair	95 – Computer, household goods repair
46 – Wholesale trade (excluding vehicles)	96 – Personal services
47 – Retail trade (excluding vehicles)	97/99 – Private households, international organizations
49 – Land transport, pipelines	

Methodology

Selection of industries

- Excluding industries affected by potential confounding policies
  - Collective minimum-wage standards in 2011
  - Cleaning industry is excluded (Jordfald and Svarstad 2020)
- Excluding 5 contaminated or spillover industries from control industries to ensure a clean donor pool
  - Potential contamination channels arise through labor mobility (transferring safety practices via subcontracted workers), supply-chain pressure (where suppliers face client-driven standards), physical overlap (e.g., casinos inside hotels or catering falling under shared RVO visits), and regulatory diffusion via various agreements
- Final sets of industries
  - Treated industries: Catering and accommodation
  - Control industries: 72 unregulated industries

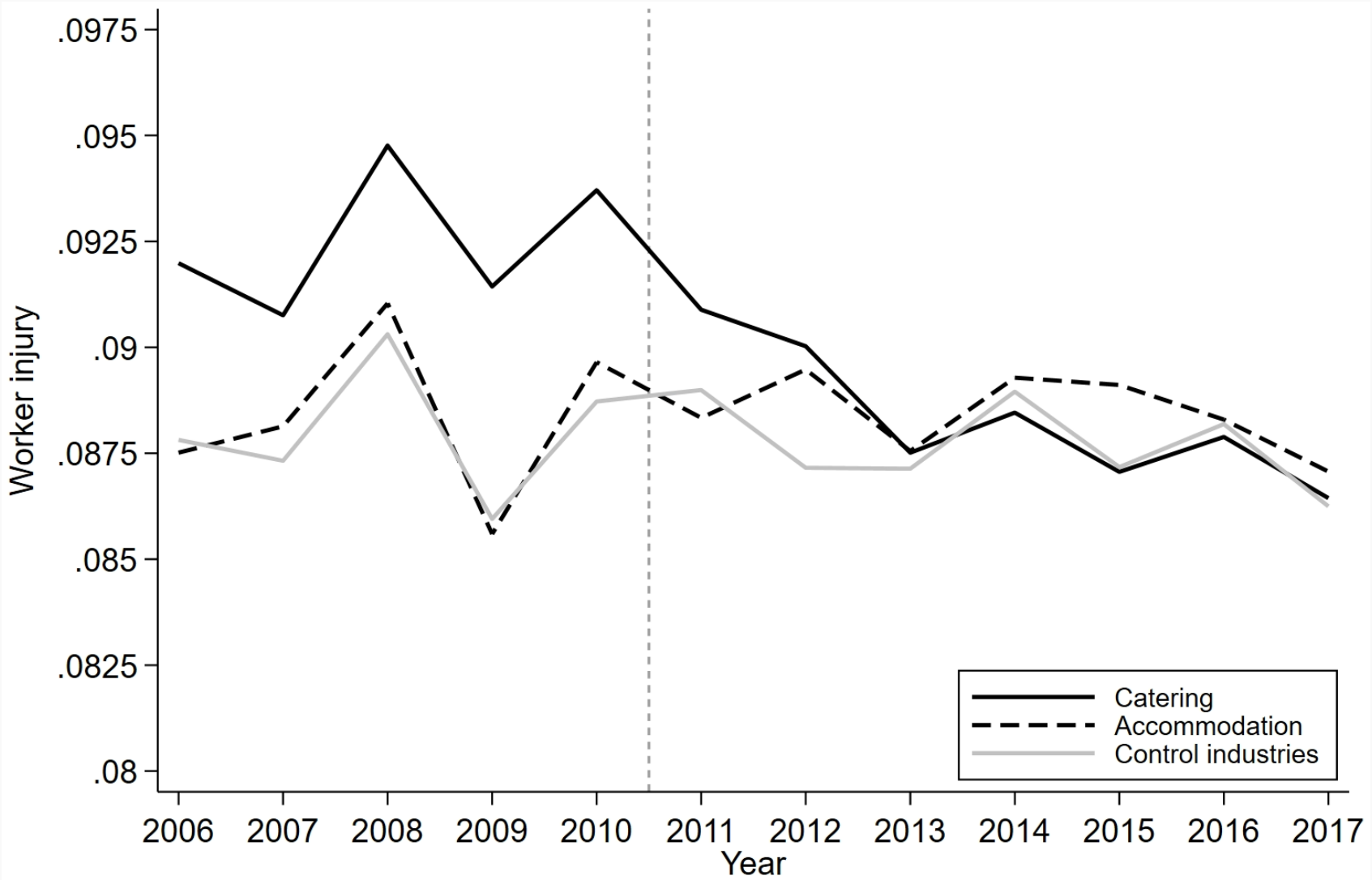
Methodology

Choice of predictors

- Baseline sets of predictors (over the pre-scheme period)
  - Average health outcome (2006–2010)
  - Average lagged health outcome (2007–2010)
- Reasons
  - Avoiding overfitting for SC (Abadie 2021)
  - Provide significant predictive power for SCM predictors (Doudchenko and Imbens 2016), lagged health status serves as a proxy for health dynamics (Bound et al. 1999; Benitez-Silva and Ni 2008; White 2023)
  - Additional covariates are unnecessary when pre-treatment outcomes are included (Botosaru and Ferman 2019; Kaul et al. 2022)

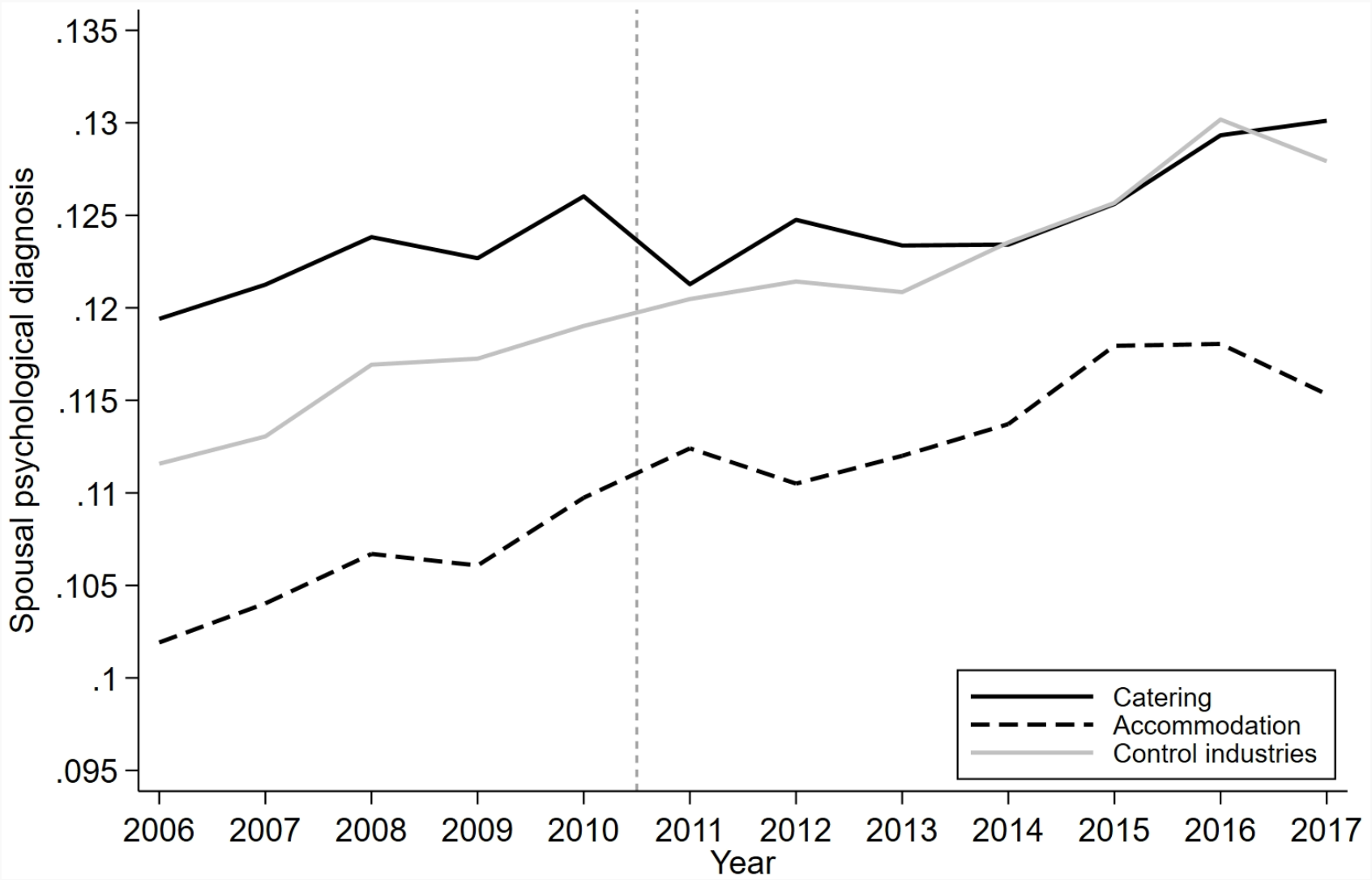
Descriptive evidence

Worker injury



Descriptive evidence

Spousal psychological diagnosis

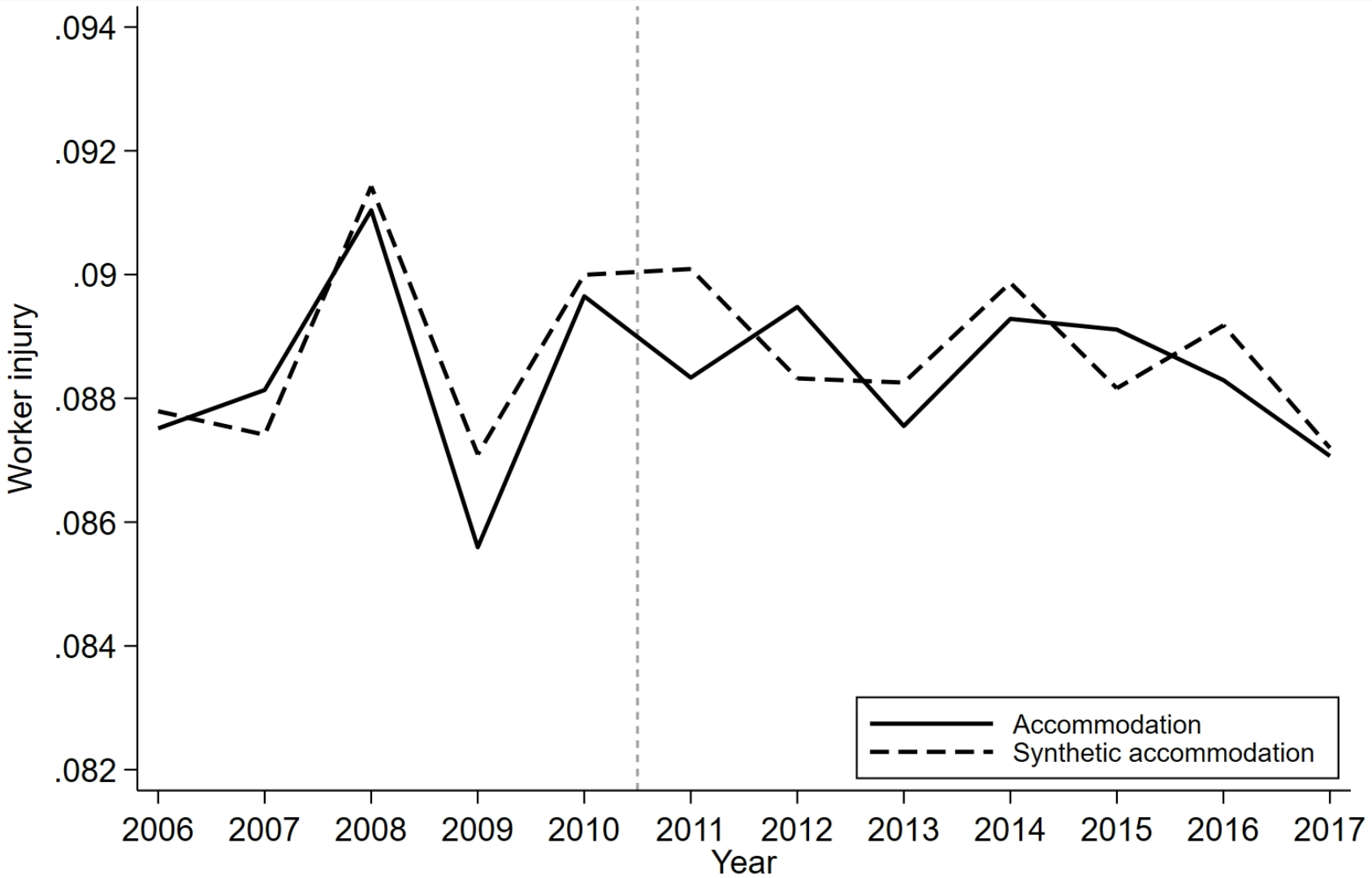


Direct effects on worker injury

Catering

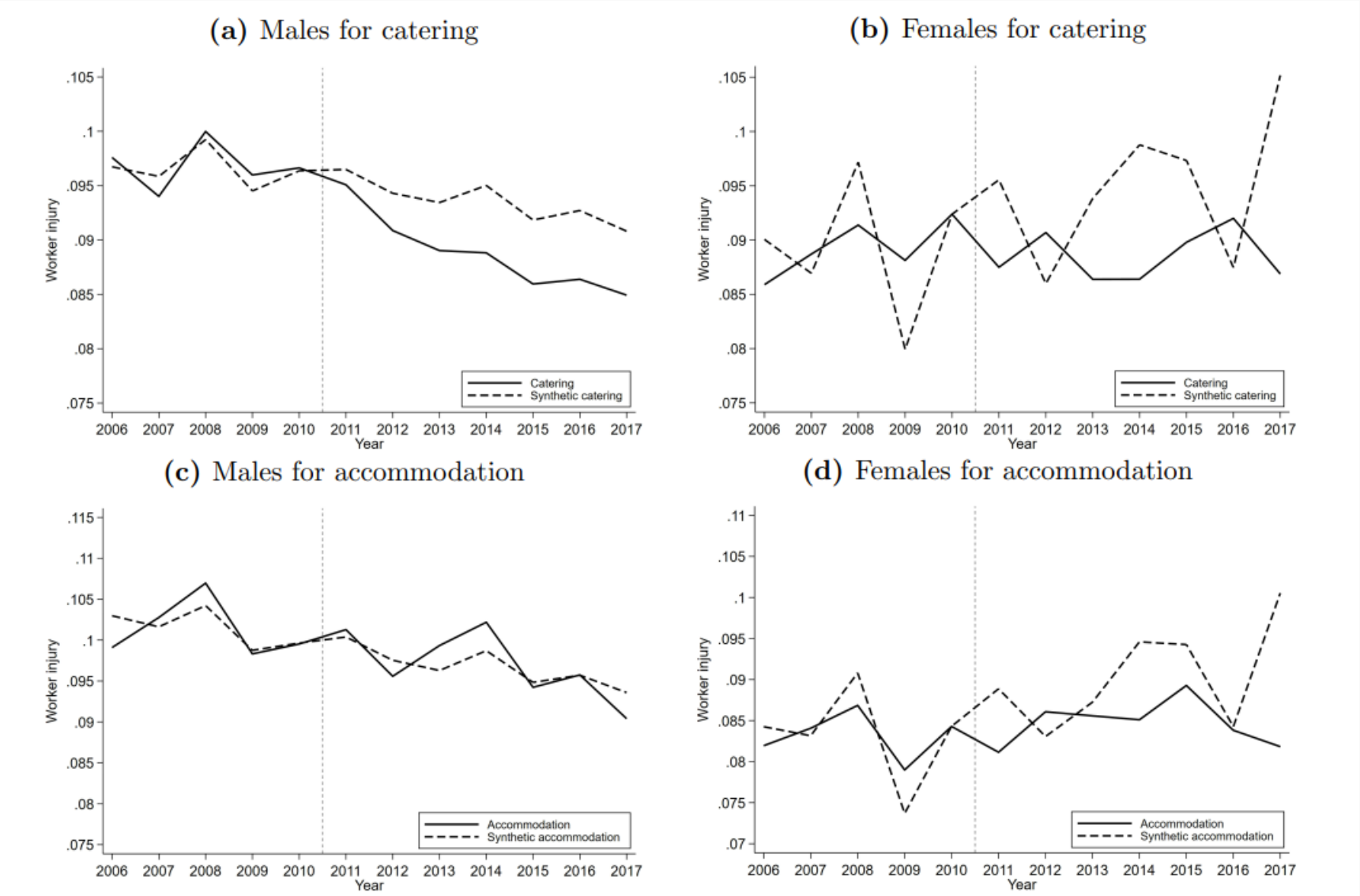
Direct effects on worker injury

Accommodation



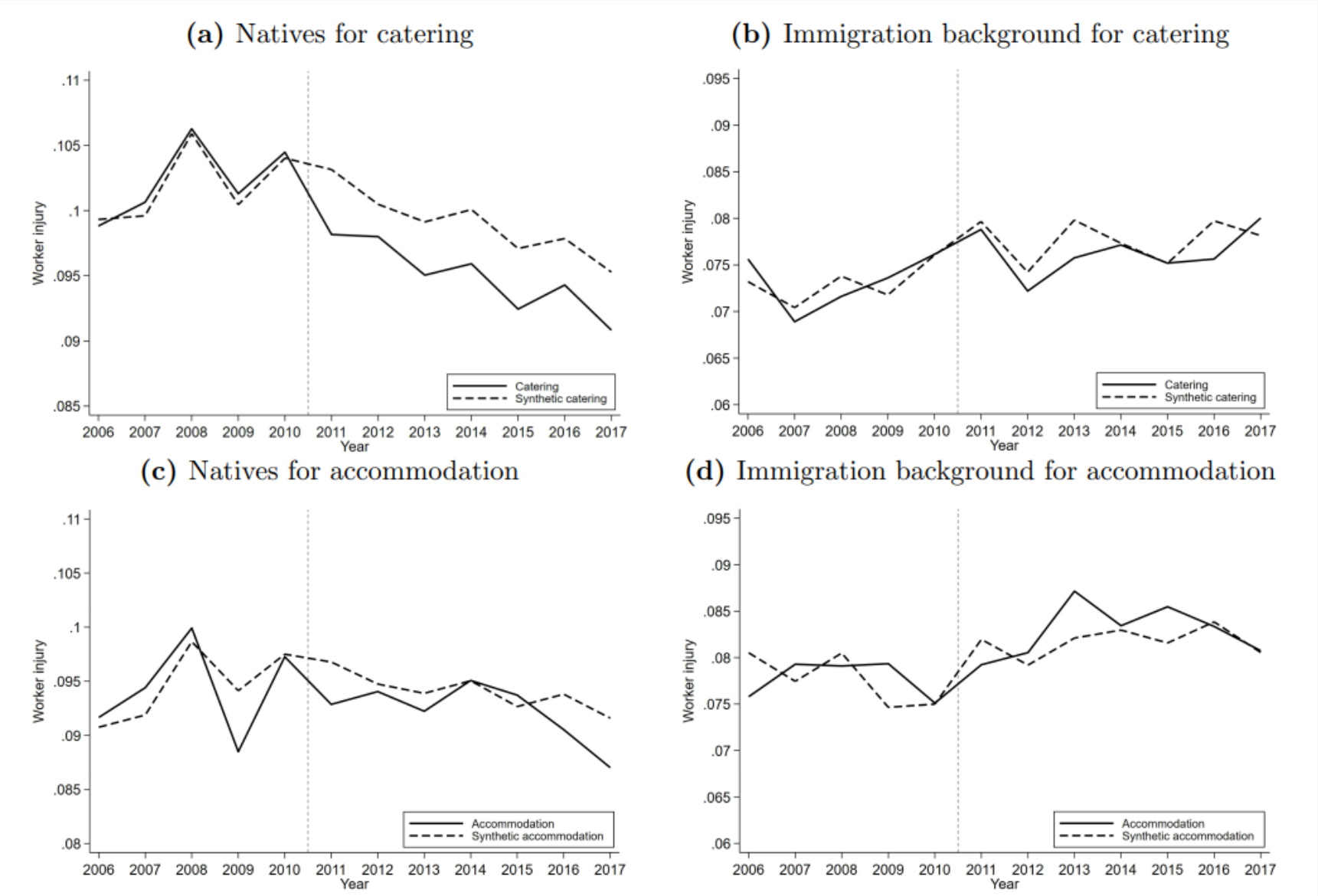
Direct effects on worker injury

Heterogeneity by genders



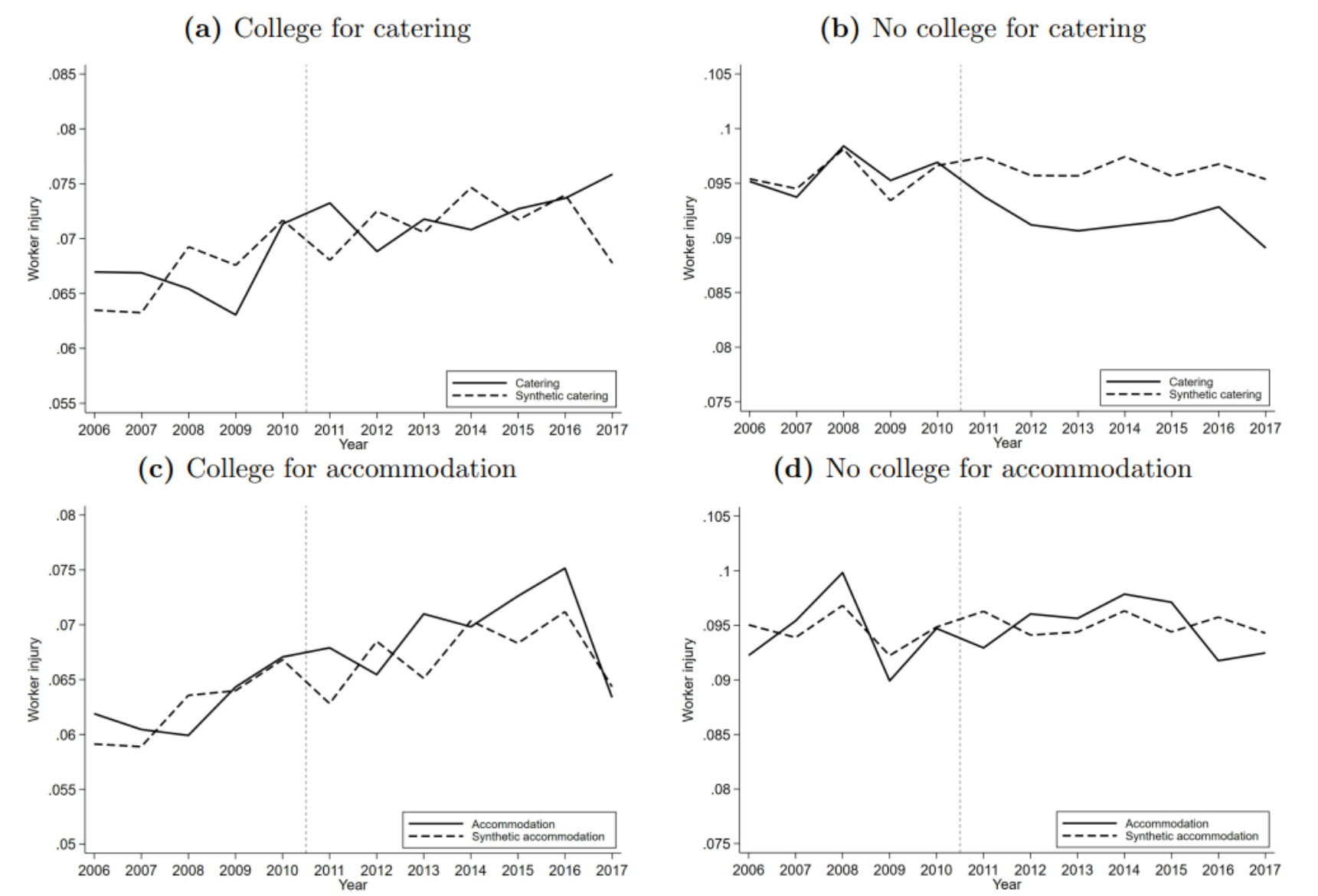
Direct effects on worker injury

Heterogeneity by immigration background



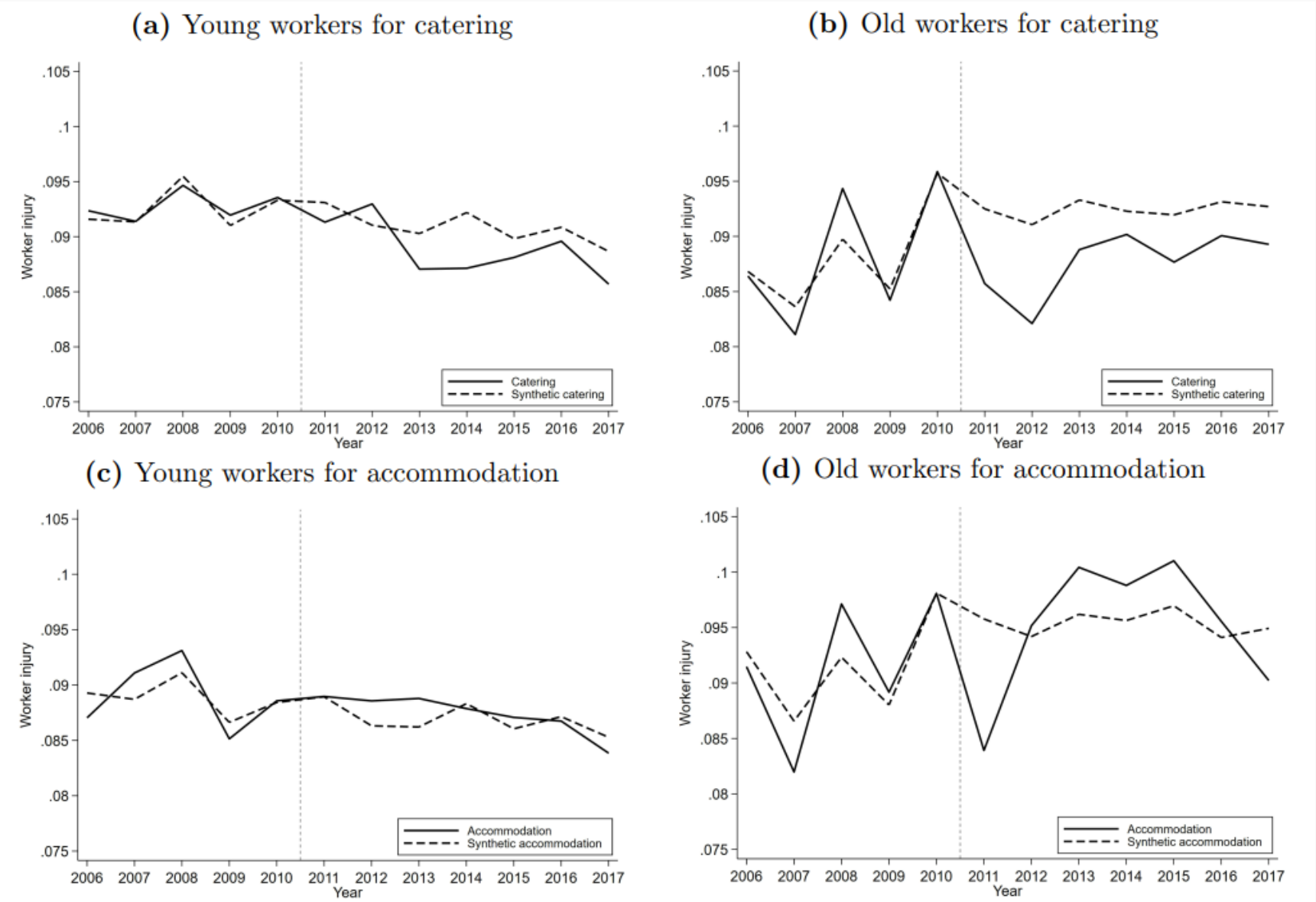
Direct effects on worker injury

Heterogeneity by education



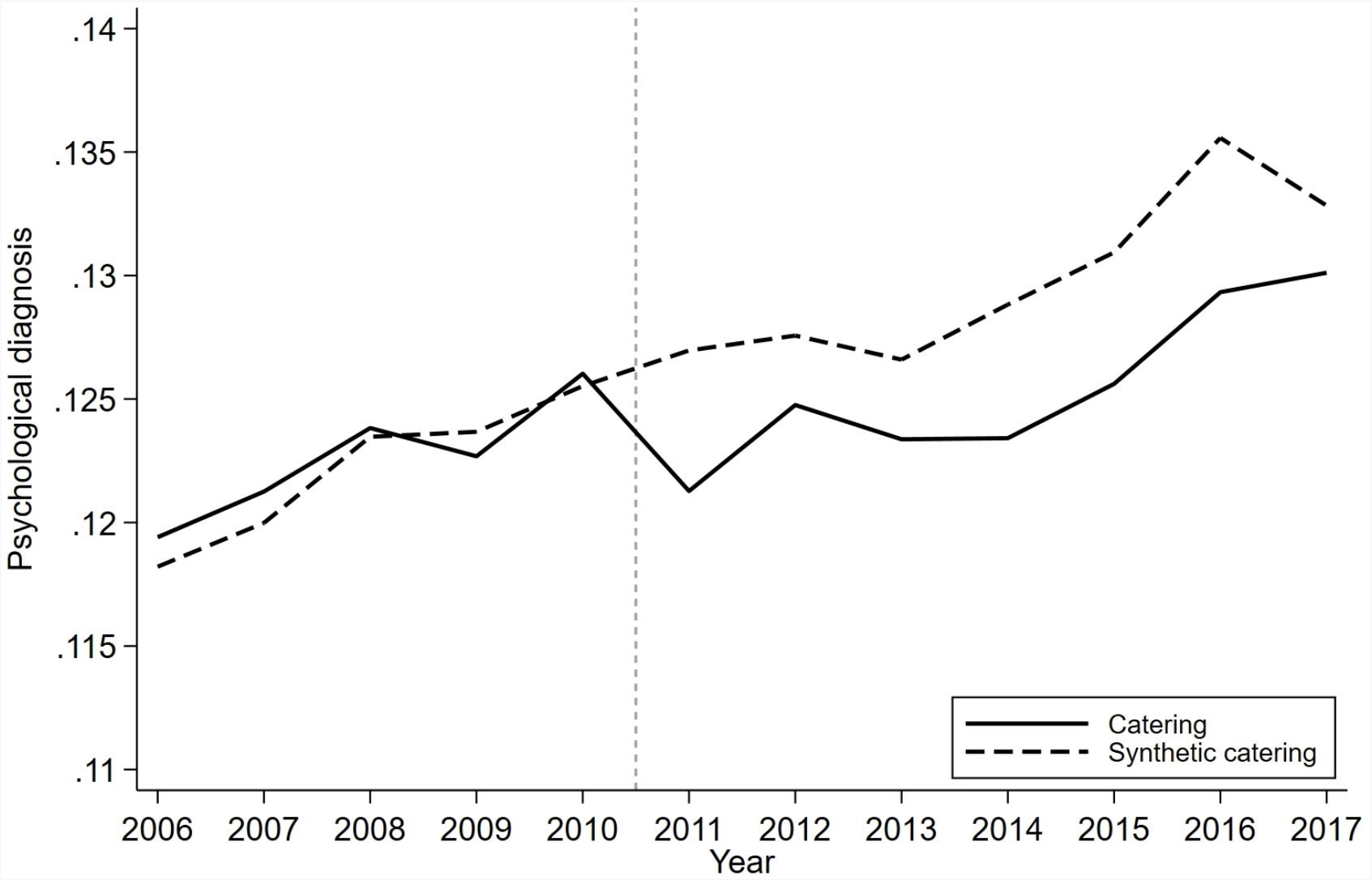
Direct effects on worker injury

Heterogeneity by age groups



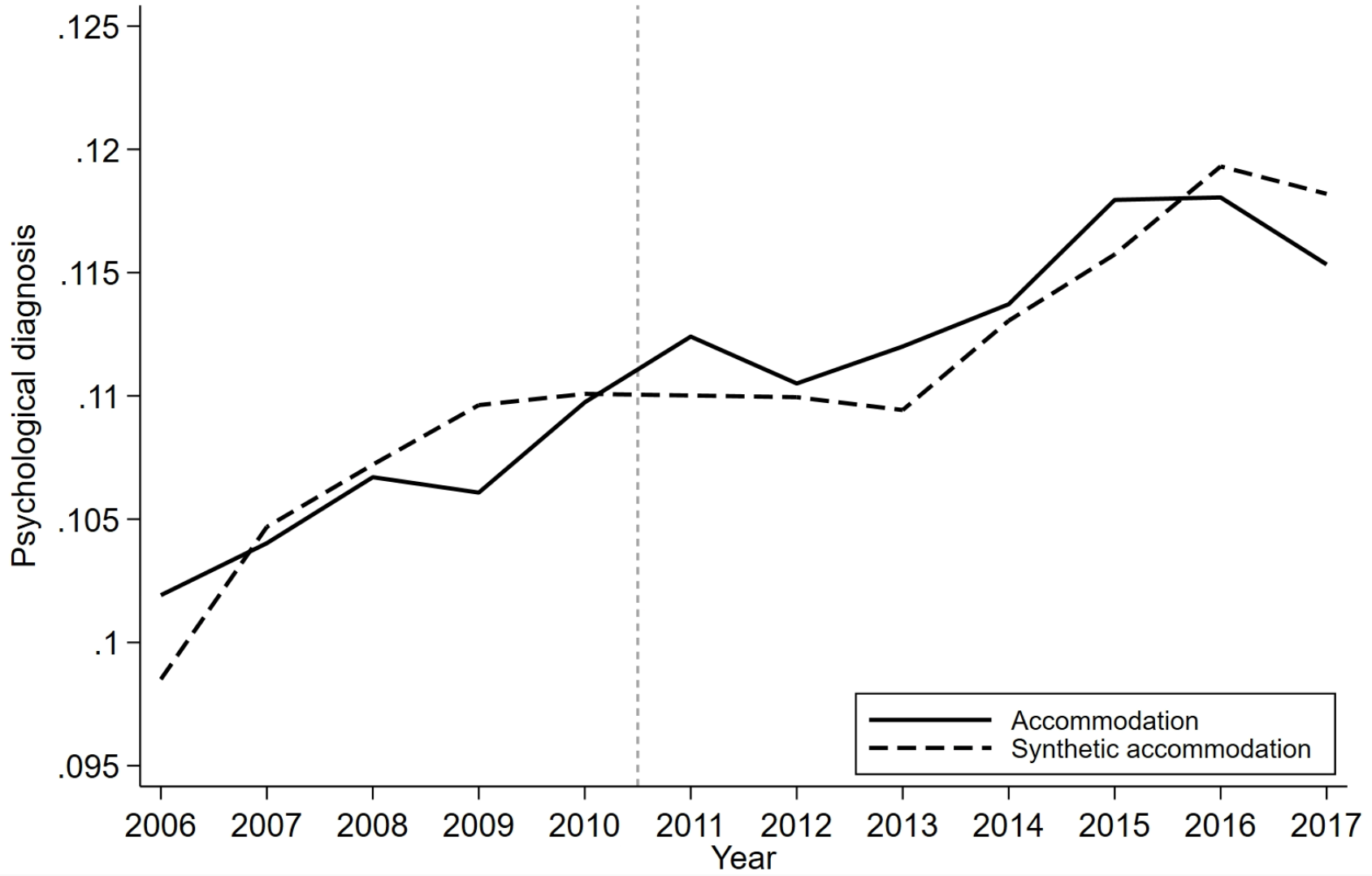
Spillover effects on spousal psychological diagnosis

Catering



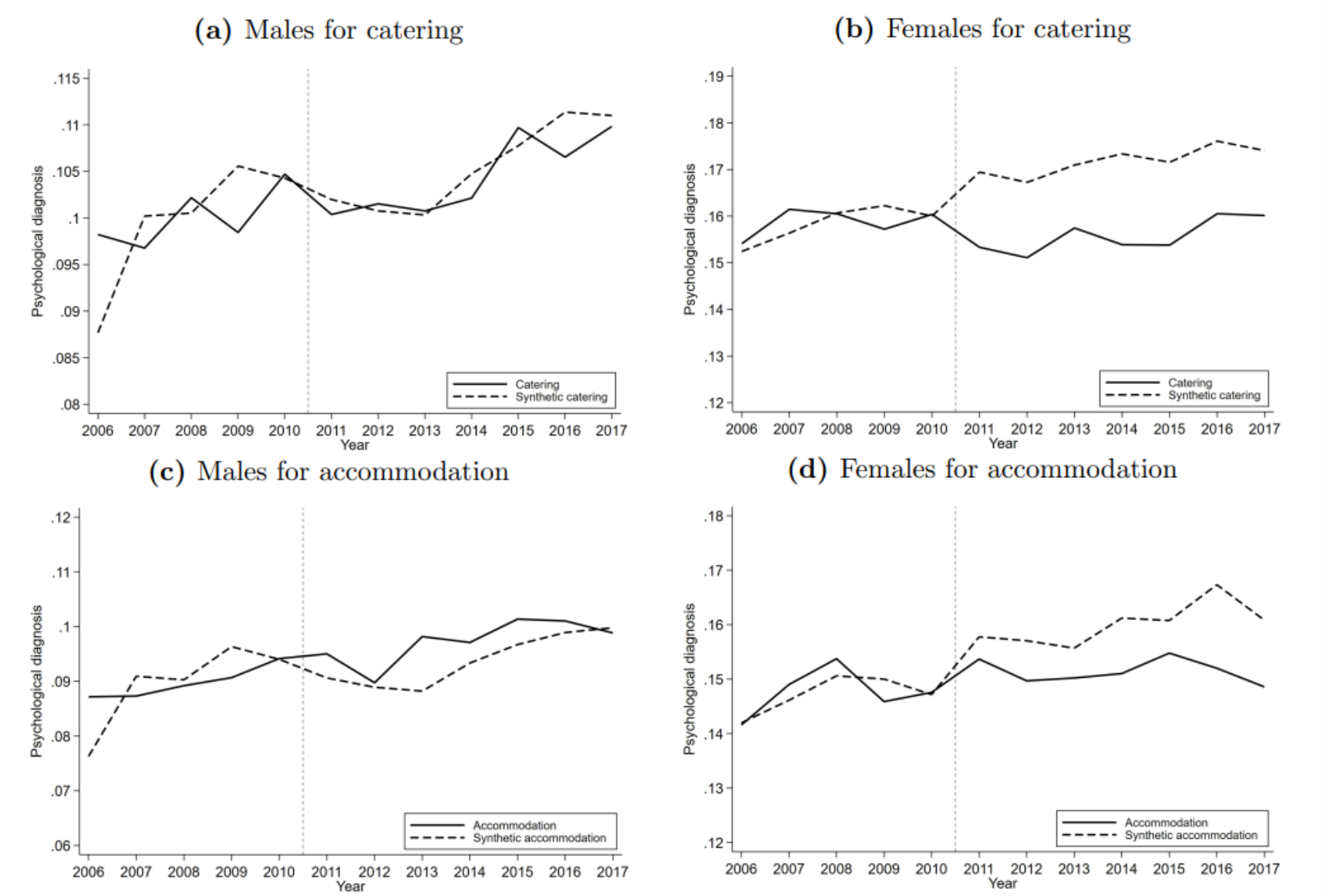
Spillover effects on spousal psychological diagnosis

Accommodation



Spillover effects on spousal psychological diagnosis

Heterogeneity by spousal genders



Placebo, robustness, and potential threats

Validity

- Placebo tests
  - In-industry placebo tests
  - In-time placebo tests
- Robustness checks
  - Leave-one-out robustness checks
  - Alternative donor pools
  - Alternative sets of predictors
- Post-scheme/pre-scheme Mean Squared Prediction Error (MSPE) ratios
- Potential threats
  - Selection into the treatment by worker mobility (industry size)
  - Selection into the treatment by spouse composition (having a spouse, a spouse at work)
  - Placebo outcomes (spousal injury)

Conclusion

- This research evaluates the direct and spillover health benefits of a workplace safety enforcement policy in Norway using high-quality administrative data
- Effects are heterogeneous across the treated industries with high versus low pre-scheme health risks
  - An annual reduction of 0.31 ppts (-3.4%) on worker injury in the catering industry
  - An annual reduction of 0.45 ppts (-3.5%) on spousal psychological diagnosis in the catering industry
  - No significant effects for accommodation (low-risk)
- Effects are heterogeneous across socioeconomic groups
  - Effects on worker injury in the catering industry concentrated among males, natives, low-educated, and young workers
  - Effects on spousal psychological diagnosis in the catering concentrated among female spouses
  - No significant effects for accommodation (low-risk)

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