Child Penalties in Time Use: A Global Perspective

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Outline

1. Motivation
2. Data & Methodology
3. Children & parental time investments
4. Parenthood & gender specialisation in time use
5. Welfare Impacts of Gender Specialisation

The impact of children on time use

The arrival of children drives large changes to household behavior:

- Parental investment in human K formation (Becker, 1960)
  - Patterns vary widely across the world (Doepke and Tertilt, 2018)
- Large gender differences in labor market trajectories
  - Child penalties explain most of gender inequality around the world (Kleven et al, 2019; Kleven et al, 2025)
- Impacts on household welfare
  - E.g.: via impacts on leisure (Aguiar and Hurst, 2007), bargaining power (Doepke and Kindermann, 2010); relationship dissolution (Deschamps, 2025)

The impact of children on time use

- Impact of childbirth on different dimensions underpinned by within-household **changes in time allocation**

- Existing evidence suggests large changes with important gender differences
  - Aguilar-Gomez et al (2025); Cuevas-Ruiz et al (2025)

- Our project:
  - Takes agenda to a **global** scale to understand its relationship with economic development
  - Consider fine grained changes in **detailed** activities to underpin mechanisms

The impact of children on time use

We build a unique **global** harmonized repository of time use data to investigate:

- How does the allocation of activities within the household changes with the arrival of a child?
  - → Particular focus on intra-household gender specialization
- How does this pattern vary across countries and over time?
  - → Global coverage including historical datasets
  - → Systematic patterns across path of development
- How does gender differences in the allocation of time shape inequality in labor market?
  - → Micro-foundations of mechanism behind child penalties

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Data: building a global map of time use

Partnership with Centre for Time Use Research (CTUR-UCL)

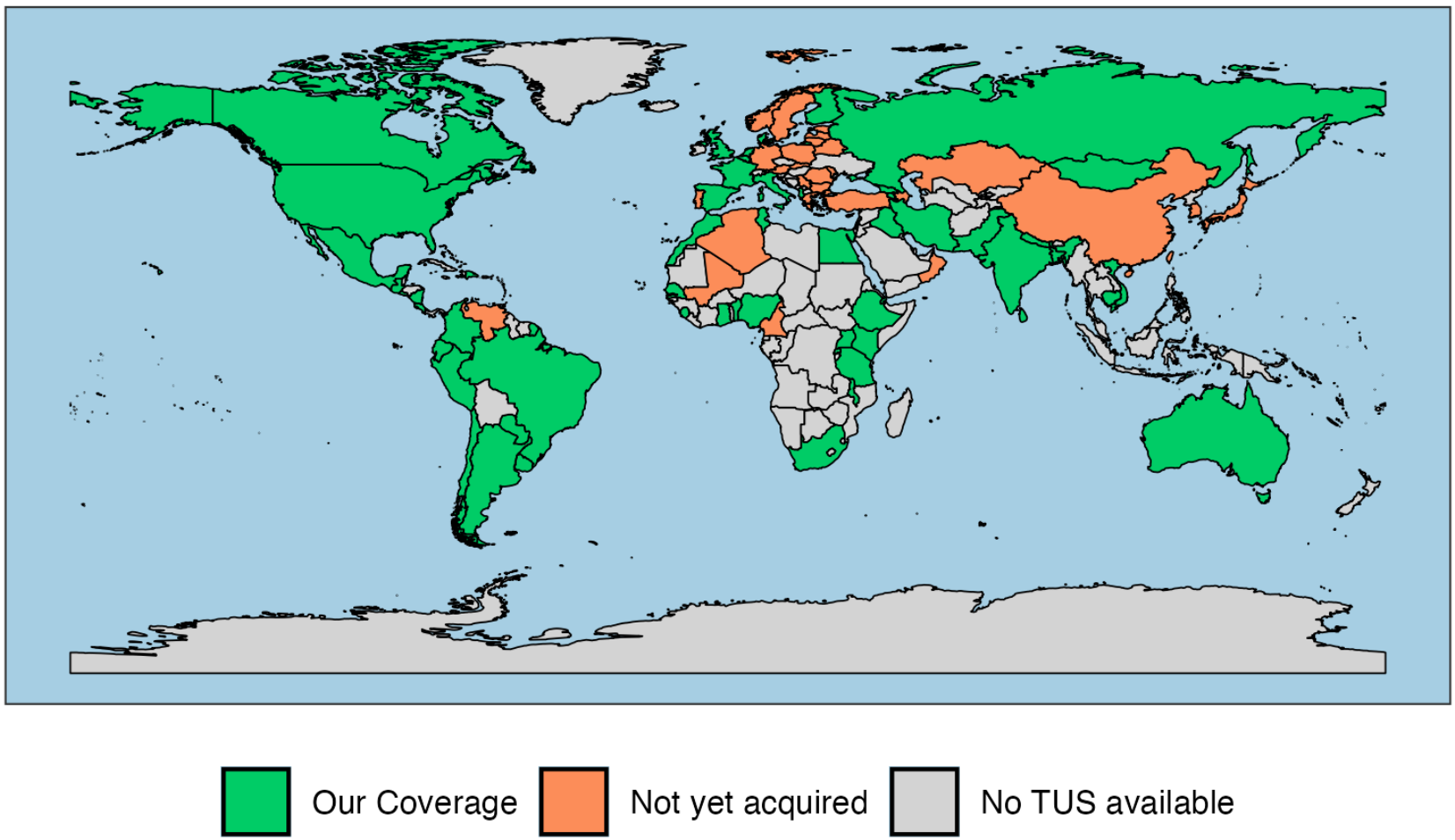
We create **unique global repository** of time use microdata covering 88 countries

- This version: initial results with 14 countries

We combine and harmonize:

- Existing cross-country harmonized time-use data:
  - e.g.: MTUS, HETUS
  - Re-harmonization from individual country files for consistent time categories
- Individual country-level time diaries
- Country-level household surveys with information on time-use

Data: building a global map of time use



Harmonizing time diaries across countries:

Country-level time use data converted to *long diary format*.

- Unit of observation:
  - Time diaries: individual x 15min slot with corresponding activity
  - Household surveys: an individual x activity with time duration

Country-specific activities categorized in **3-level hierarchy**:

- **1-digit codes**:
  - Active Time - including market work and home production
  - Leisure - including self-care
  - Education
- **2-digit codes**: broad sub-categories
  - e.g.: paid work, care work, house chores, formal education
- **3-digit codes**: granular types
  - e.g.: childcare, production of goods for own consumption, cleaning and cooking, sleep

Categories are mutually exclusive and sum to the 1,440 minutes of the day.

Scaling Harmonization with LLMs

Challenges of Manual Task Harmonization

- Labor-intensive and time-consuming annotation
- Inherent noise: human coders may disagree on ambiguous labels
- Difficult to scale rapidly to new surveys and survey waves

LLM-Powered Classification Pipeline

- Leverage the ChatGPT API to assign hierarchical task labels automatically
- Ensemble-style approach:
  - Run multiple iterations of the LLM classification model
  - Select the most frequent label to mitigate hallucinations
- Classification runtime reduced by orders of magnitude

Performance & Validation

- After fine-tuning, model accuracy on par with human annotators; disagreement concentrated in intrinsically ambiguous activities. Hallucinations dealt with via RAG.
- Approach aligns with advances in LLM-based text classification (Gao et al., 2023; Liu et al., 2024)

Methodology

- Goal: study how time use evolves around childbirth for households, and quantify gender specialization
  - Within-household specialization as a **mechanism** underpinning child penalties

- Global time-use data is **cross-sectional**
  - Observe individuals either post-birth or without kids, but not pre-birth $\rightarrow$ cannot run event study (Kleven et al, 2019)

- Solution: pseudo-event study methodology (Kleven, 2022; Kleven et al, 2025)
  - Matching on observables to create population of future parents
  - Relax panel data requirement, allowing global coverage

- Pseudo event-studies validated in contexts where we have time use panels
  - e.g.: time use matched with admin data in Sweden
  - (Not today)

Pseudo event-study

- Denote event-time relative to the first childbirth by t
  - People with children, we observe event times $t \geq 0$
  - People without children, **we don't observe event times** $t < 0$
- Idea: create a synthetic population of "future parents" who are very similar to observed parents
- Parent i at event-time $t = 0$, age a with characteristics X_i **matched** to:
  - Non-parents, age $a - s$ and characteristics $X_j = X_i \Rightarrow$ observation for $t = -s$
  - X_i includes gender, marital status, education and urban/rural

$$Y_{it}^{g} = \boldsymbol{\alpha_t^g} \cdot \boldsymbol{D}_{it}^{Child} + \boldsymbol{\beta^g} \cdot \boldsymbol{D}_{it}^{Age} + \boldsymbol{\gamma^g} \cdot \boldsymbol{D}_{it}^{Year} + \nu_{it}^{g}.$$

- Child-penalty calculated as **differential impact on women compared to men**, averaged over 10 years

$$CP = \frac{1}{11} \cdot \sum_{i=0}^{10} \frac{\hat{\alpha}_t^m - \hat{\alpha}_t^f}{E[\tilde{Y}_{it}^w | t]}$$

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Total Parental Time Use

How does the birth of a child reshape the total time allocation of parents around the world?

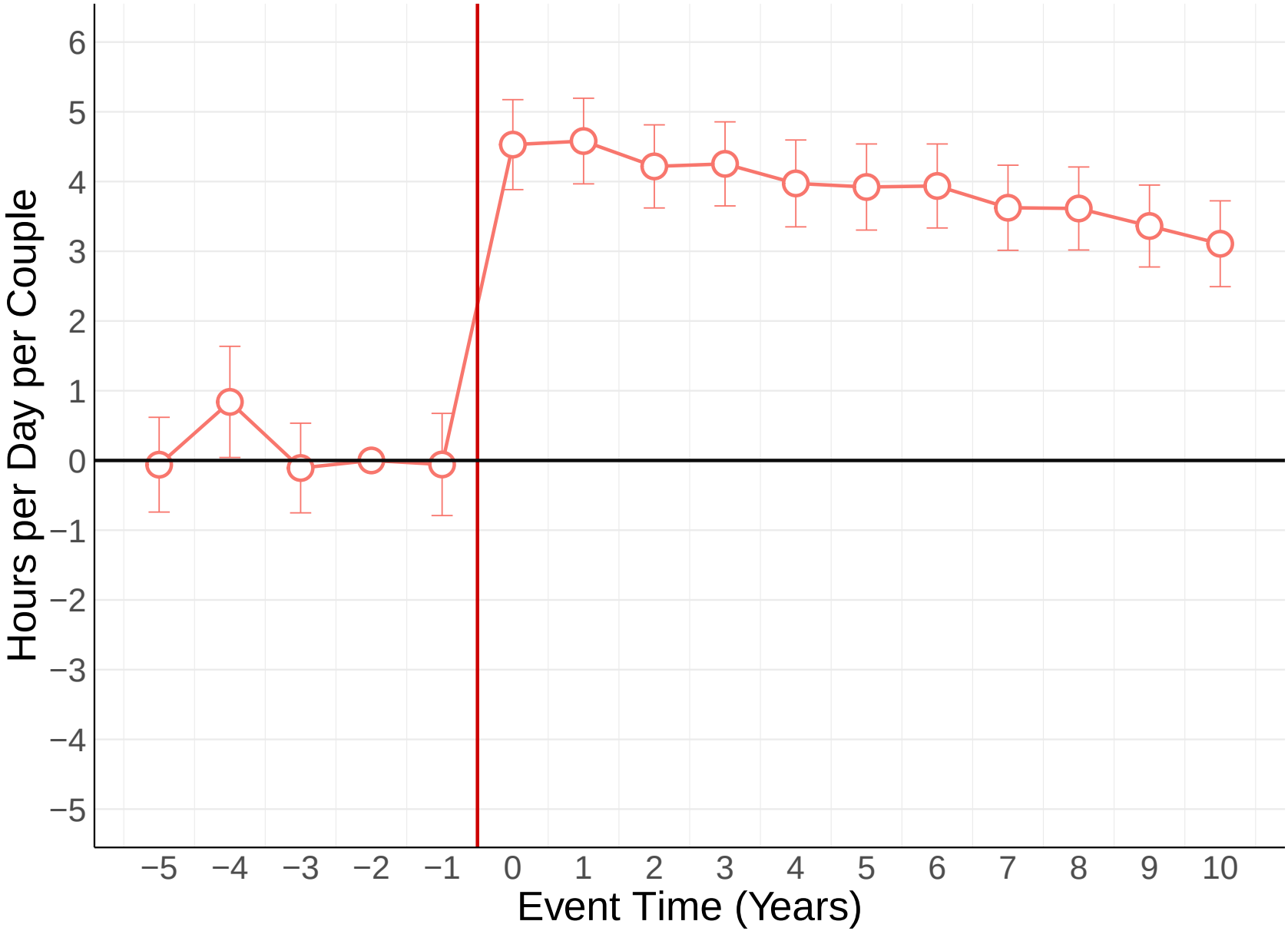
What we measure:

- Total parental time use, defined as the sum of the mother's and father's time.

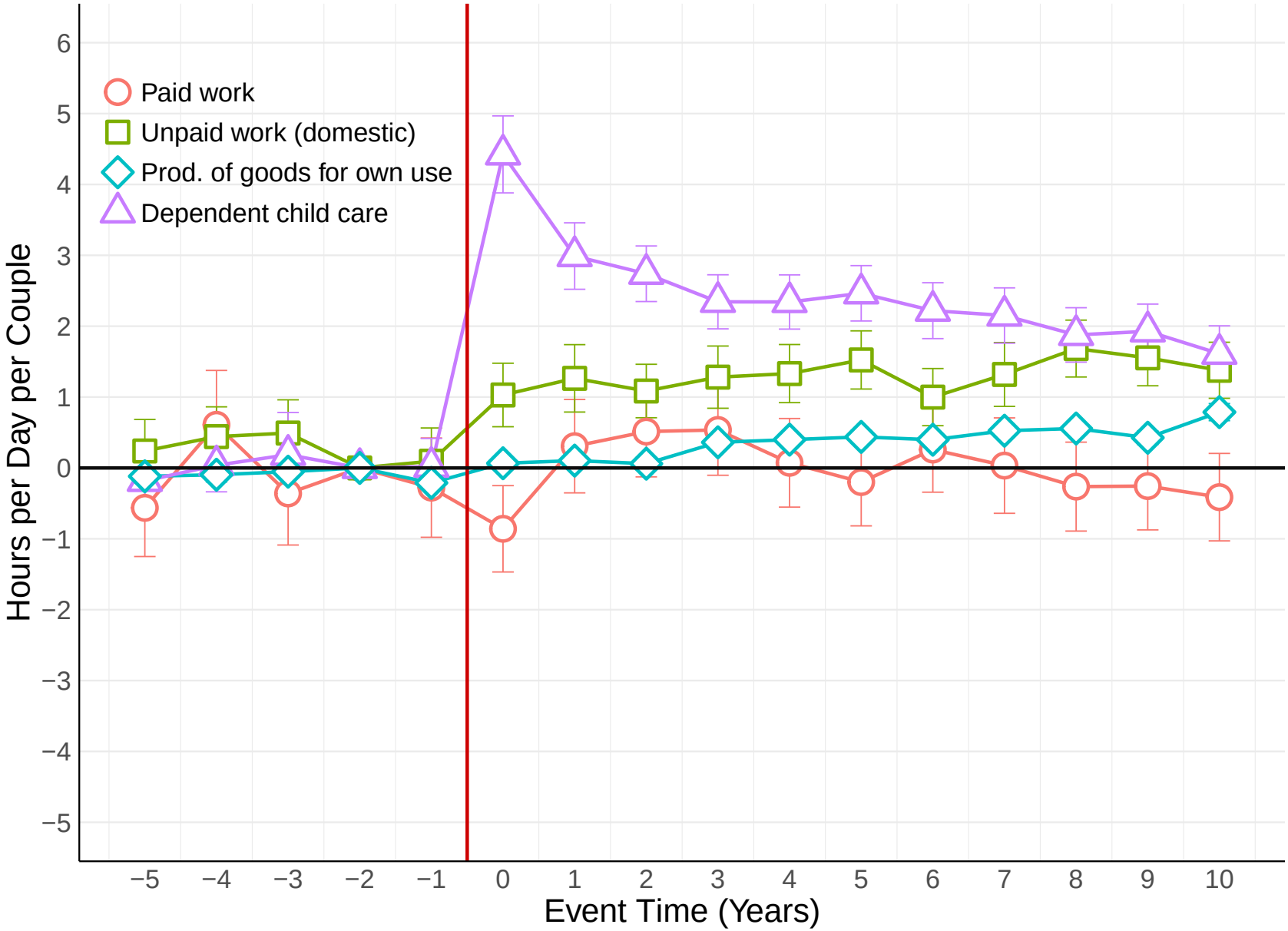
We present changes around childbirth at two levels of detail:

- 1-digit level: Active time, Leisure, Education
- 2-digit level:
  - Active time: paid work, unpaid domestic work, child care, production for own use.
  - Leisure: basics (sleep, eating, personal care), social activities, entertainment, active leisure.

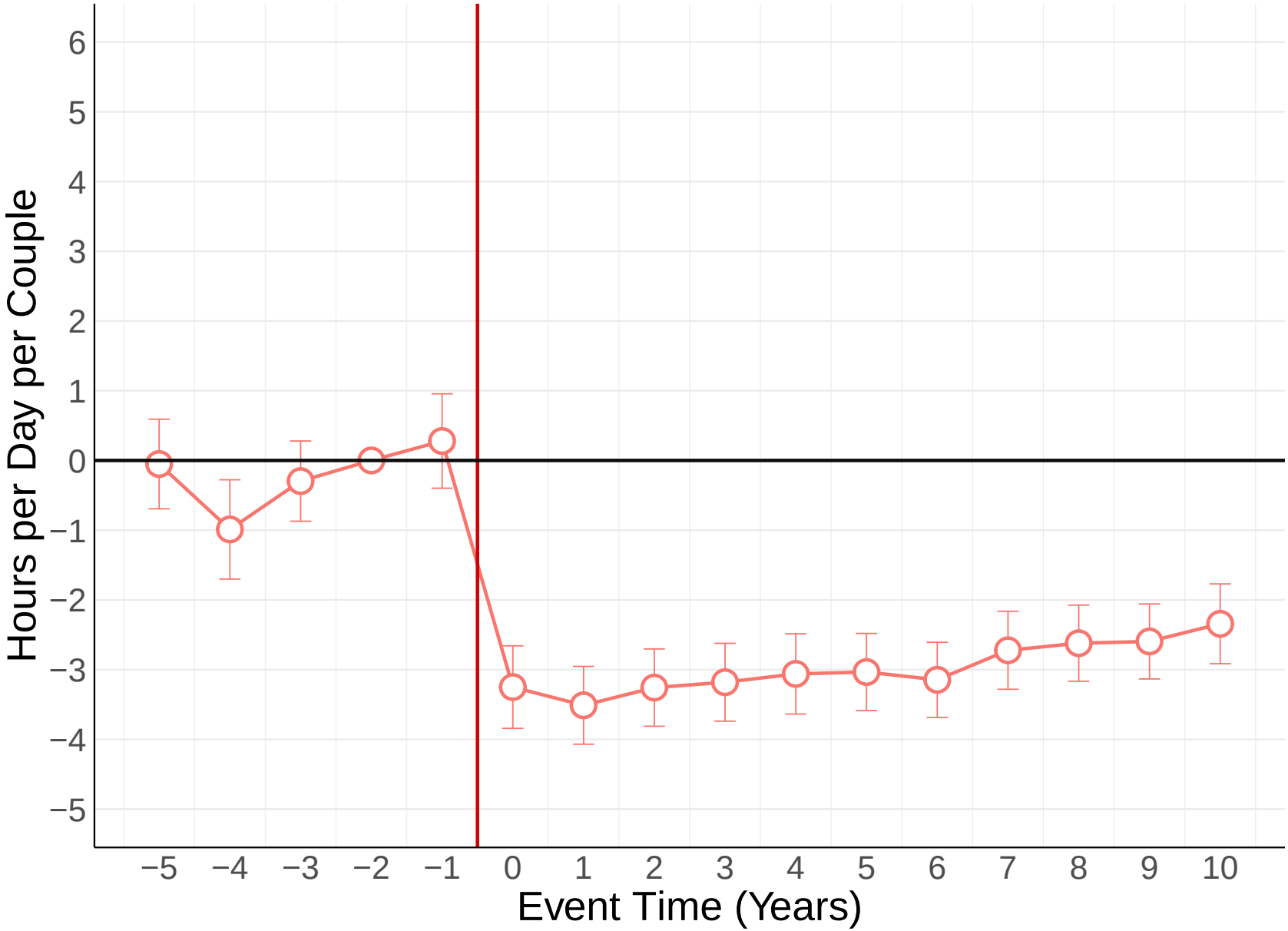
Evolution of Parents' Active Time



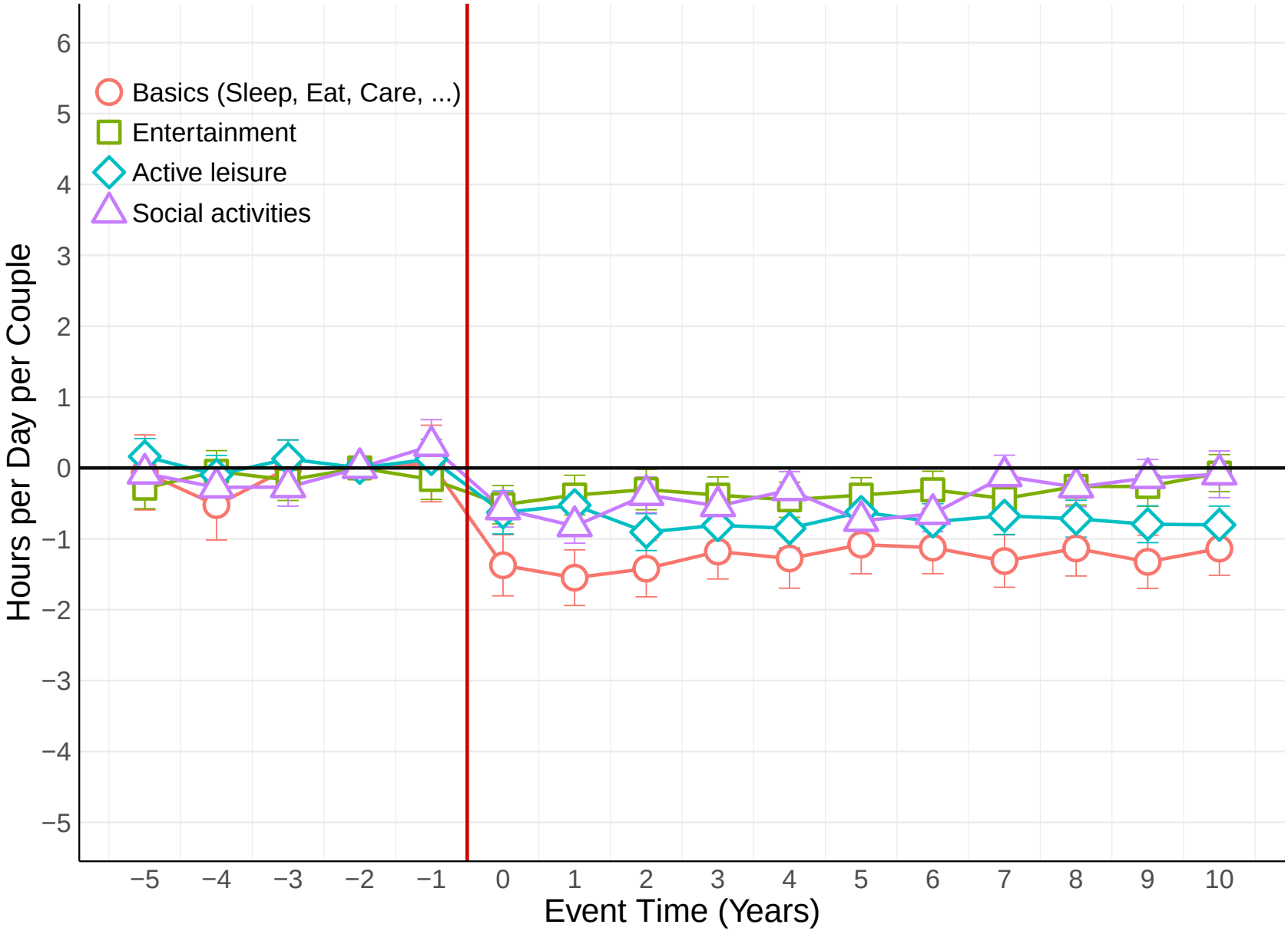
Active Time decomposition



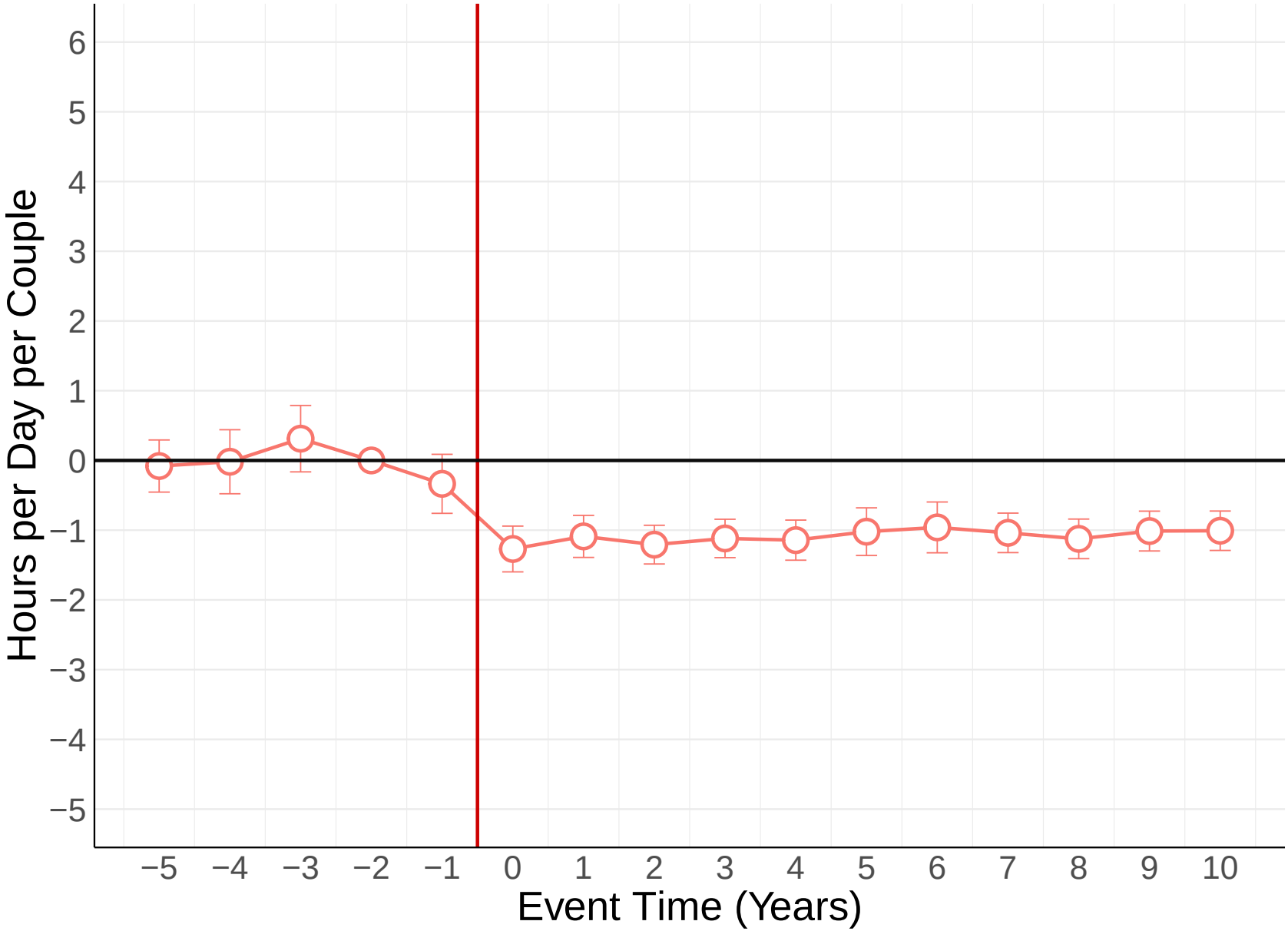
Evolution of Parents' Leisure Time



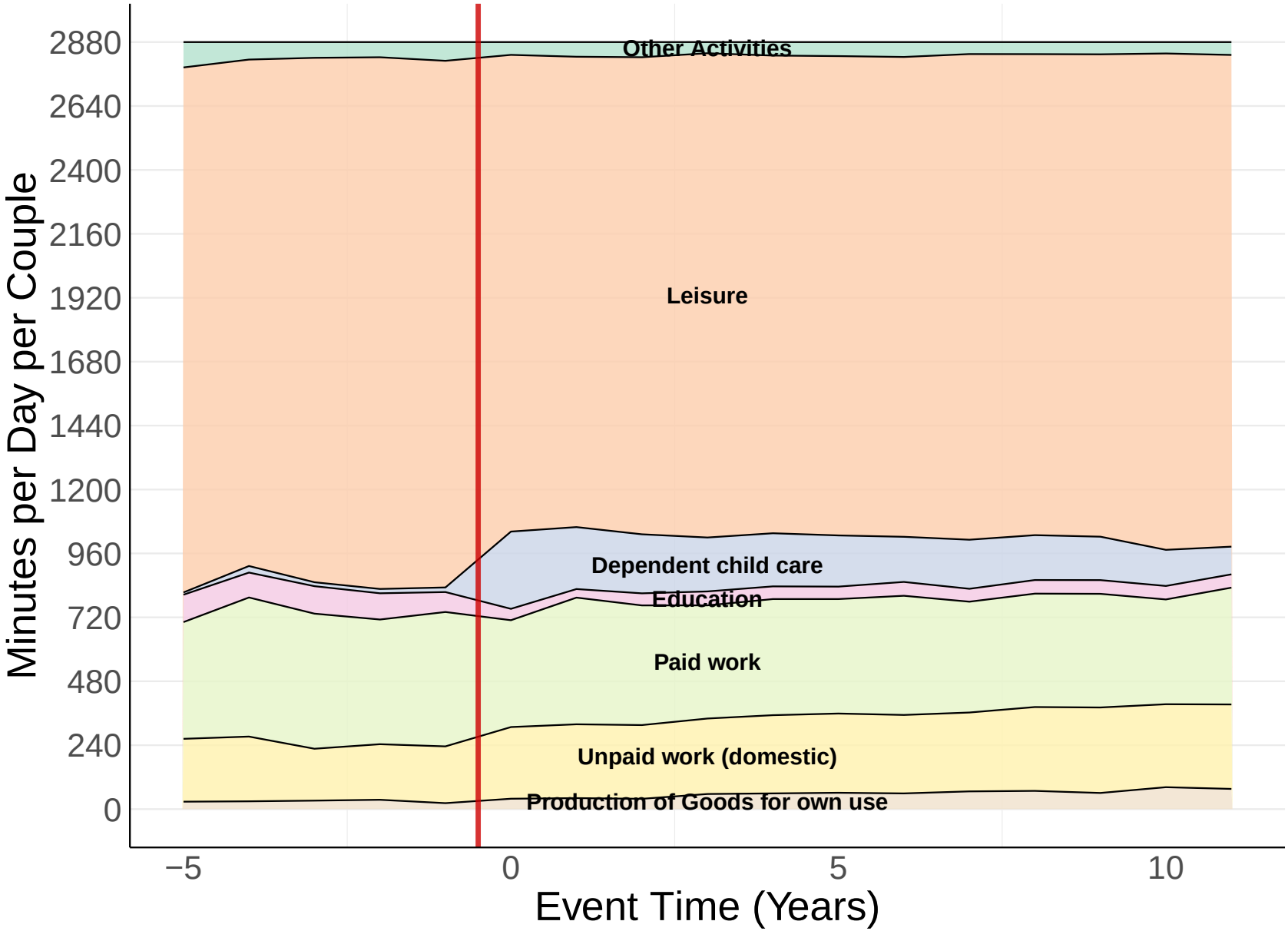
Leisure decomposition



Evolution of Parents' Education



Pseudo-ES in Level: All world



Parental Time Investment: Global Takeaways

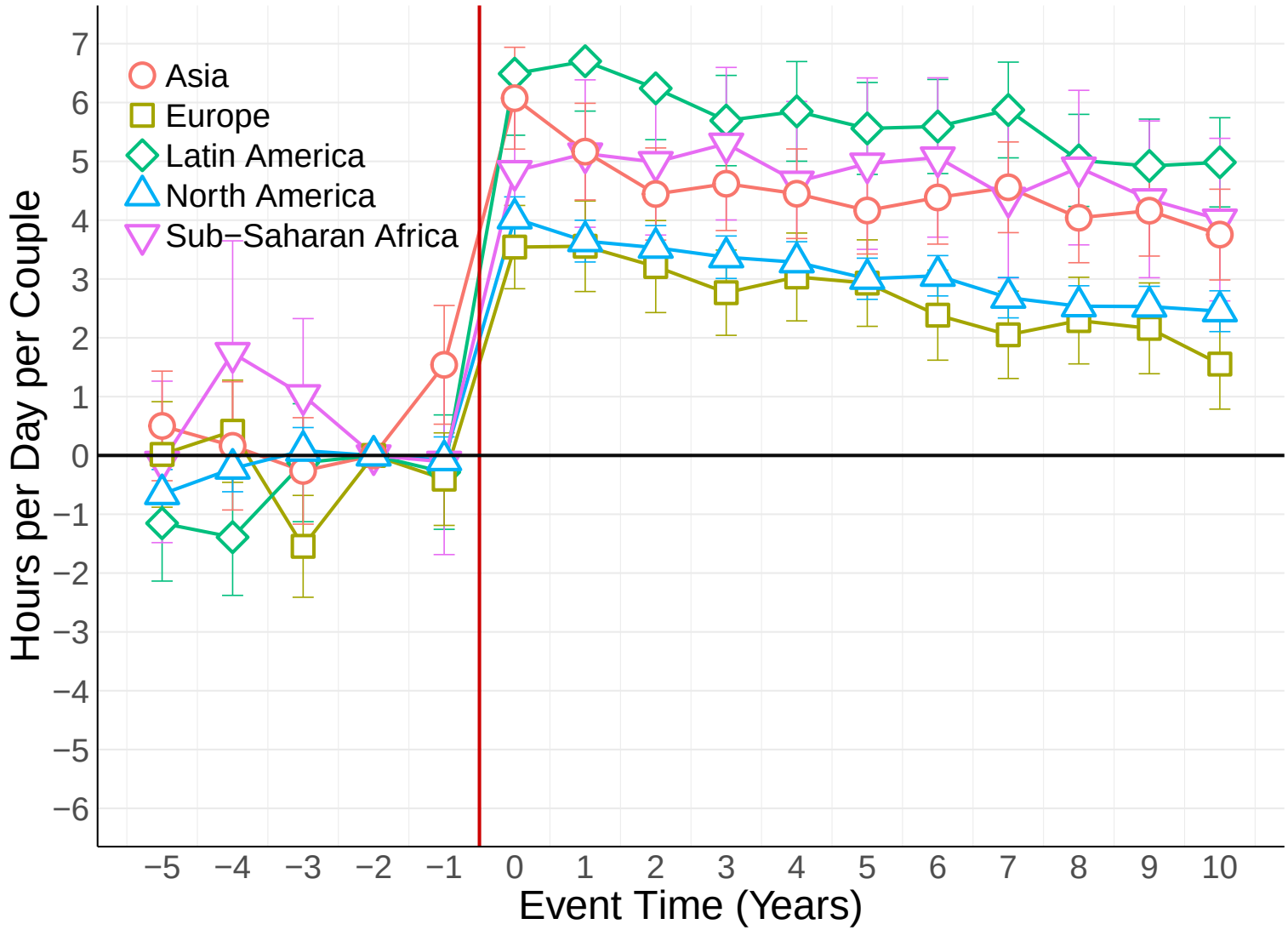
The birth of a child is a large shock to parental time allocation.

- Active time increases substantially and persistently.
  - Child care spikes immediately and then declines gradually, remaining well above pre-birth levels.
  - Unpaid domestic work increases steadily over time.
  - Paid work decreases slightly; time in production for own use is broadly stable.

- Leisure declines sharply, with similar reductions across all subcategories.

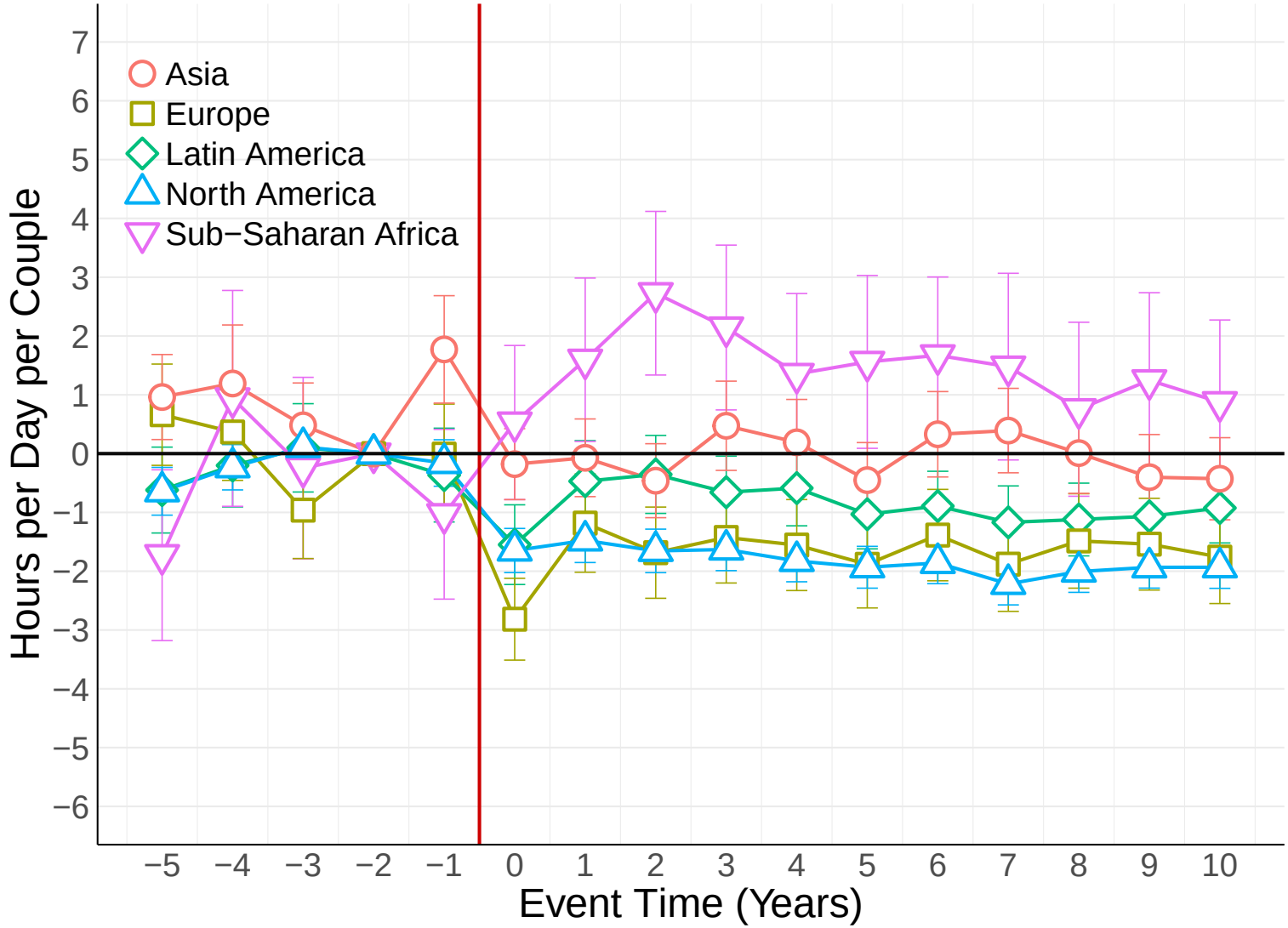
- Education time also declines, though by smaller amounts.

Evolution of Parents' Active Time



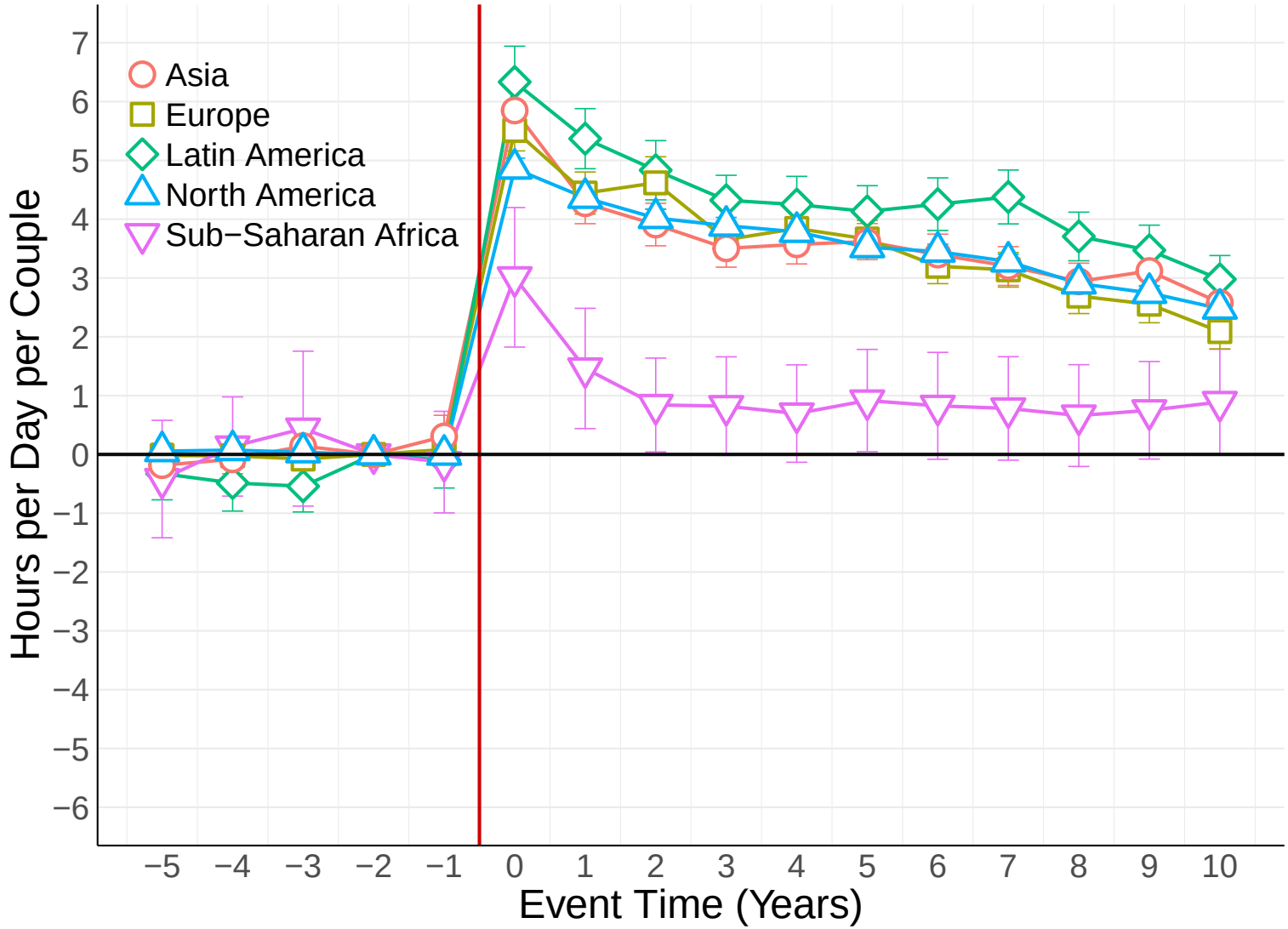
By Gender

Active Time decomposition: Paid Work



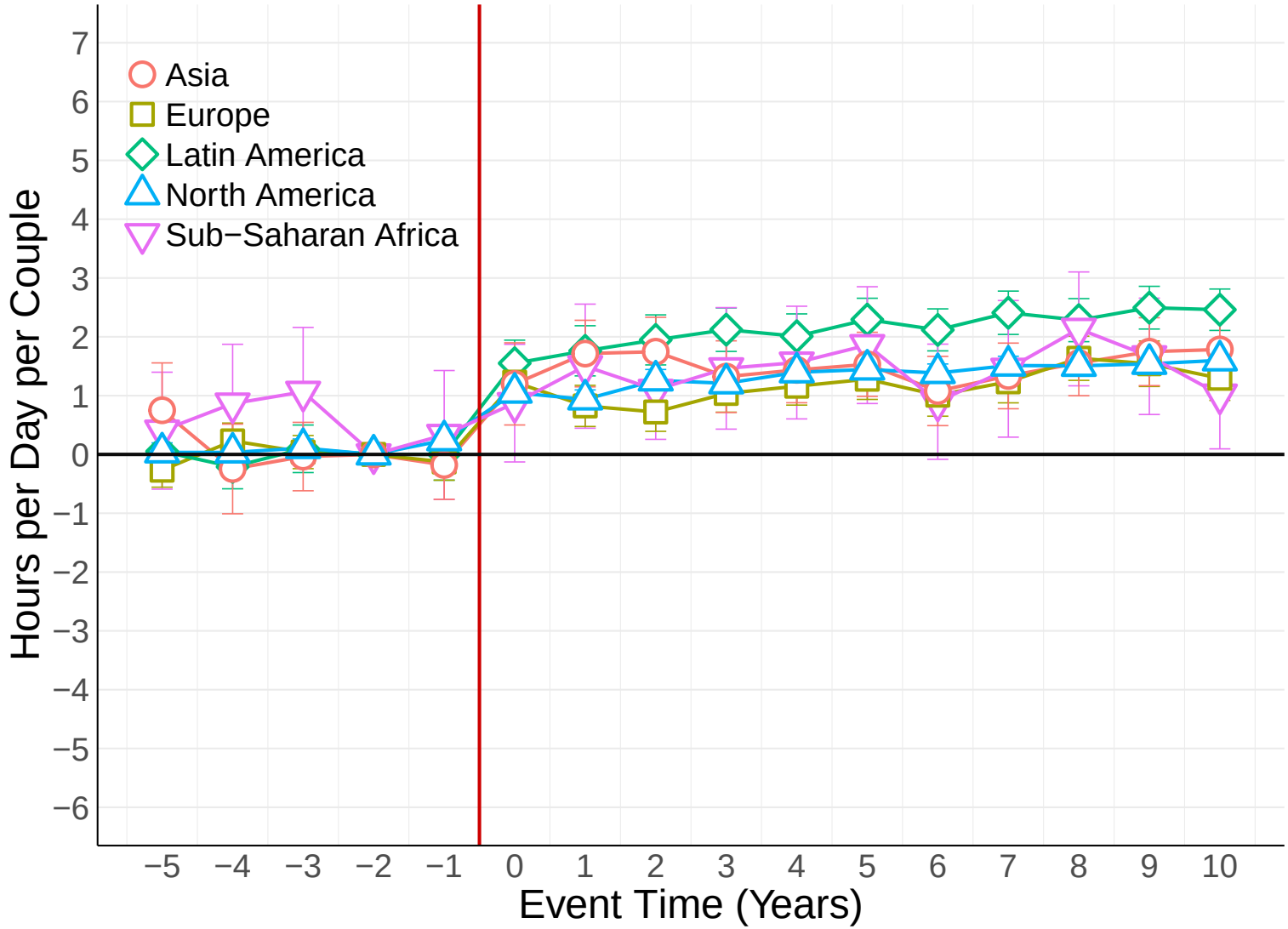
By Gender

Active Time decomposition: Dependent Child Care



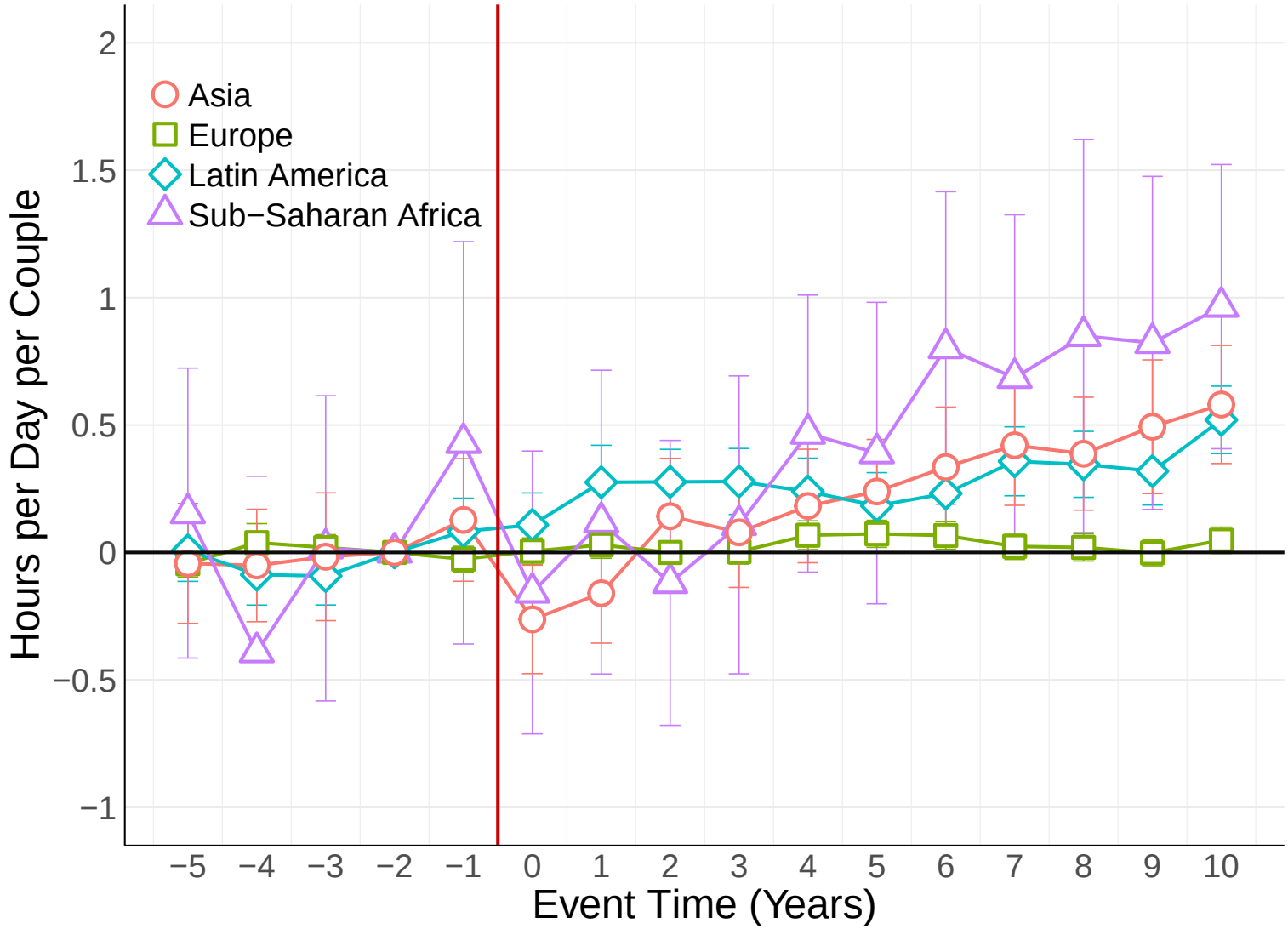
By Gender

Active Time decomposition: Unpaid Domestic Work



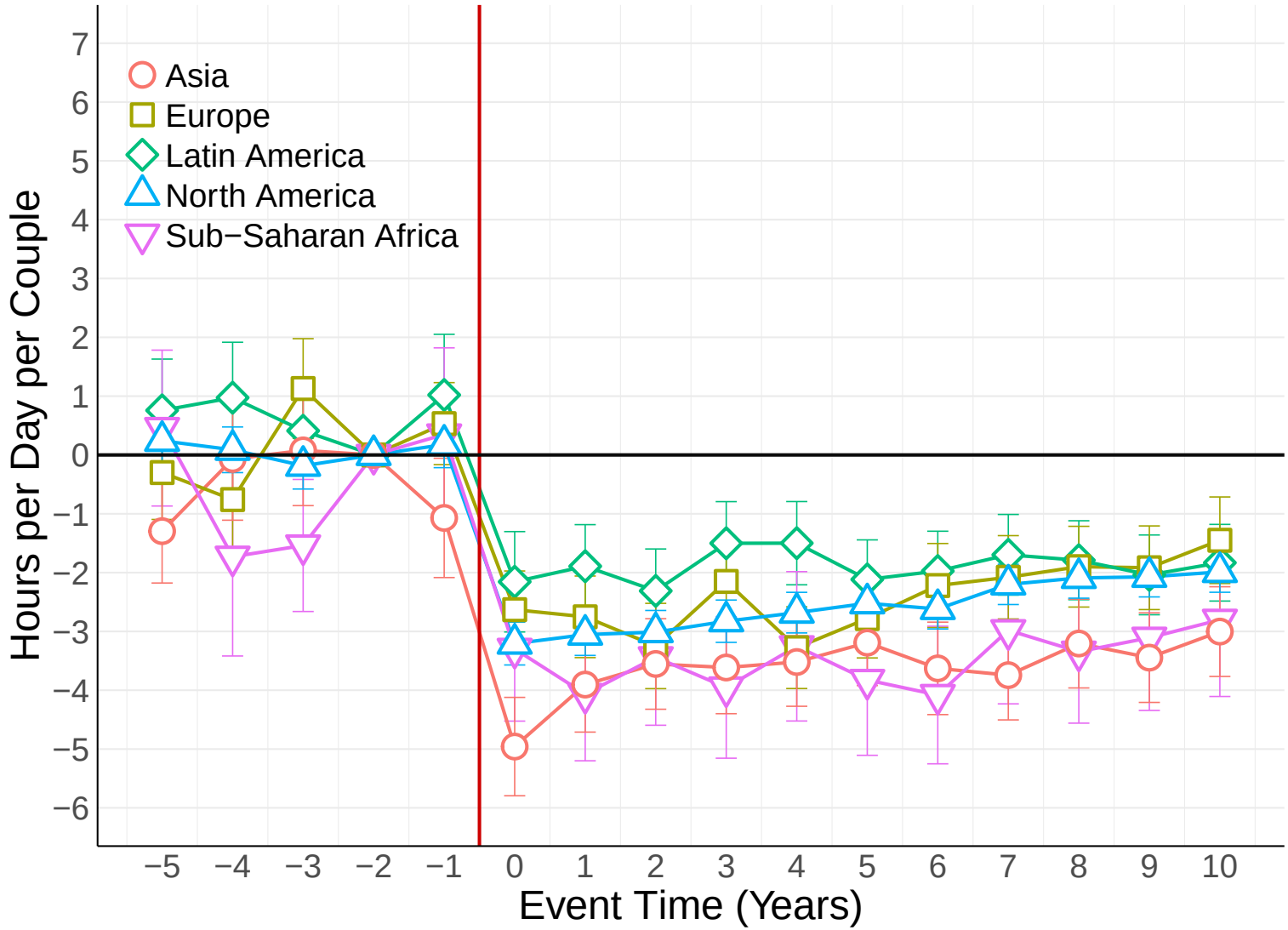
By Gender

Active Time decomposition: Production of good for own use



By Gender

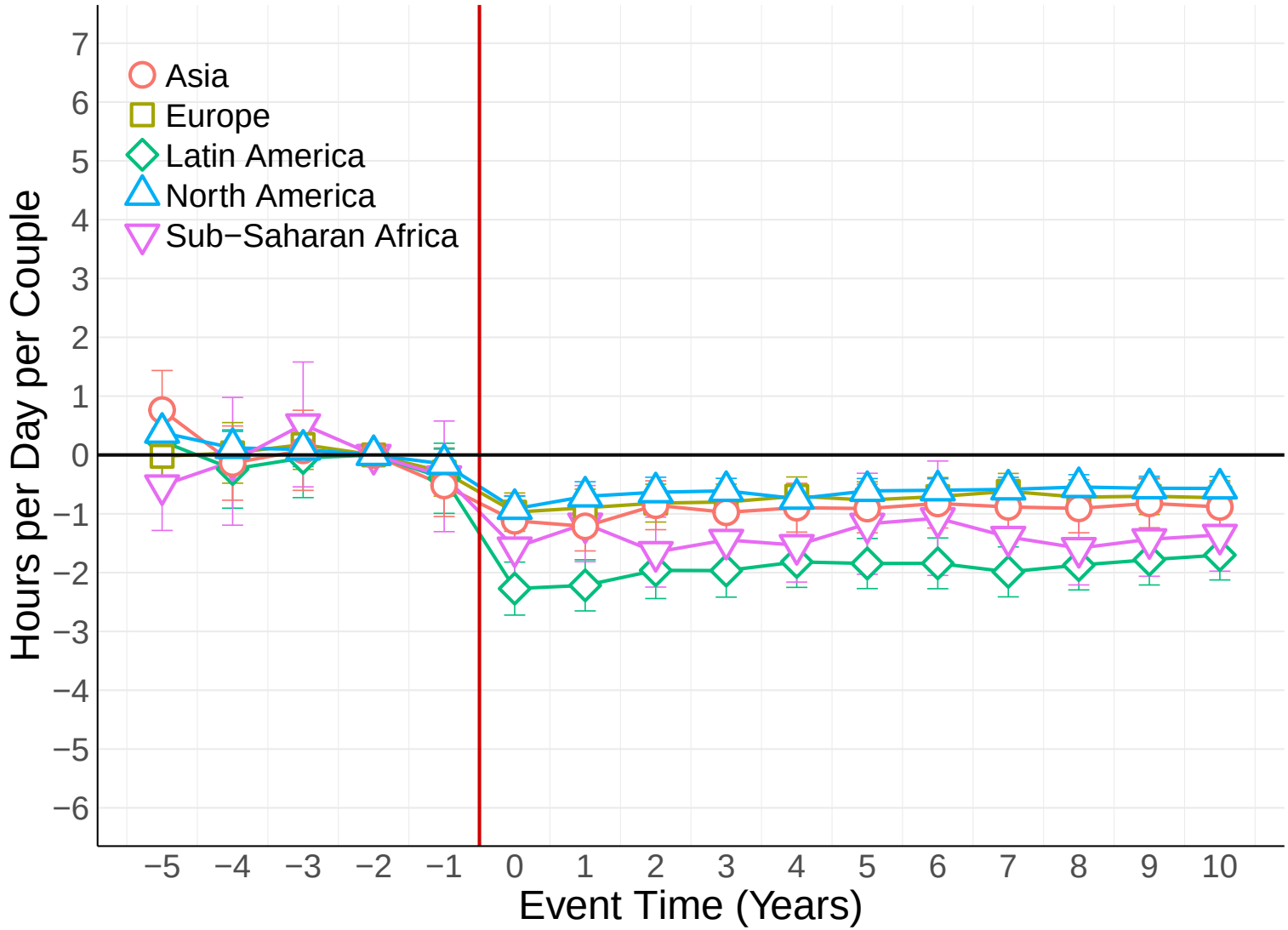
Evolution of Parents' Leisure



Figure

By Gender

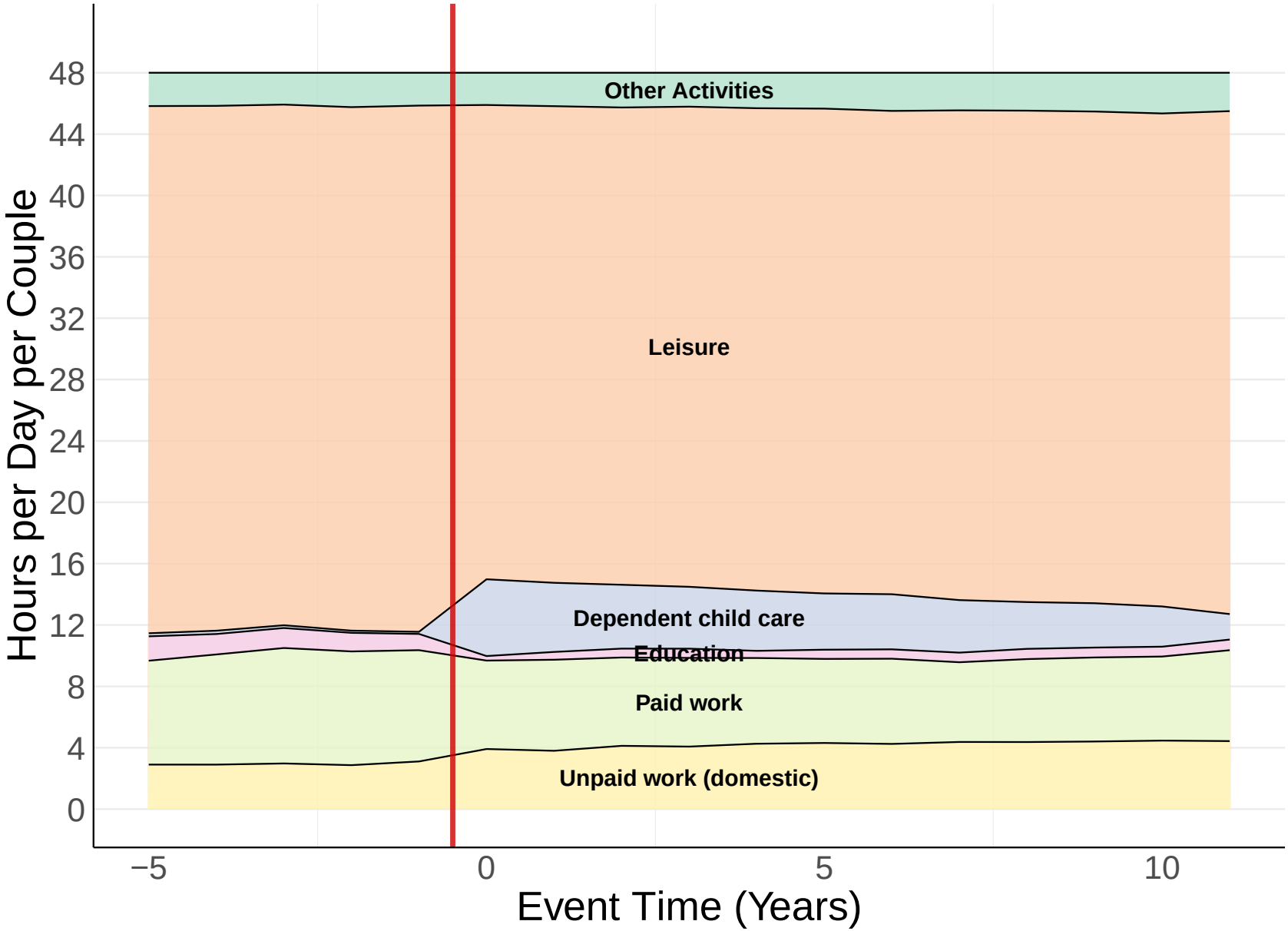
Evolution of Parents' Education



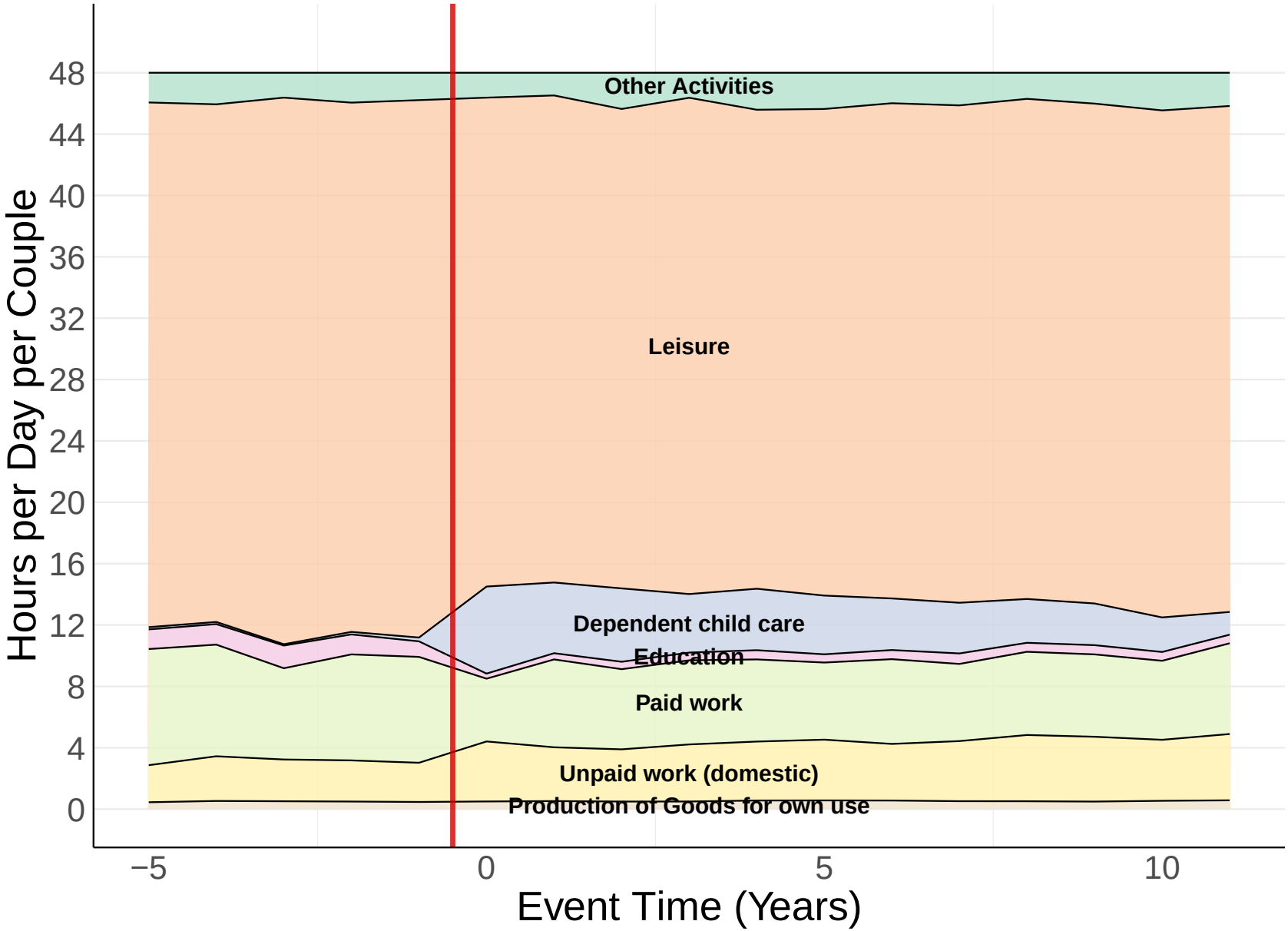
Figure

By Gender

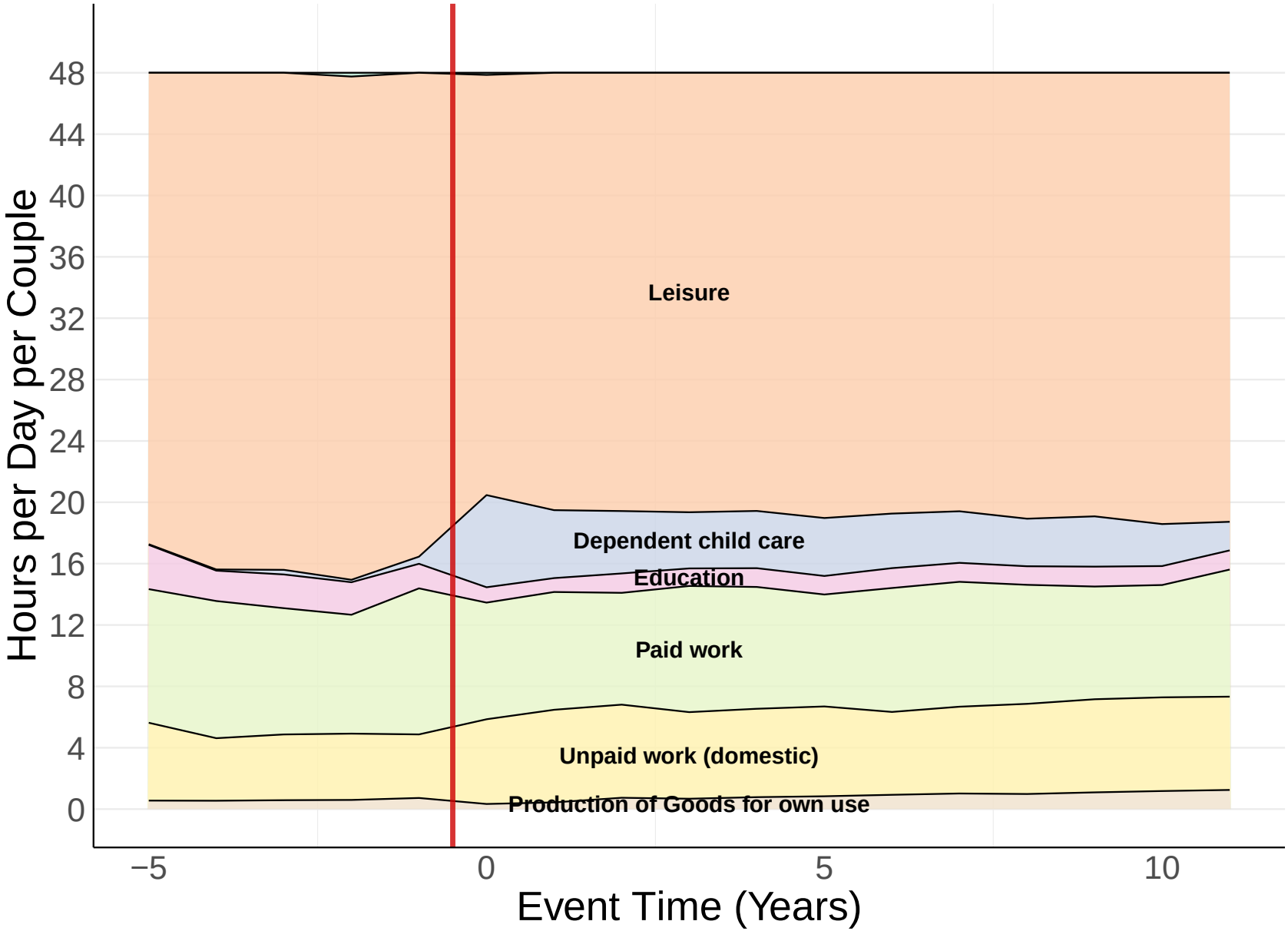
North-America



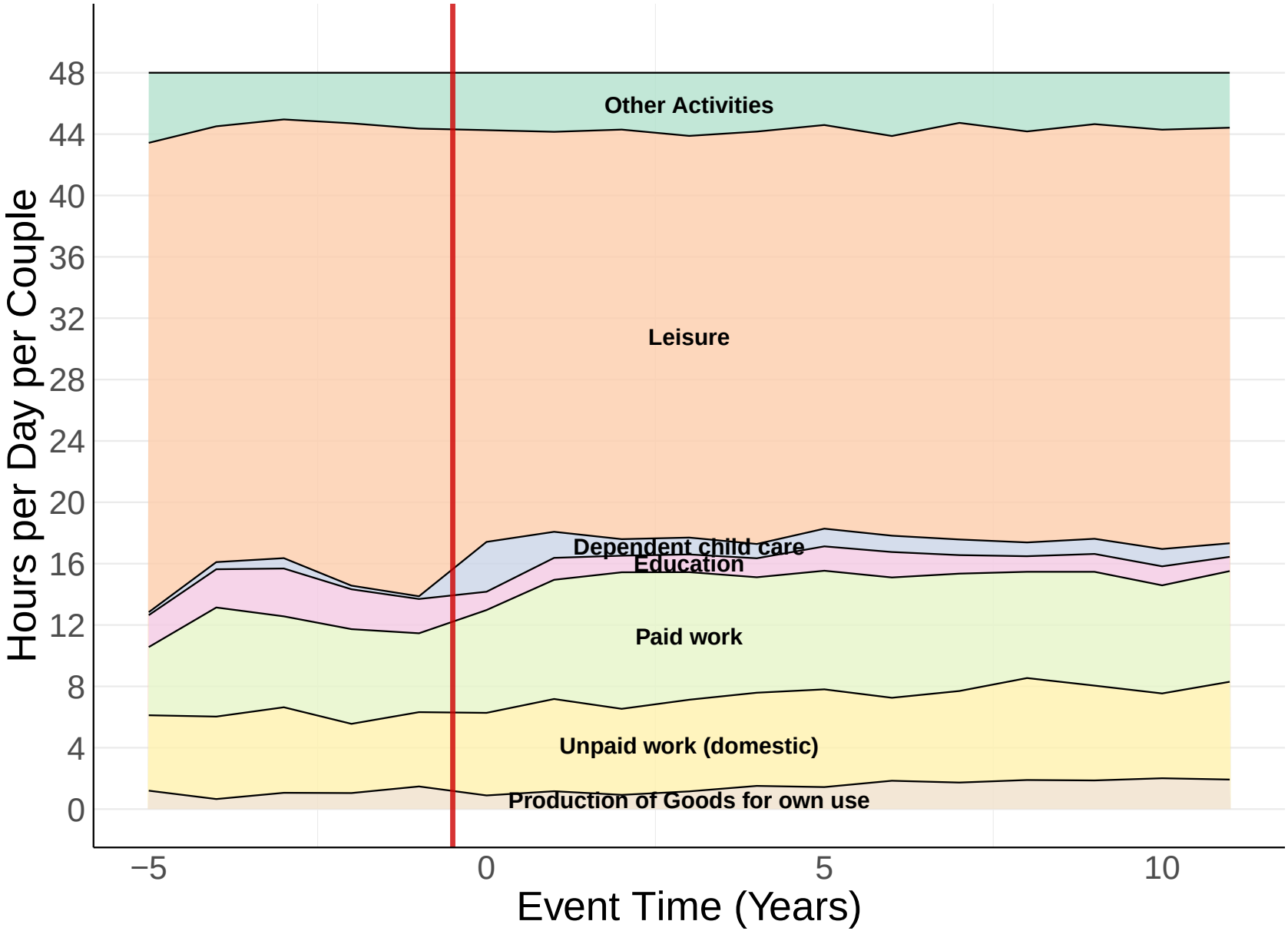
Europe


Other Activities
Leisure
Dependent child care
Education
Paid work
Unpaid work (domestic)
Production of Goods for own use
Hours per Day per Couple
48
44
40
36
32
28
24
20
16
12
8
4
0
−5
0
5
10
Event Time (Years)

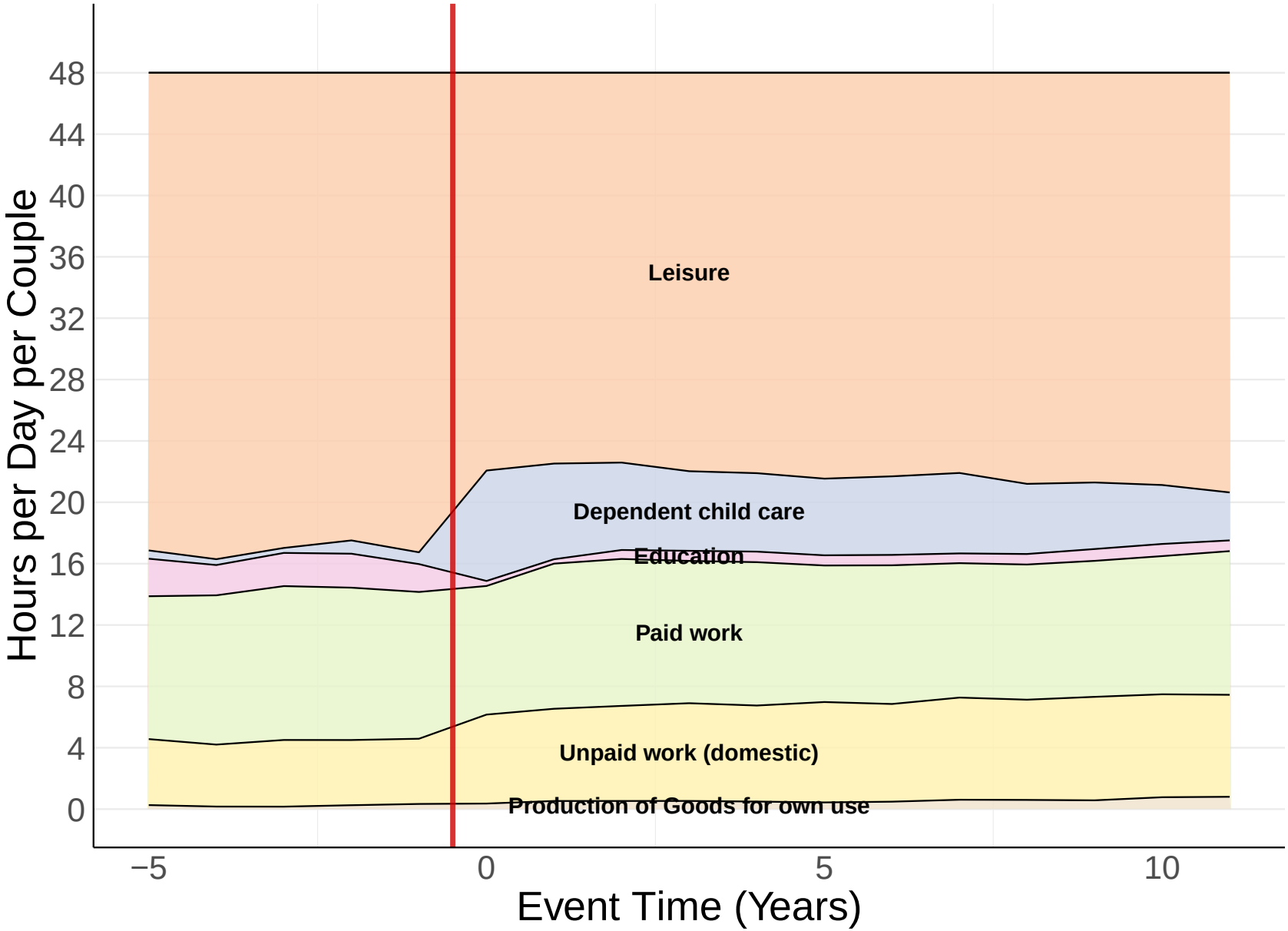
Asia


Hours per Day per Couple
48
44
40
36
32
28
24
20
16
12
8
4
0
Leisure
Dependent child care
Education
Paid work
Unpaid work (domestic)
Production of Goods for own use
−5
0
5
10
Event Time (Years)

Sub-Saharan Africa



Latin-America



Parental Time: Regional takeaways I

Across all regions, the arrival of a child leads to similar qualitative adjustments.

- Active time increases, while leisure and education decrease.

The magnitude of these changes varies across regions.

- Increases in active time are largest in Latin America.
- In most regions, higher active time comes primarily at the expense of leisure.
    - In Latin America, leisure and education decrease by similar magnitudes.

Parental Time: Regional takeaways II

What drives the regional differences in active time?

- Substitution between paid work and child care is larger in Europe and North America.

- Large increases in child care and lower decreases in paid work in Latin America and Asia.

- Sub-Saharan Africa shows smaller increases in child care but also an increase in paid work.

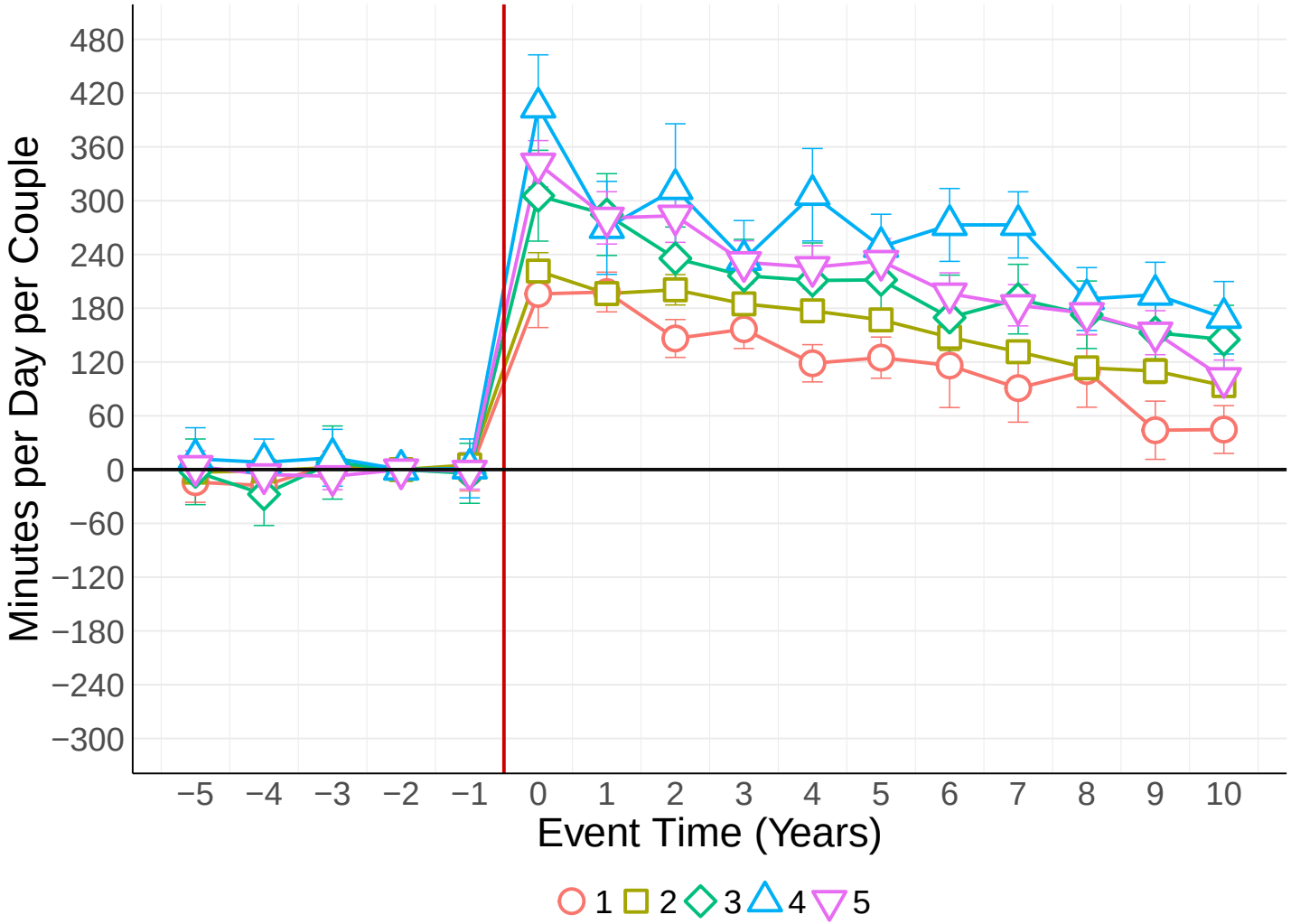
Parental time investment & development

- We assign each household their rank in the 2022 worldwide income distribution (Chancel et al. (2022))
- We then run pseudo-ES regressions pooled by worldwide income groups

$\Rightarrow$ Document how parental time investment evolves over course of development

Parental time investment & development

Parental time in child care by quintiles in worldwide income distribution

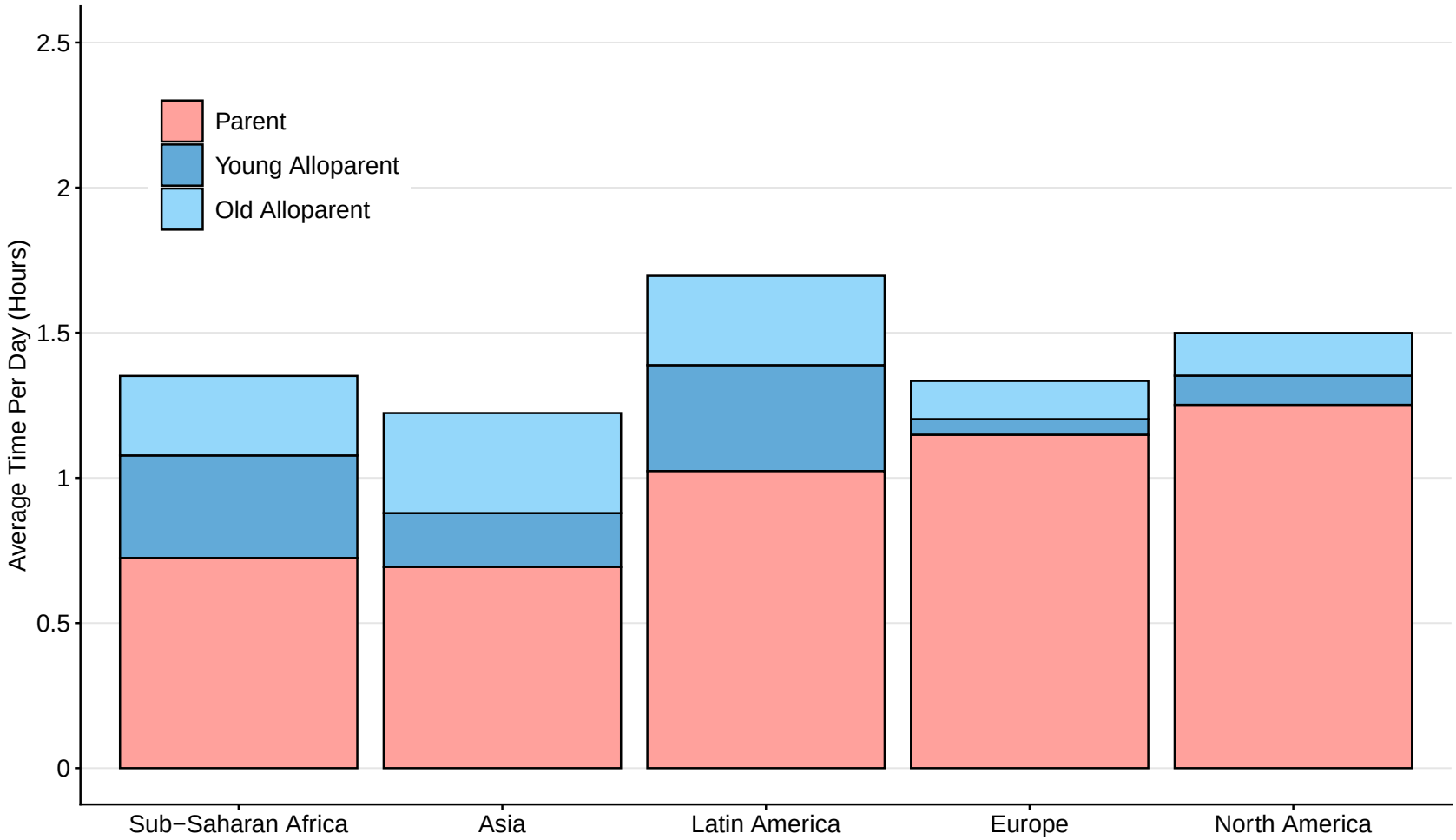


Parental vs Alloparental Time investments in children

- Alloparental care is evolutionary crucial in Sapiens
  - e.g. Hrdy [2024], Rilling [2024]
- Measure total amount of time spent on child care per person, split between parents vs alloparents
  - *Young alloparents*: siblings, non-parents living in the household
  - *Old alloparents*: grand-parents, extended family members with children, other older members of the community
- Alloparental care is extremely prevalent
- Almost entirely disappears at higher level of development

Parental vs Alloparental Child Care

Average time spent on child care per day: *It takes a village!*



By Gender

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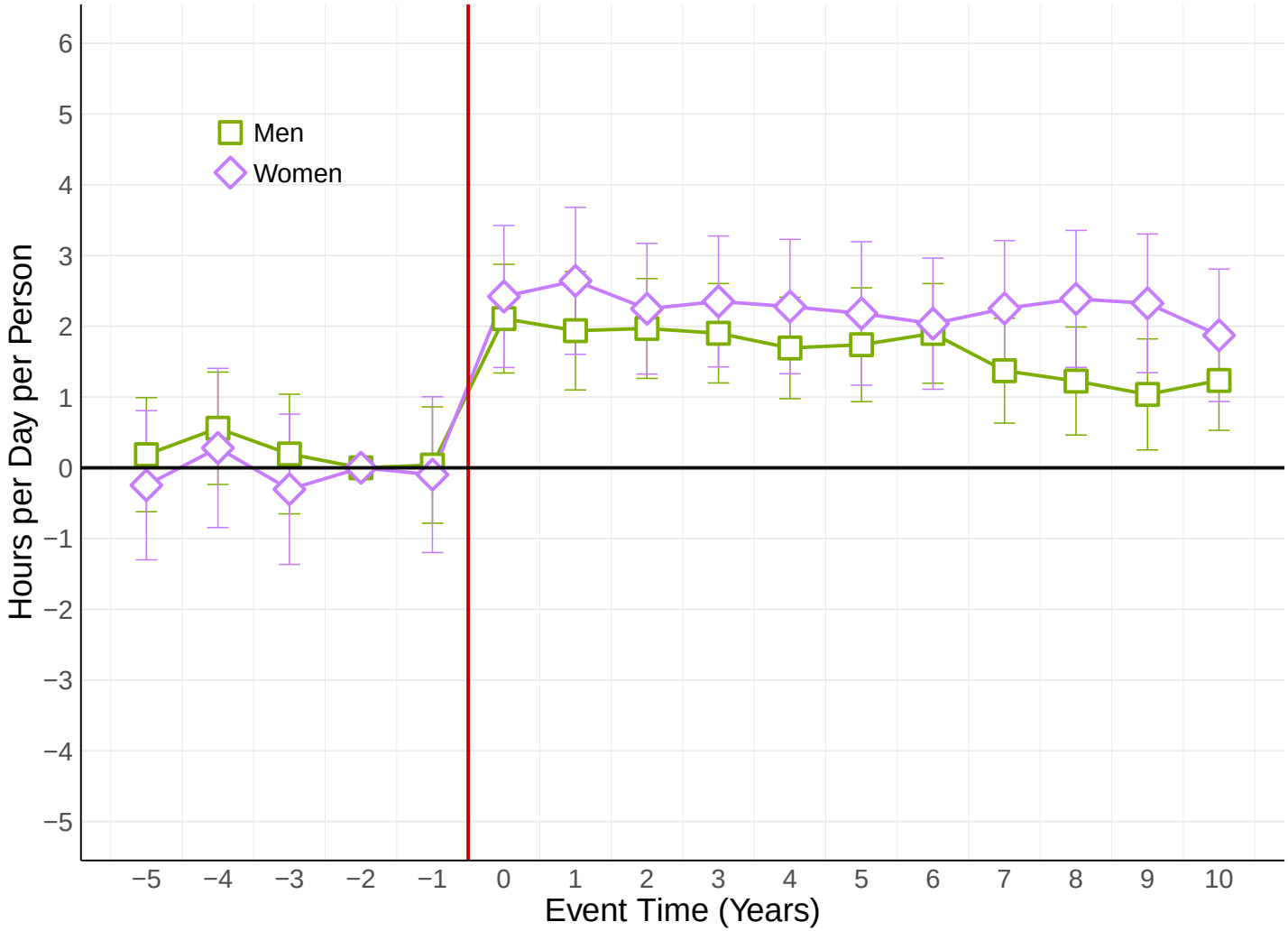
Parenthood & gender specialisation

- We showed arrival of children corresponds to large time & persistent parental time investment
- We now document how this time investment is divided across both parents
- We run pseudo-ES interacted with parental gender

$$Y_{it}^{g} = \boldsymbol{\alpha_t^g} \cdot \boldsymbol{D}_{it}^{Child} + \boldsymbol{\beta^g} \cdot \boldsymbol{D}_{it}^{Age} + \boldsymbol{\gamma^g} \cdot \boldsymbol{D}_{it}^{Year} + \nu_{it}^{g}.$$

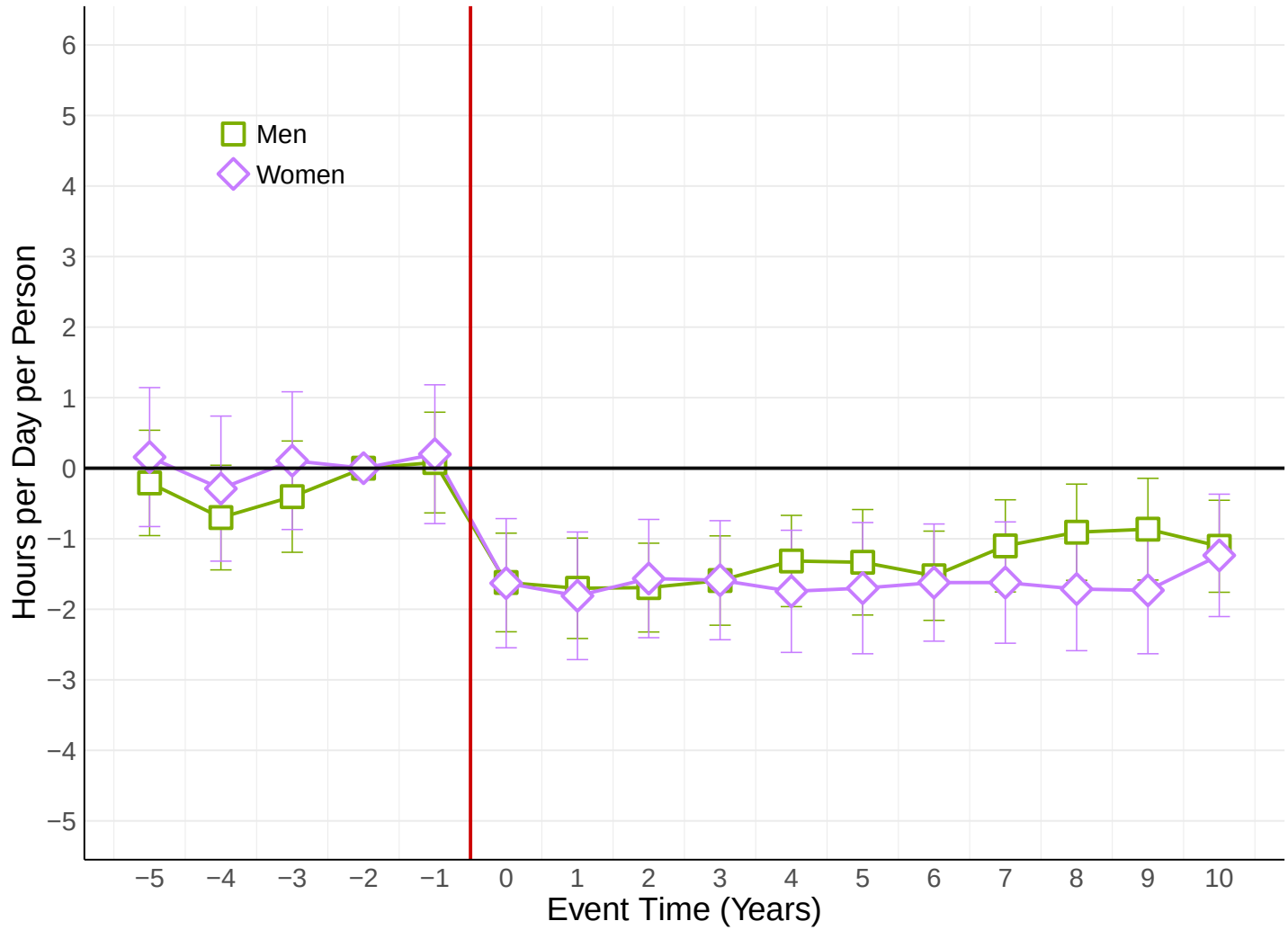
Evolution of time spent - by Gender

Average across worldwide population: Total Active Time



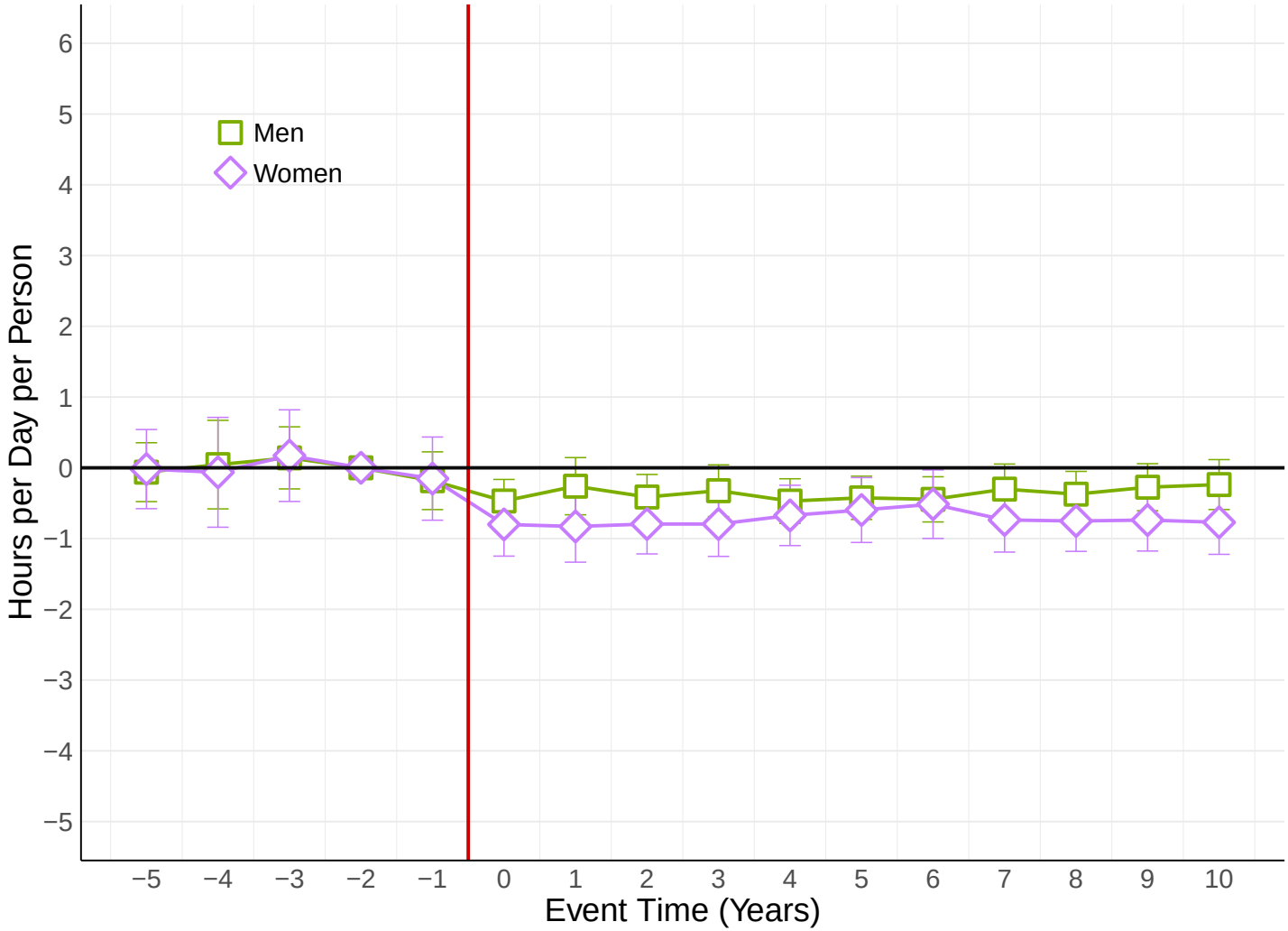
Evolution of time spent - by Gender

Average across worldwide population: Leisure



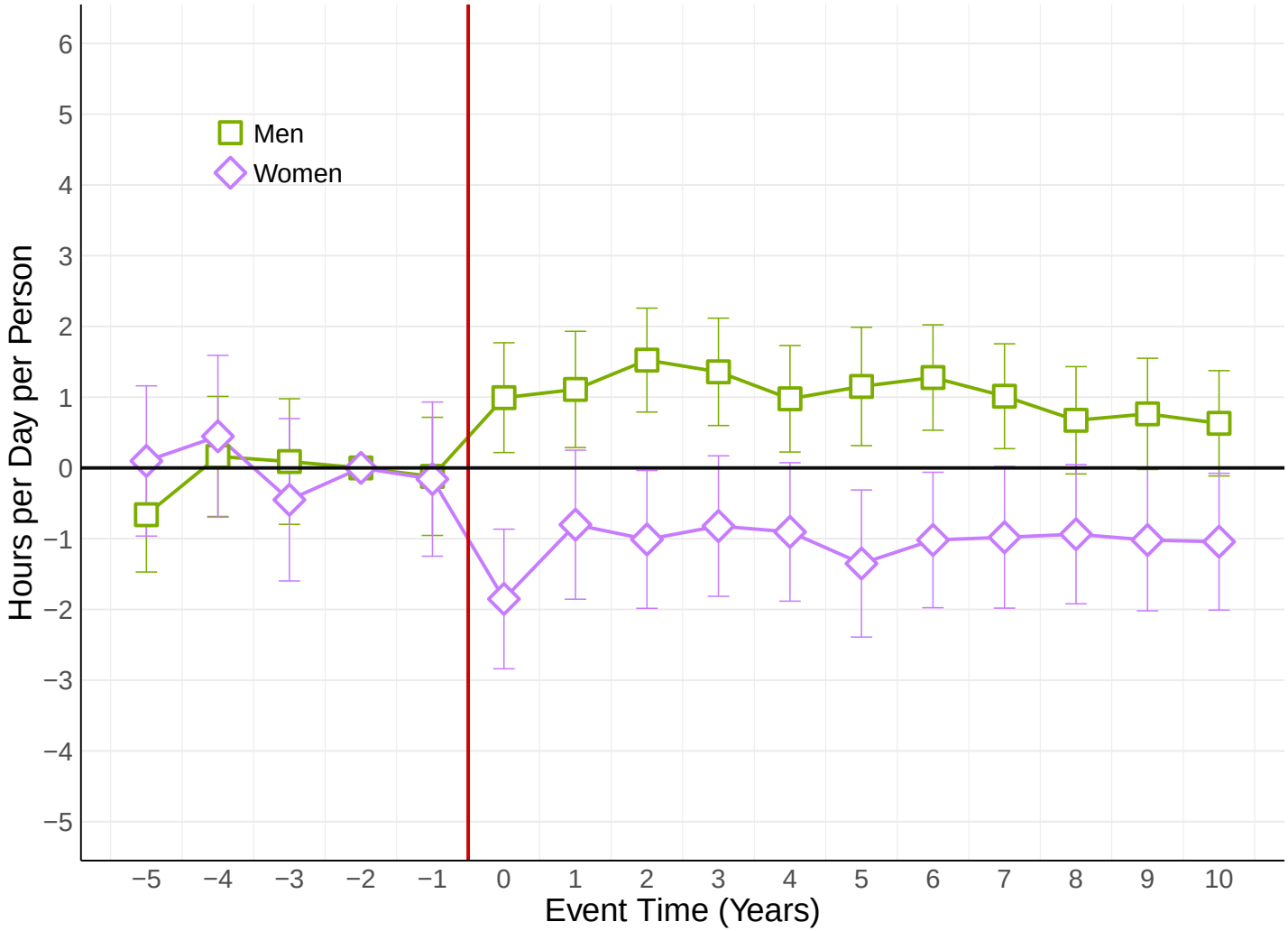
Evolution of time spent - by Gender

Average across worldwide population: Education



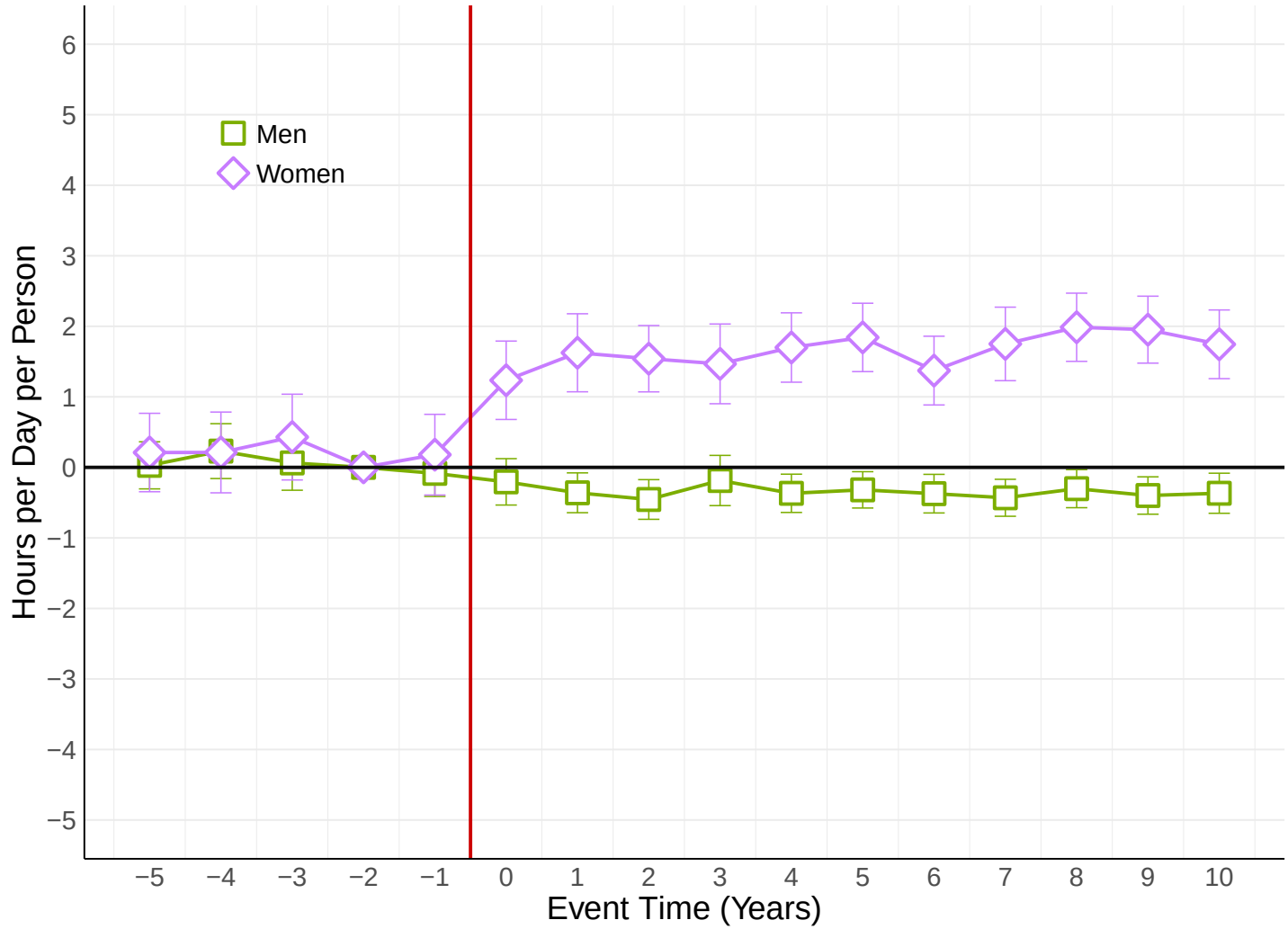
Decomposition of active time spent - by Gender

Average across worldwide population: Paid Work



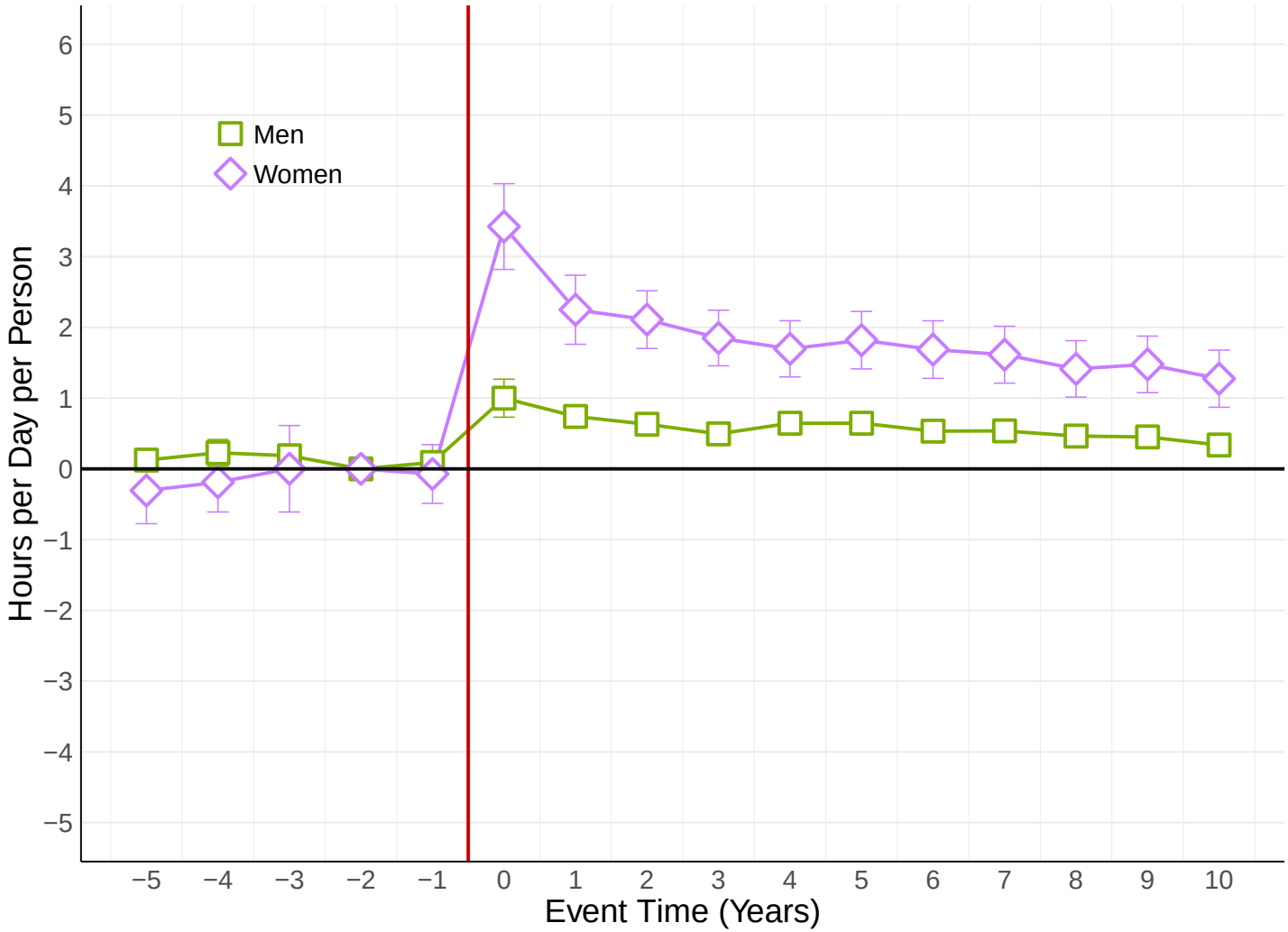
Decomposition of active time spent - by Gender

Average across worldwide population: Unpaid Domestic Work



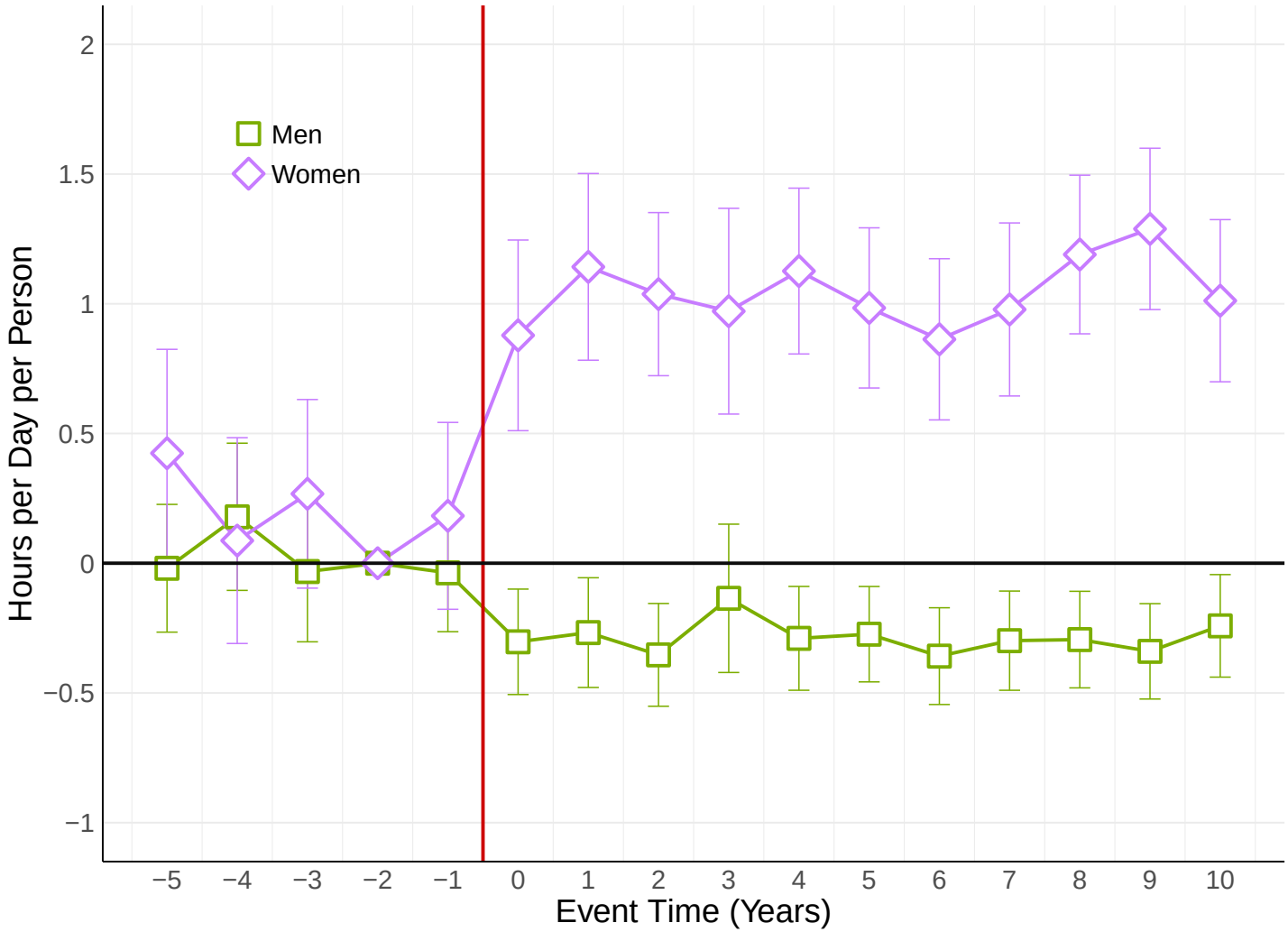
Decomposition of active time spent - by Gender

Average across worldwide population: Child Care



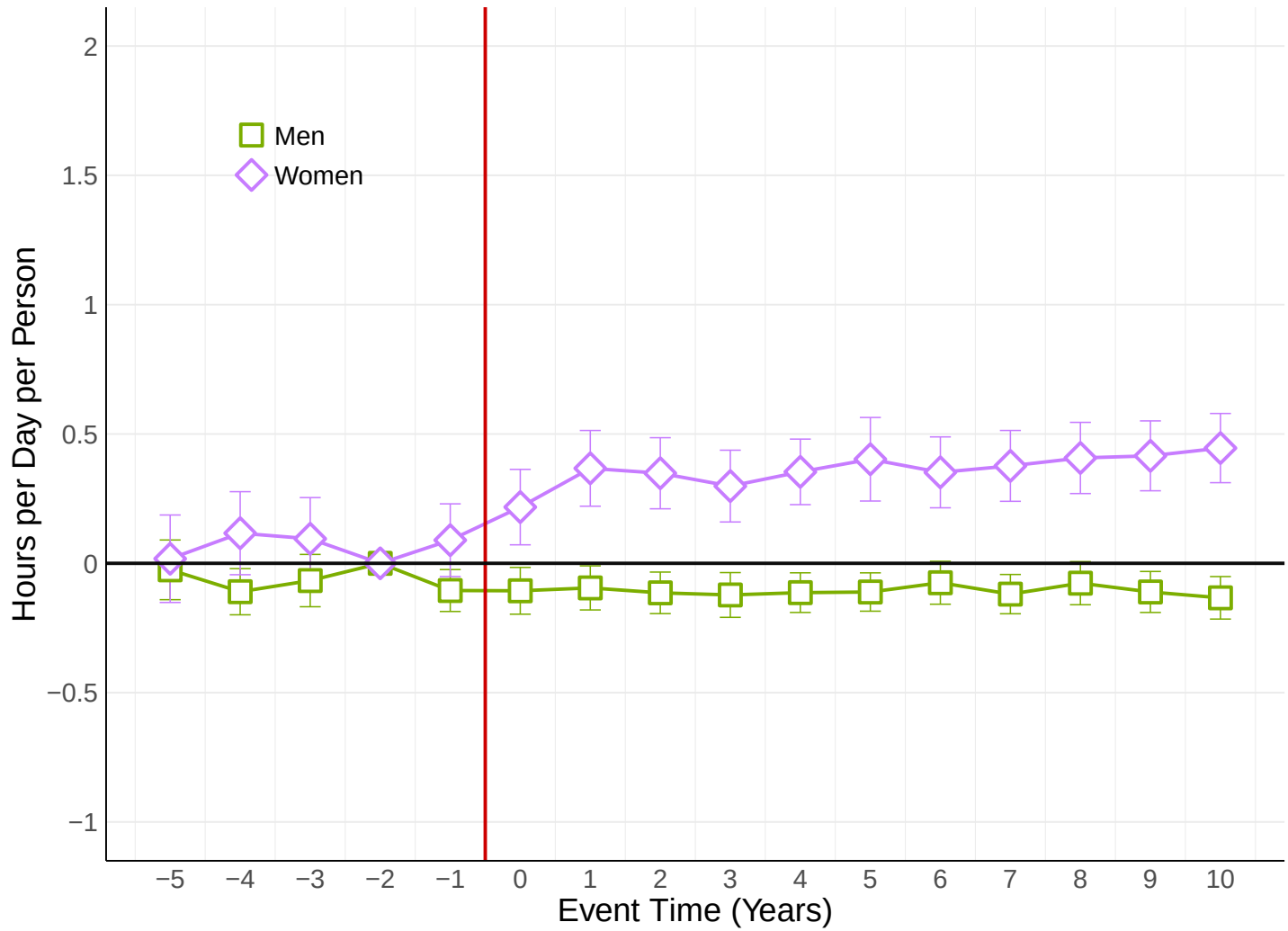
Decomposition of unpaid domestic work - by Gender

Average across worldwide population: Food Preparation



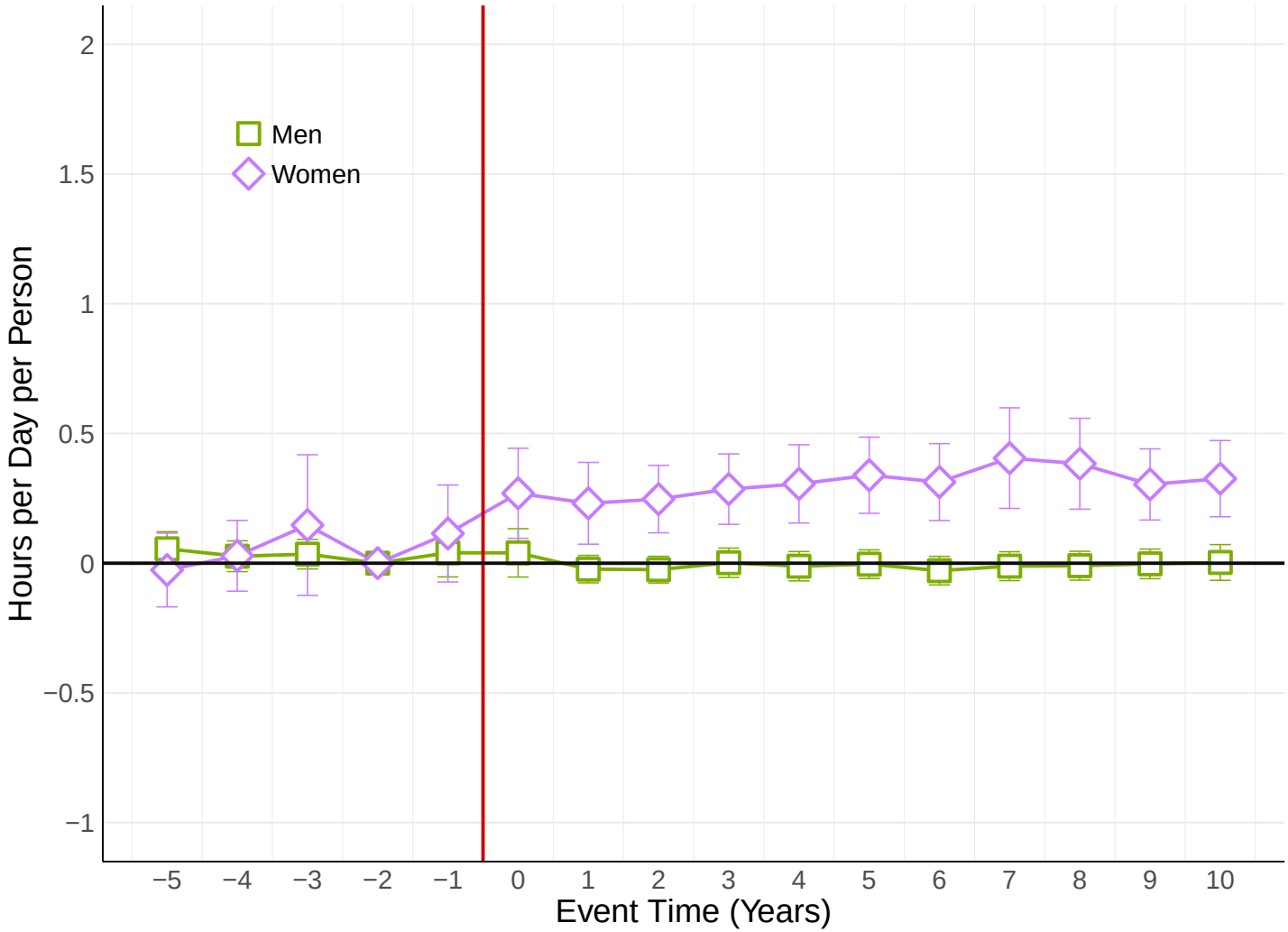
Decomposition of unpaid domestic work - by Gender

Average across worldwide population: Cleaning



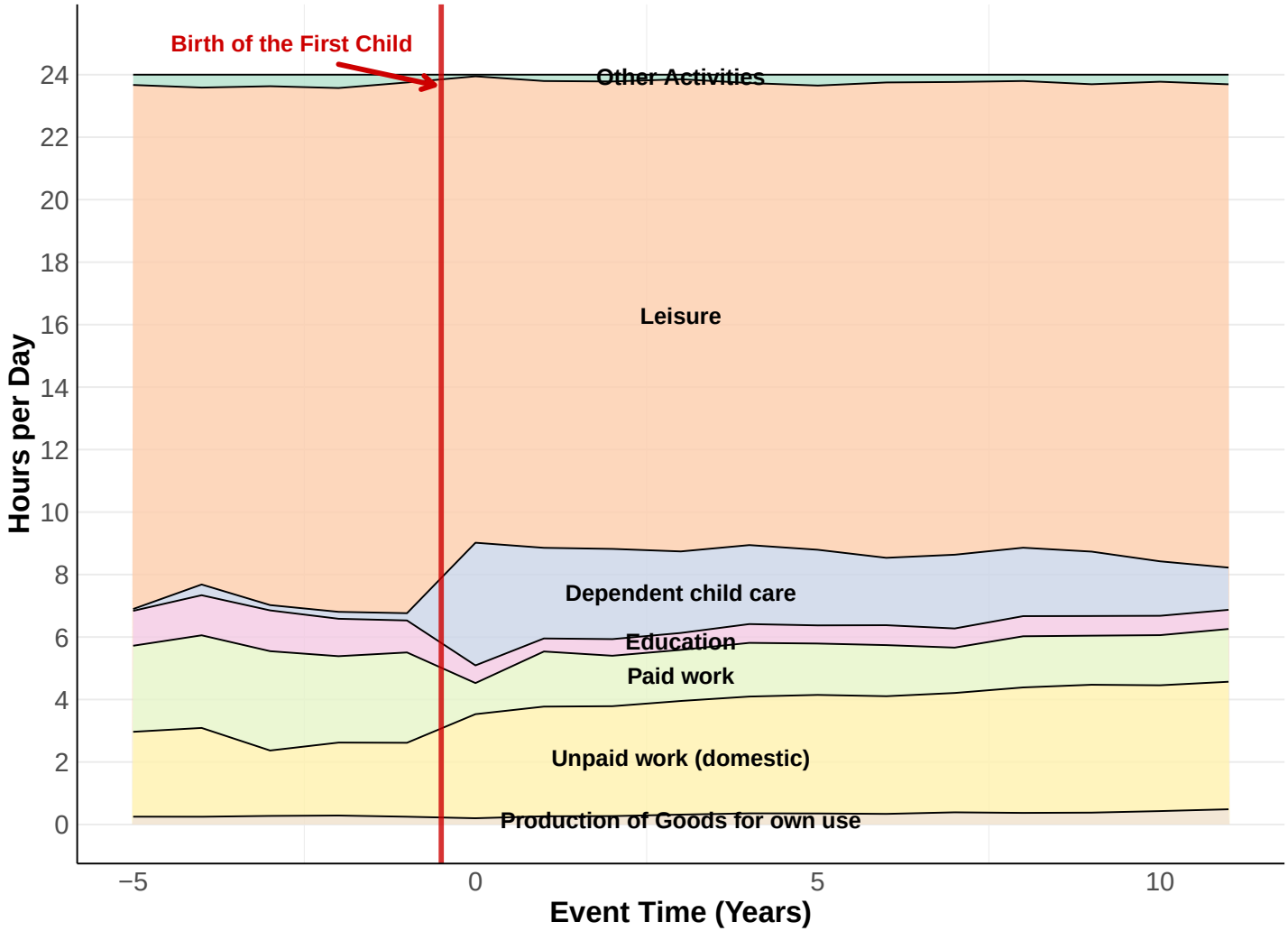
Decomposition of unpaid domestic work - by Gender

Average across worldwide population: Laundry



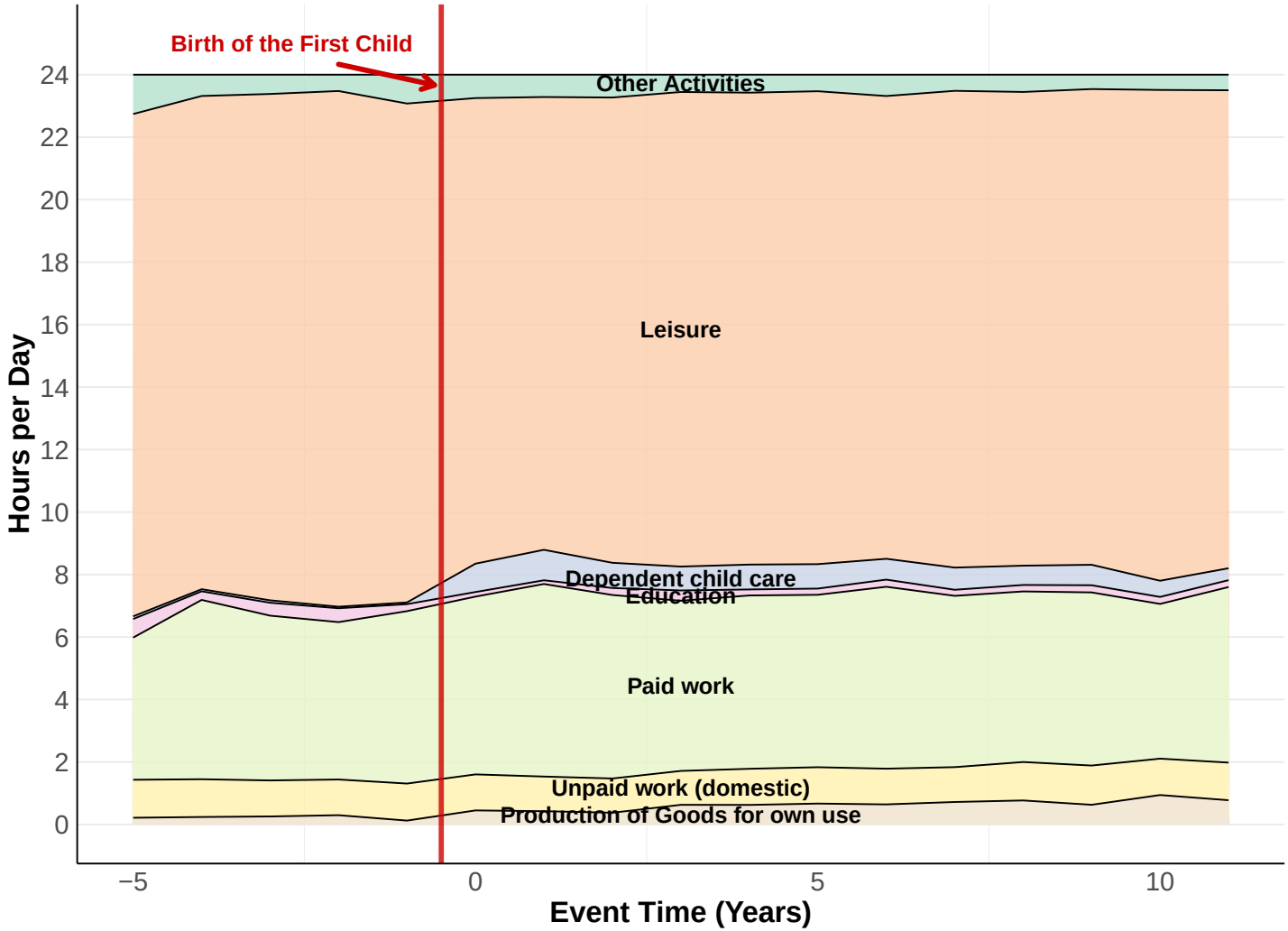
Average daily time use around parenthood

Average across worldwide population: Mothers



Average daily time use around parenthood

Average across worldwide population: Fathers



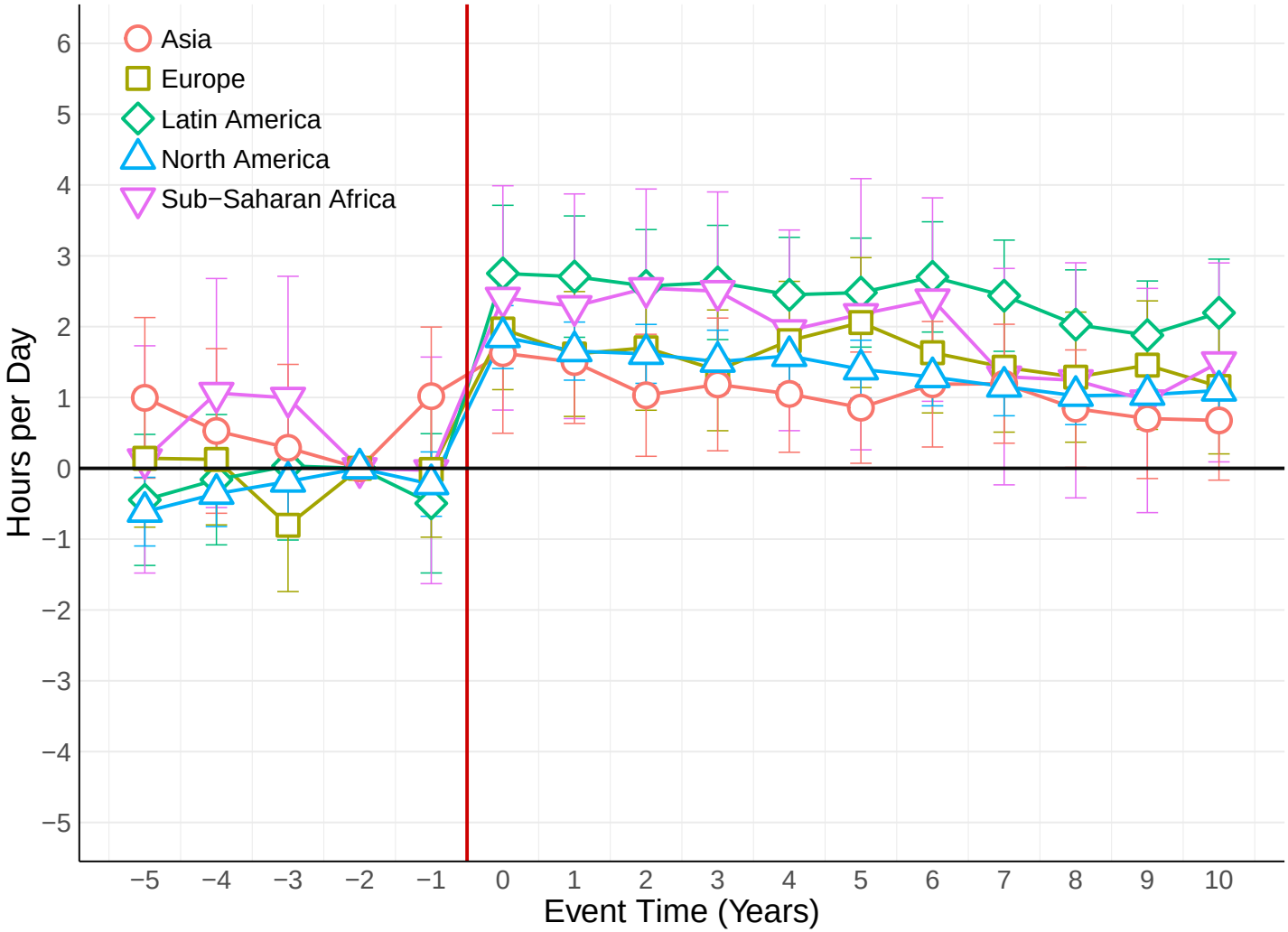
By gender: Key Takeaways

- Increase in active time for both men and women.
- Men increase time in paid work while women decrease it.
- Women show much larger increases in time in child care.
- Women also take the burden of unpaid domestic work.
  - Spread across all categories of unpaid domestic work.

Clear evidence of strong gender specialization in time use.

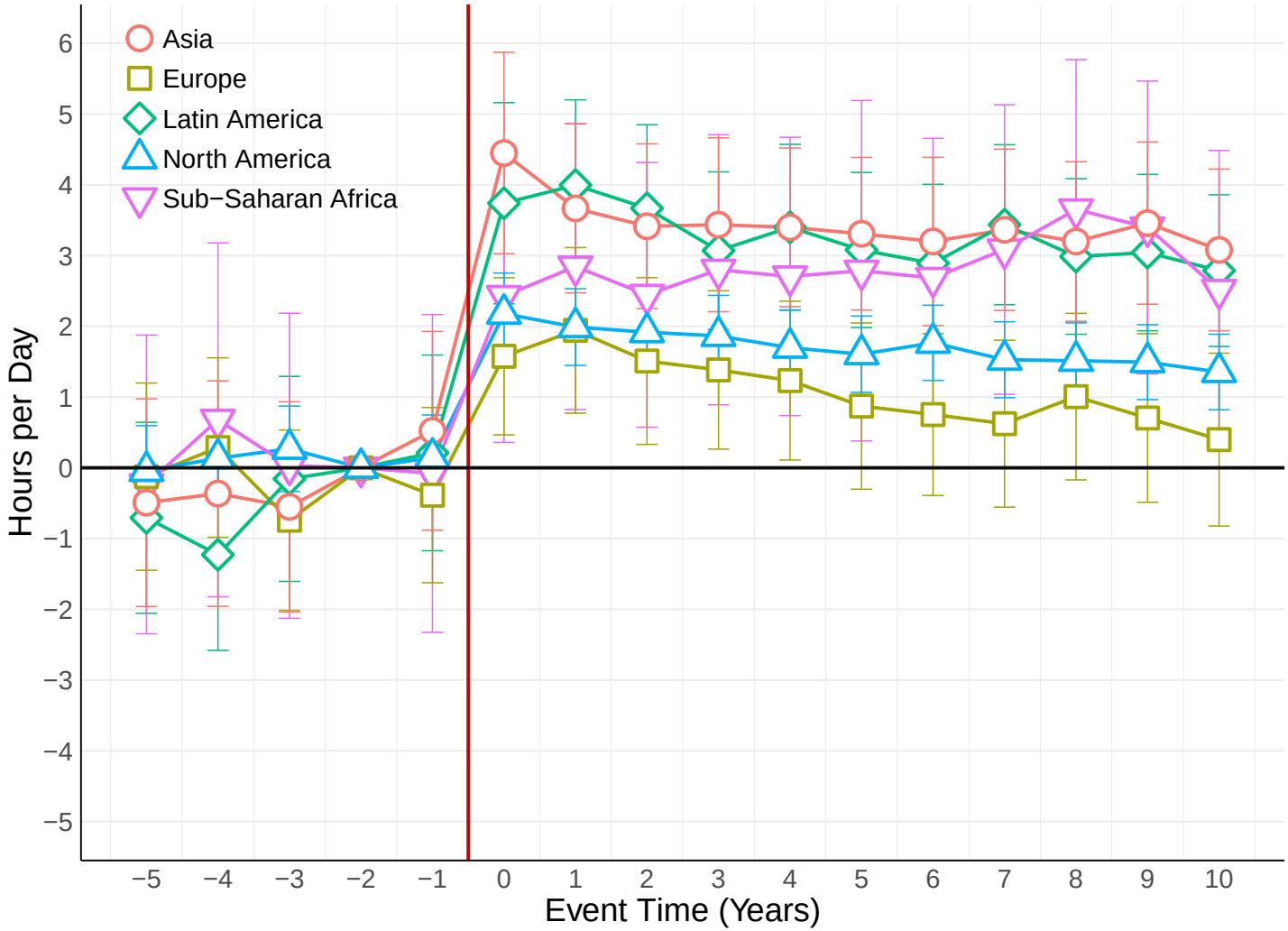
Gender Specialisation Across Geographies

Total Active Time - Men



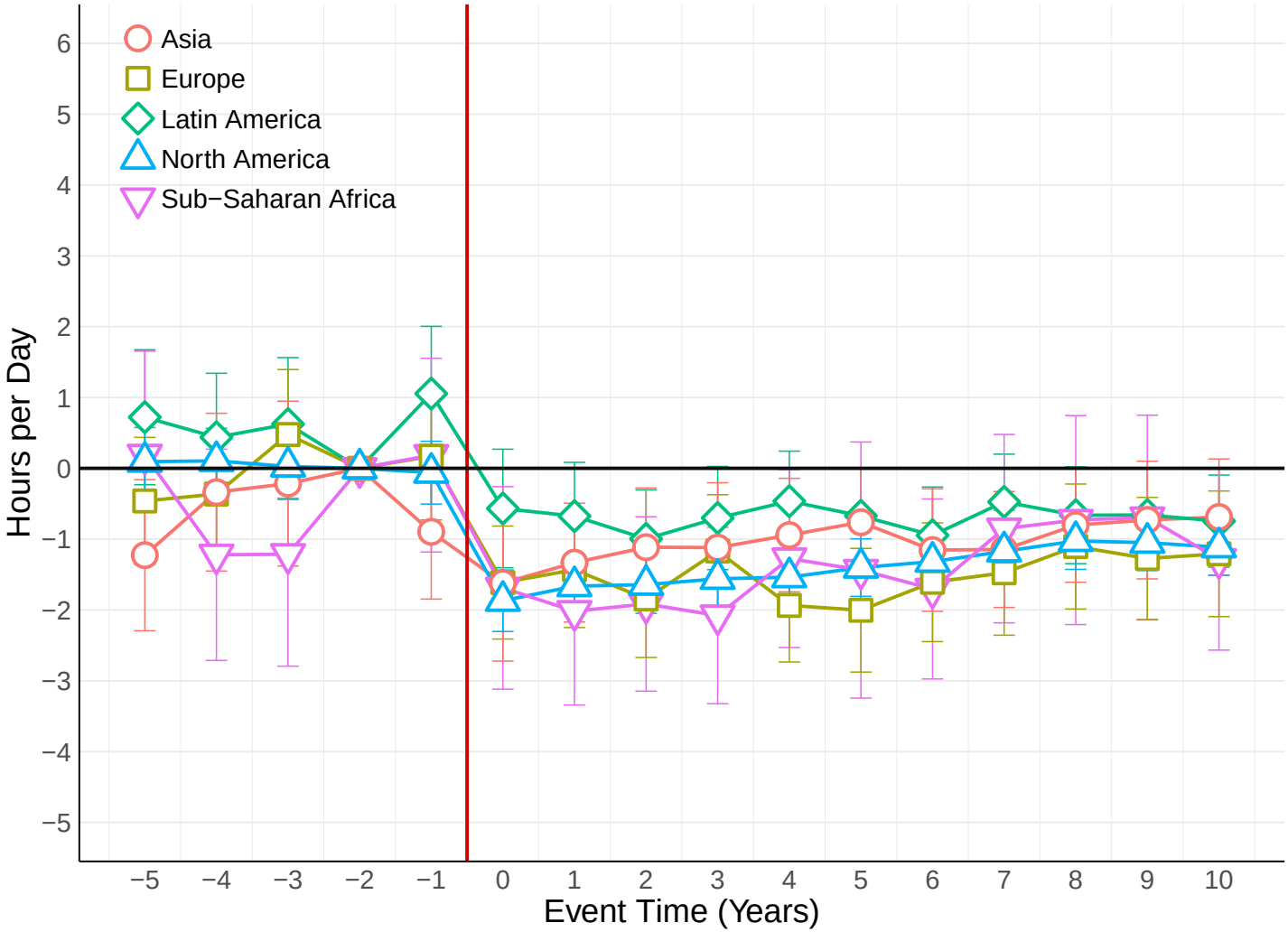
Gender Specialisation Across Geographies

Total Active Time - Women



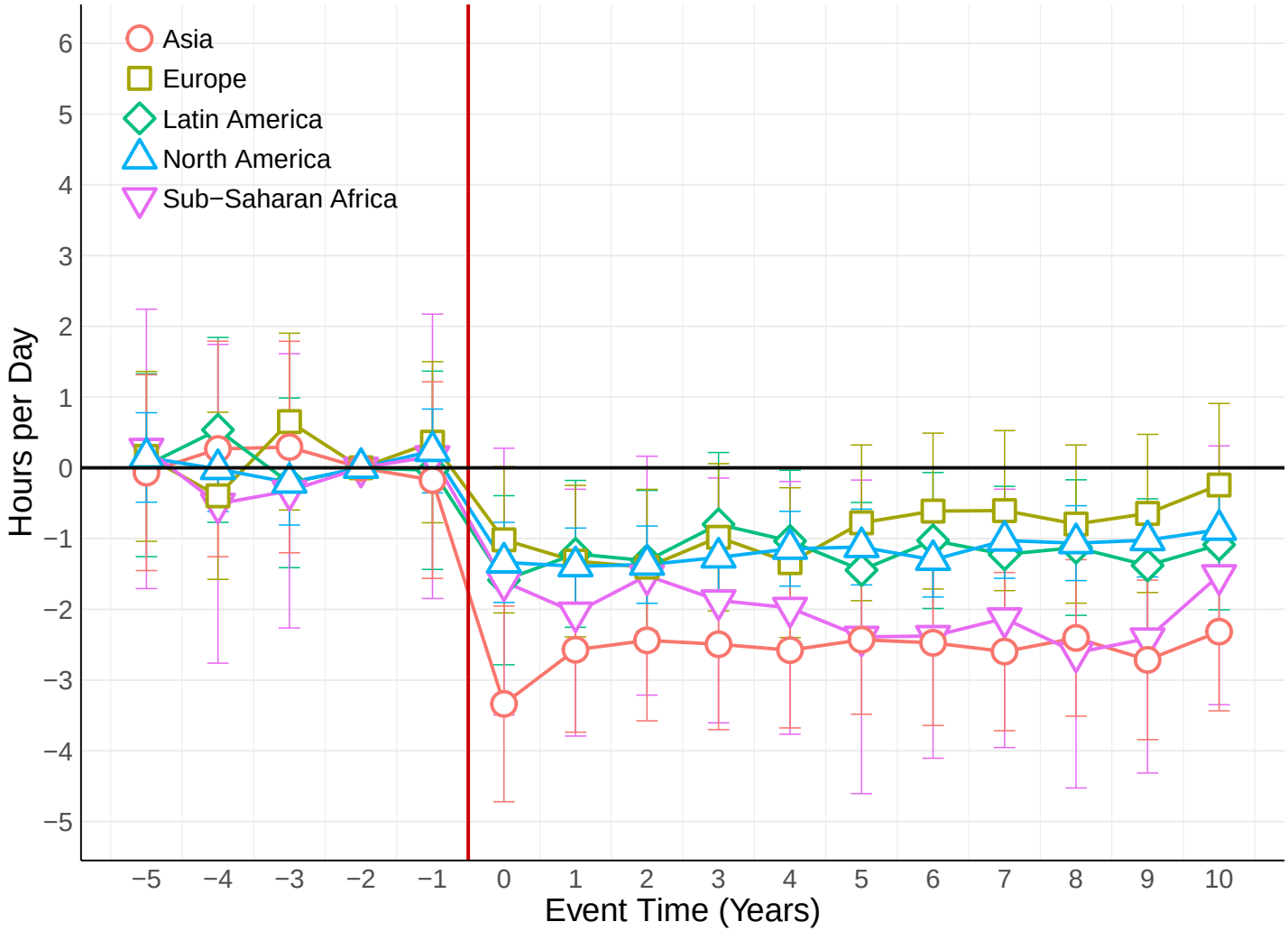
Gender Specialisation Across Geographies

Leisure - Men



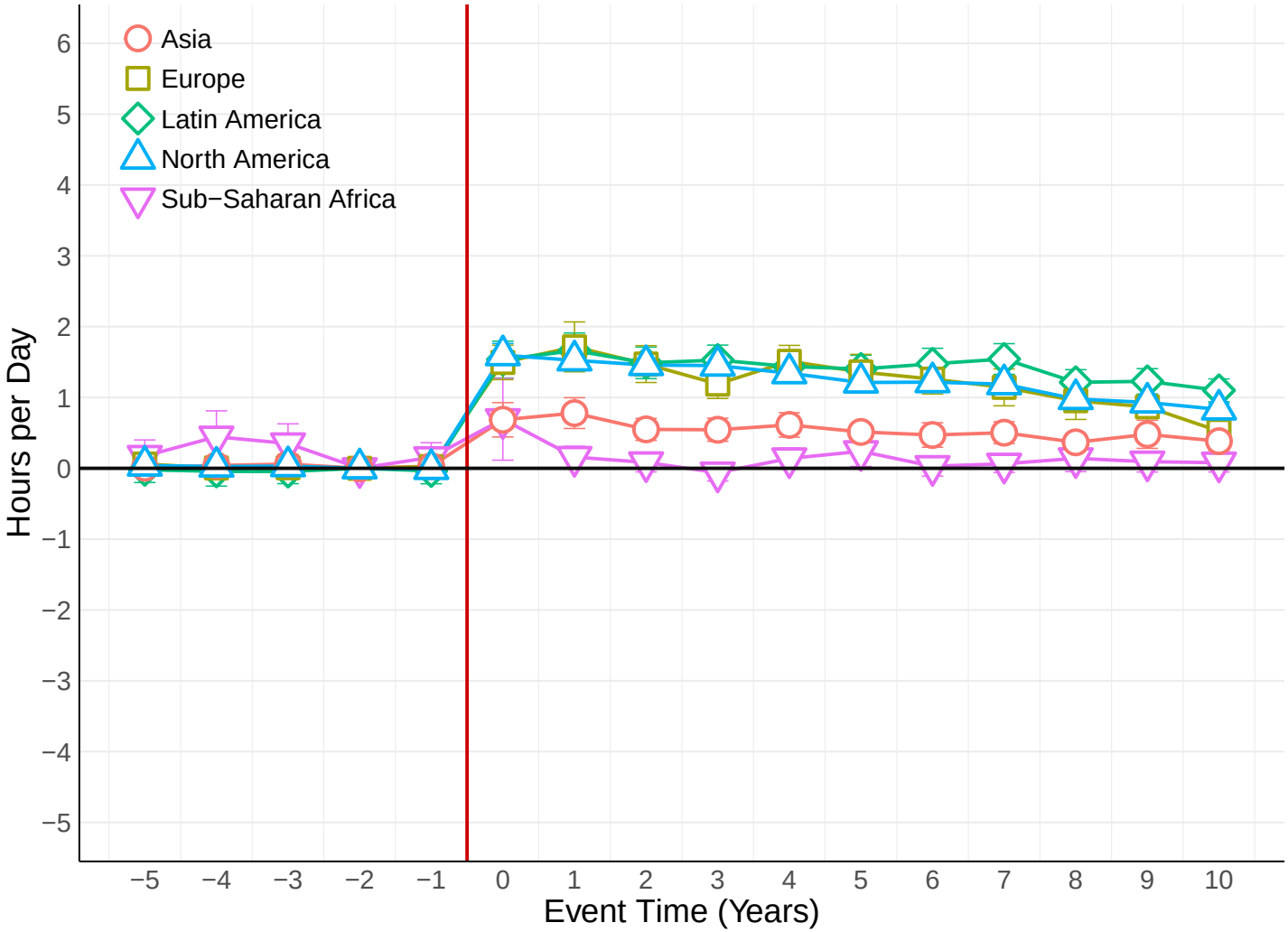
Gender Specialisation Across Geographies

Leisure - Women



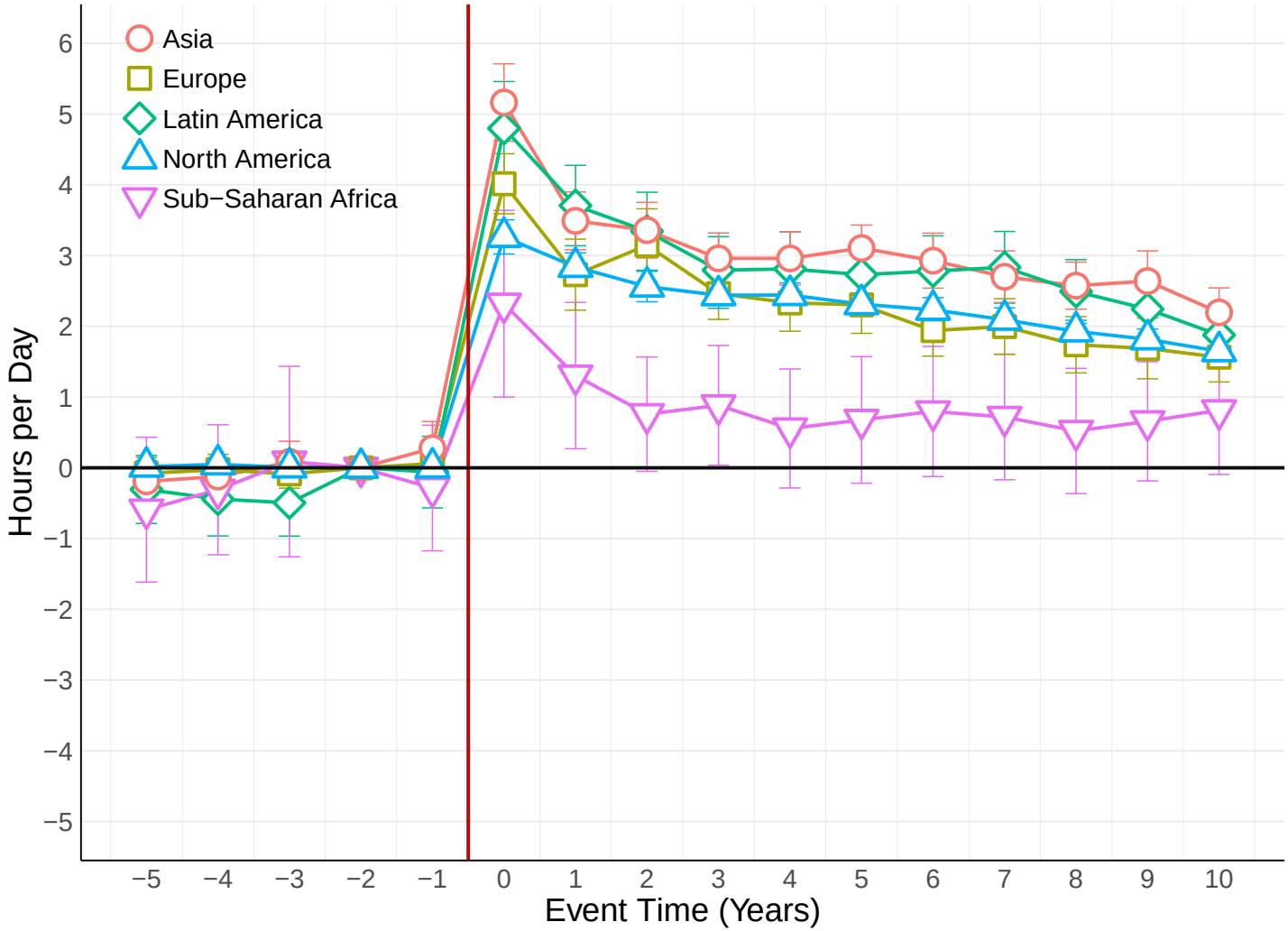
Gender Specialisation Across Geographies

Child Care - Men



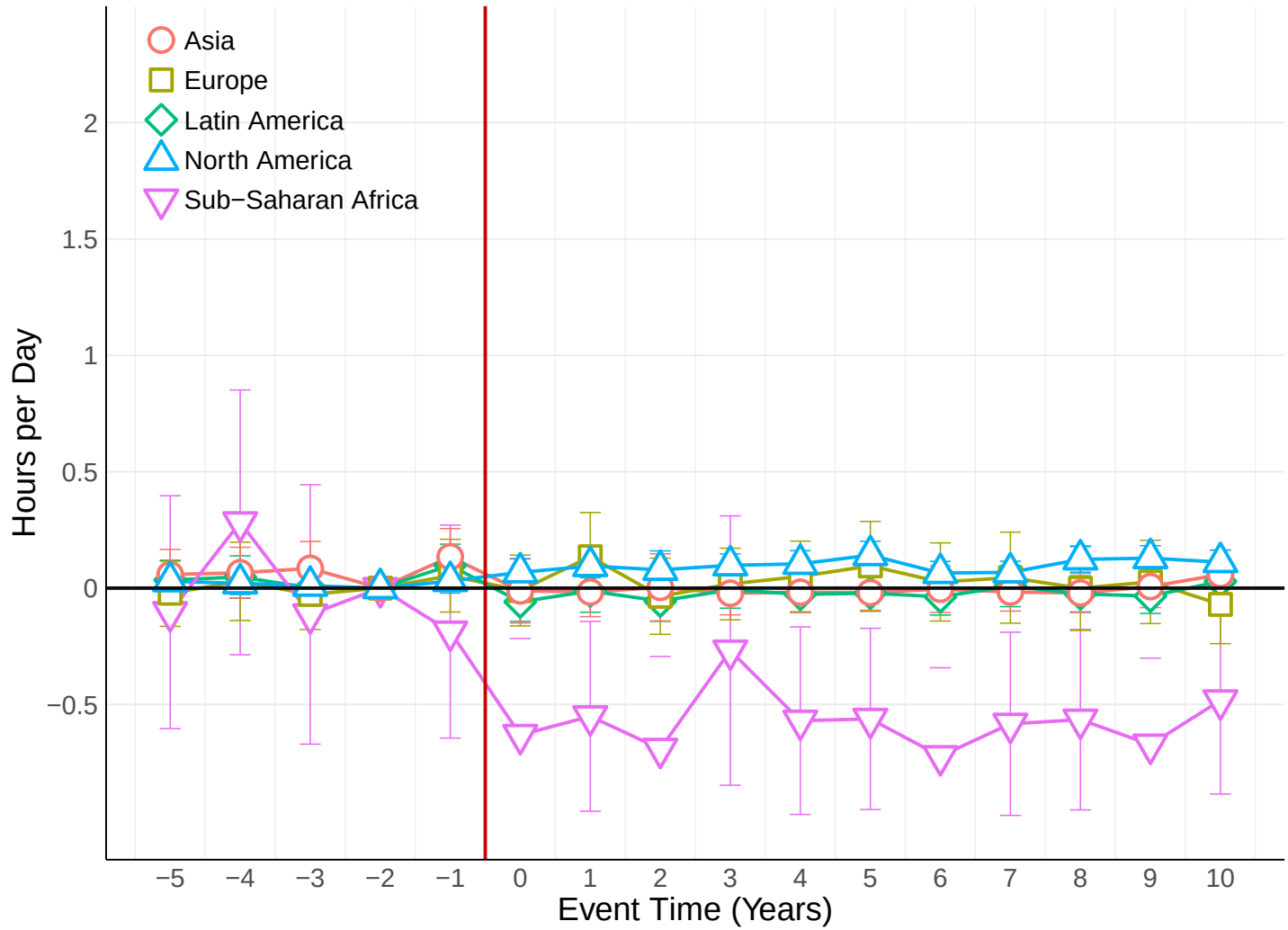
Gender Specialisation Across Geographies

Child Care - Women



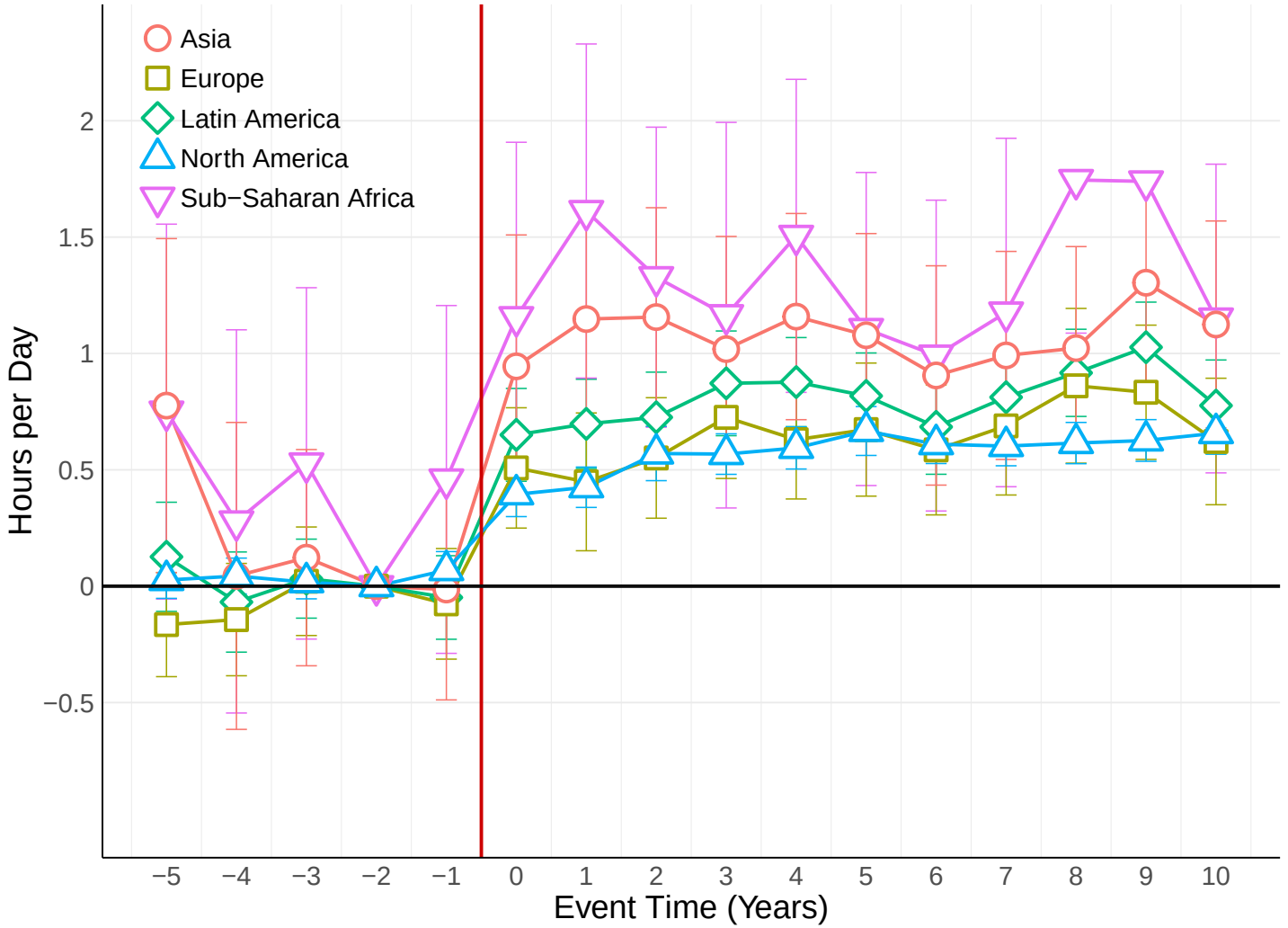
Gender Specialisation Across Geographies

Food Preparation - Men



Gender Specialisation Across Geographies

Food Preparation - Women



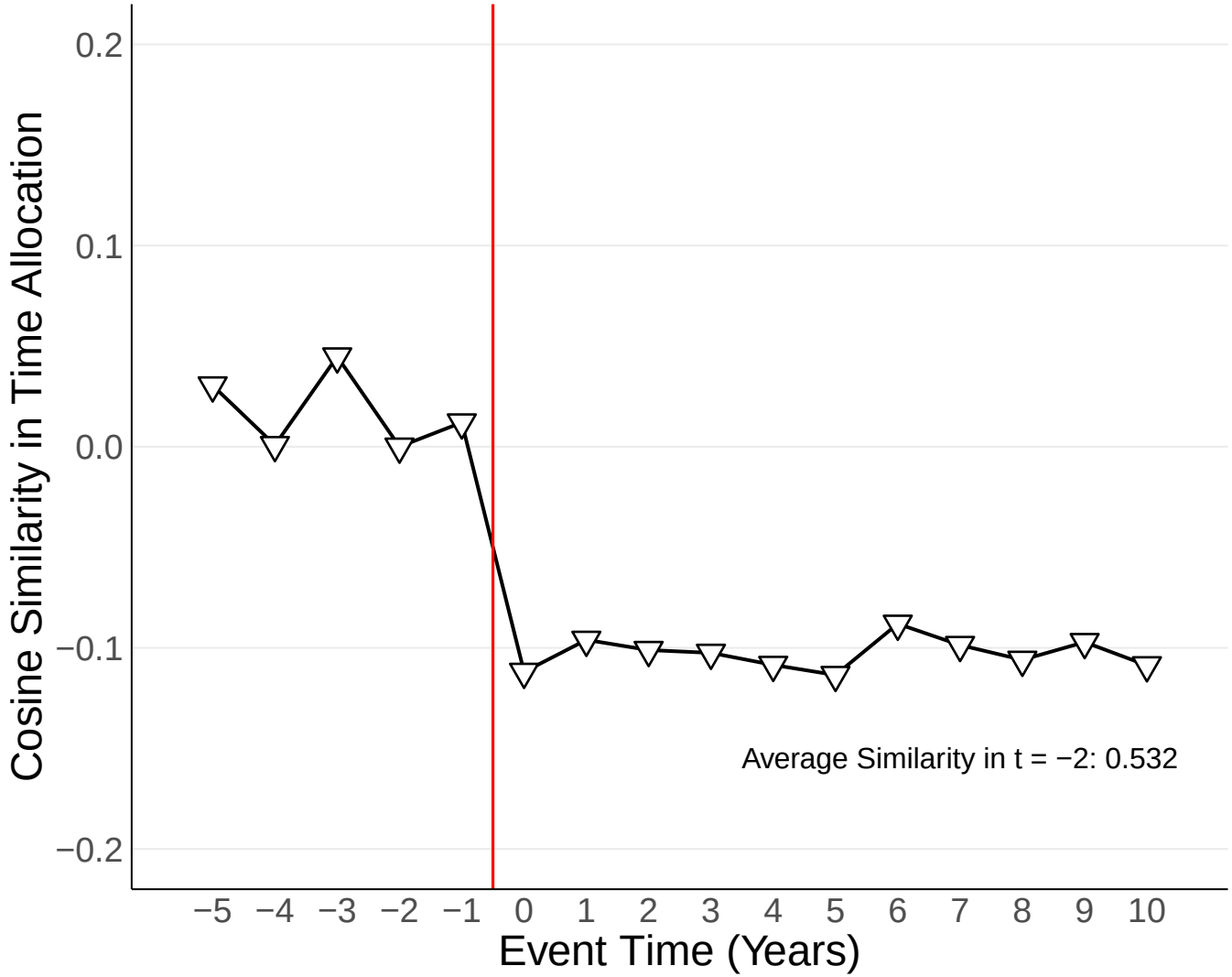
Measures of gender segregation in time use

- To capture synthetic measure of household specialisation, we compute measures of gender segregation in time use
- For each individual, we project their time use in n-dimensional space, where n is total number of possible categories of time-use.
- Within household, compute cosine similarity between mother's and father's time use vector.
  - perfect similarity: 1
  - perfect opposites: 0
- Analyse dynamics of vector similarity around parenthood

  $\Rightarrow$ **Is gender segregation in roles pre-existing parenthood?**

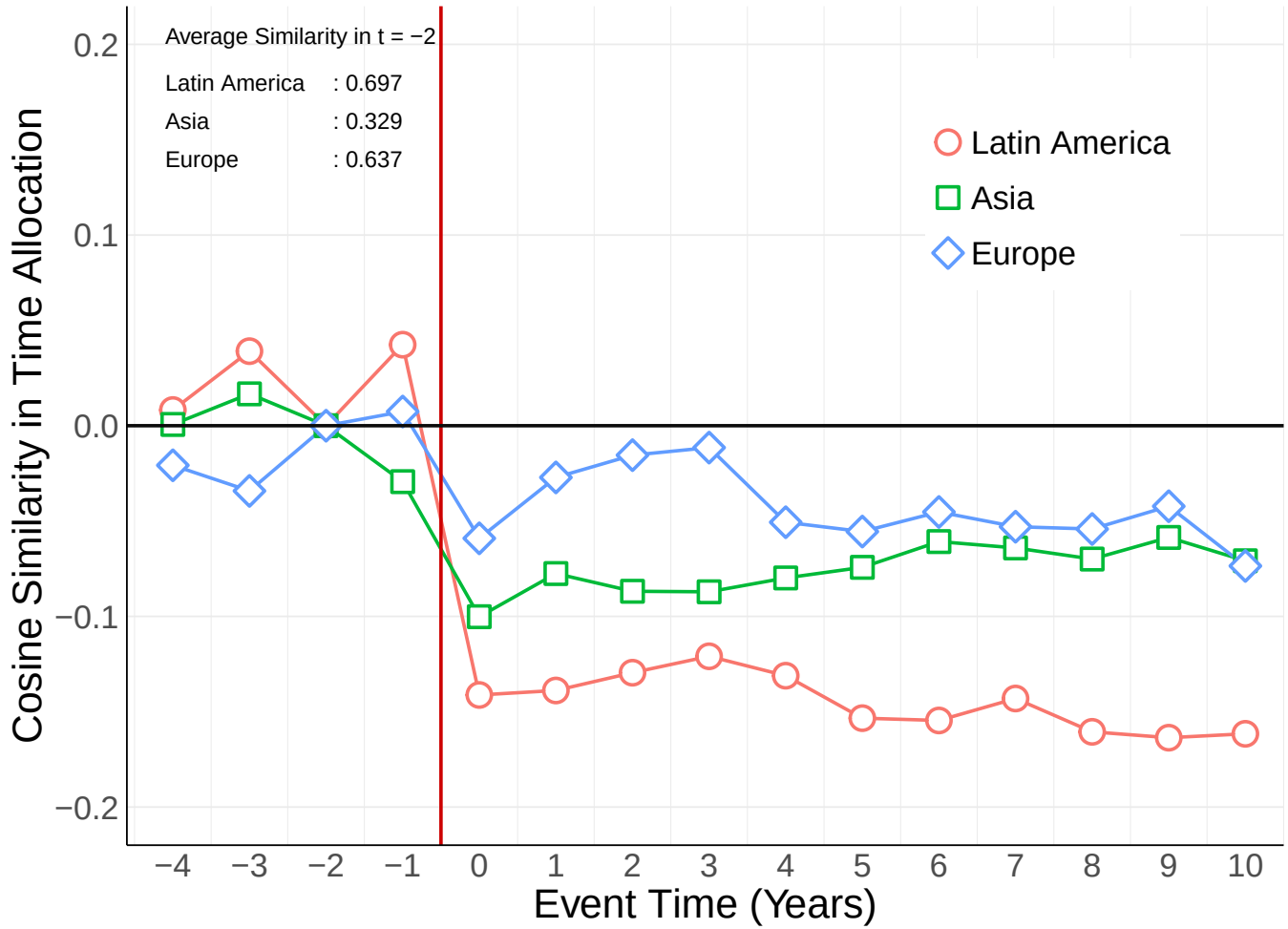
  $\Rightarrow$ **How much is parenthood contributing to gender specialisation?**

Measures of gender segregation in time use



Significant increase ($\approx$ 20%) in gender specialisation with parenthood

Measures of gender segregation in time use



Largest increase in gender specialisation in Latin America

Outline

1. Motivation
2. Data & Methodology
3. Children & parental time investments
4. Parenthood & gender specialisation in time use
5. Welfare Impacts of Gender Specialisation

Shifting Focus from Activities to Attributes

- Why Attributes?
  - Move beyond activity labels to capture *what characterizes* individuals' days, not just task composition.
  - Extract dimensions: e.g. *physical effort*, *cognitive load*, *location*.
  - Builds on existing TU literature (e.g. Cornwell, Gershuny & Sullivan 2019)

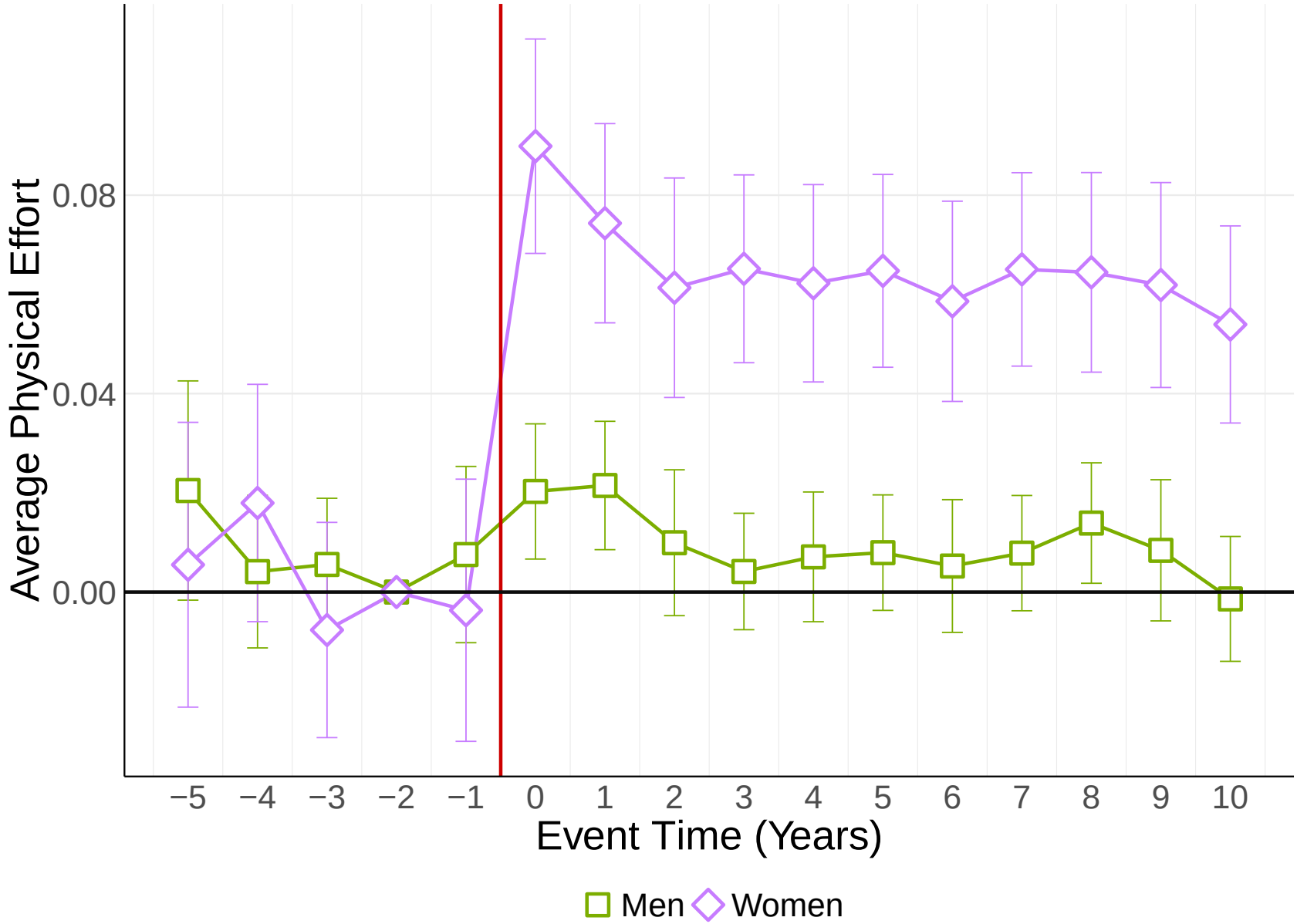
- Conceptual Framework
  1. Define a continuous latent variable ν_a for each attribute and assign it to each activity
  2. Set absolute thresholds ν_a^* to map ν_a into discrete categories (e.g.low/medium/high)
  3. Choose an aggregation statistic (mean/median/max) to summarize sub-activity values for higher-order tasks

- Key Principles
  - **Transparency**: Clear, repeatable definitions and cut-points
  - **Scalability**: Fully automatable (rule-based or LLM-assisted)
  - **Flexibility**: Add new attributes without modifying raw data

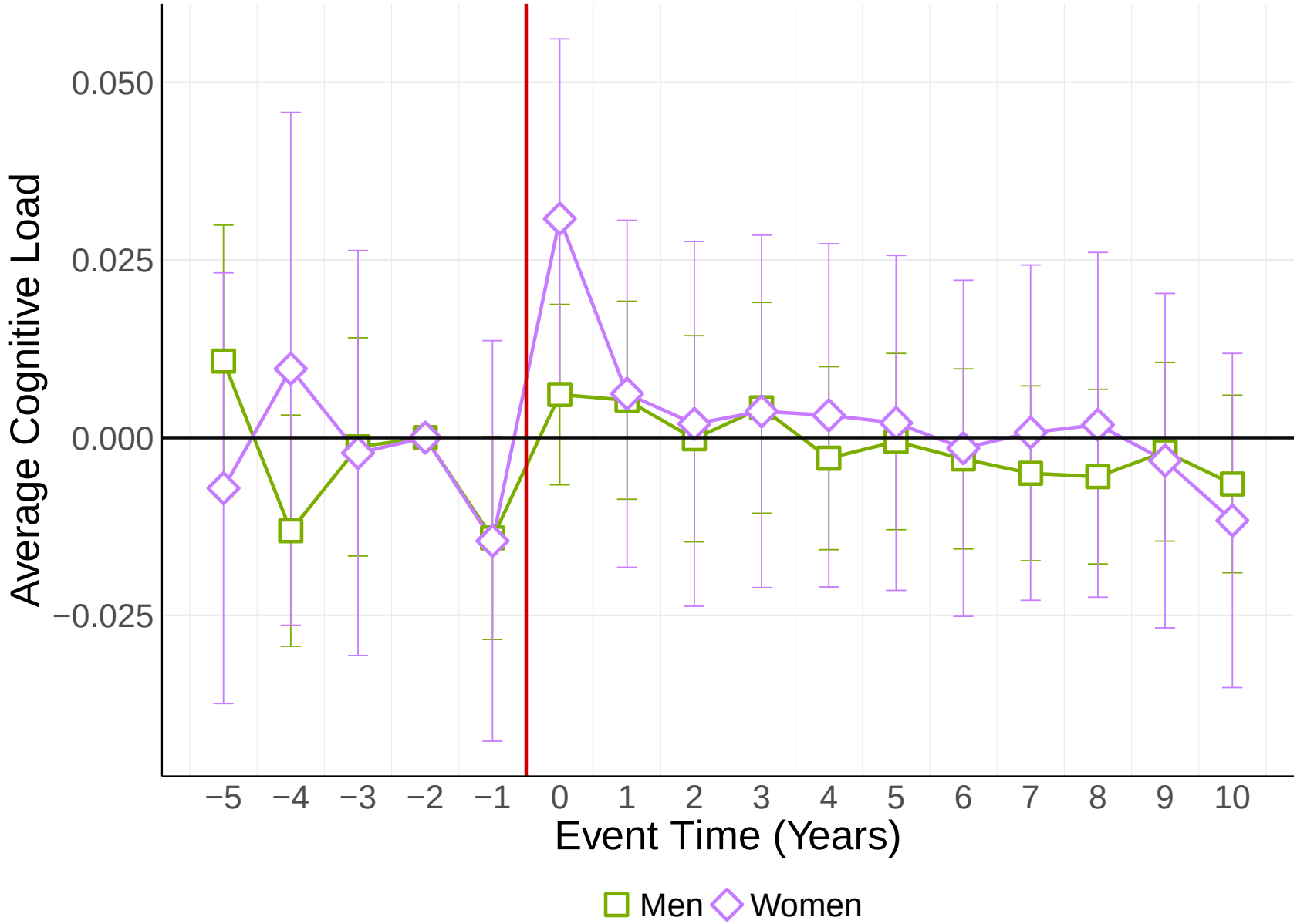
Automating Attribute Extraction with LLMs

- LLM-Based Scoring Pipeline
  1. **Batch Scoring**: Send all activity labels at once to the ChatGPT API to obtain a continuous score $\hat{\nu}_a$ per attribute, forcing cross-activity comparison.
  2. **Ensemble Averaging**: Repeat scoring procedure; compute the mean score $\bar{\nu}_a$ for each activity.
  3. **Data-Driven Thresholding**: For each attribute:
     - Run k-means clustering on $\{\bar{\nu}_a\}$ with $k =$ desired number of categories.
     - Repeat clustering n times; choose thresholds that minimize within-cluster sum of squares.
- Validation
  - **Literature**: Aligned with studies showing LLM classification matches expert judgments (e.g. Wei et al. 2024; Gao et al. 2023; Zingales et al. 2025).
  - **Human Vs LLMs**: More internal consistency then human annotators while yielding similar results (> 0.7 average correlation with humans).

Average physical effort



Average Cognitive load



Conclusion

- Birth of a child is a large shock to parental time allocation.

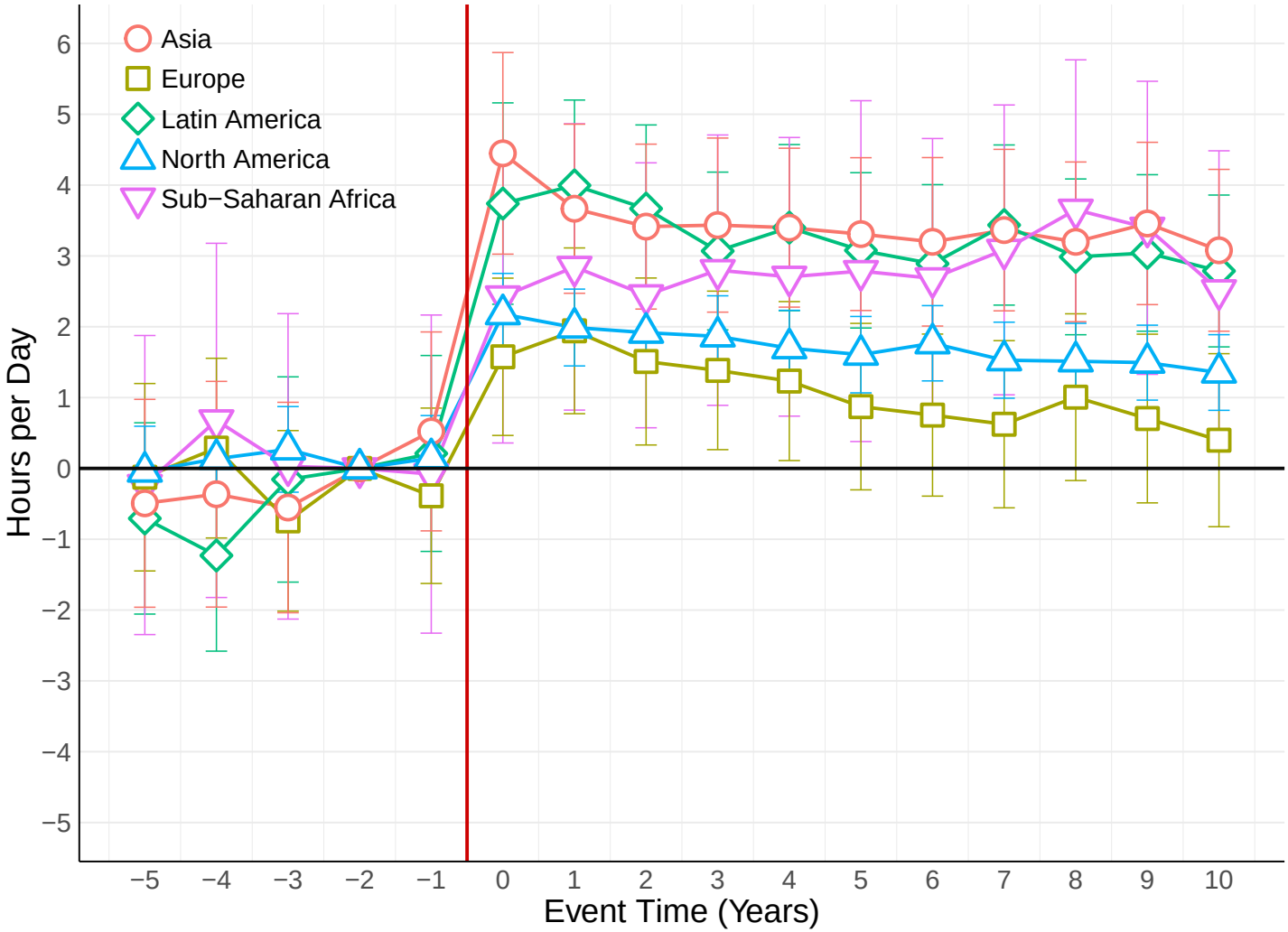
- Large heterogeneity across geographies.
  - Richer countries show higher substitutability between paid work and child care.
  - Higher prevalence of alloparental care in low and middle income countries.

- Increase in gender specialization in time use.
  - Women take the burden of child care and unpaid domestic work.
  - Potential welfare implications. E.g. Increase in physical load for women.

Appendix

Evolution of Parents' Active Time

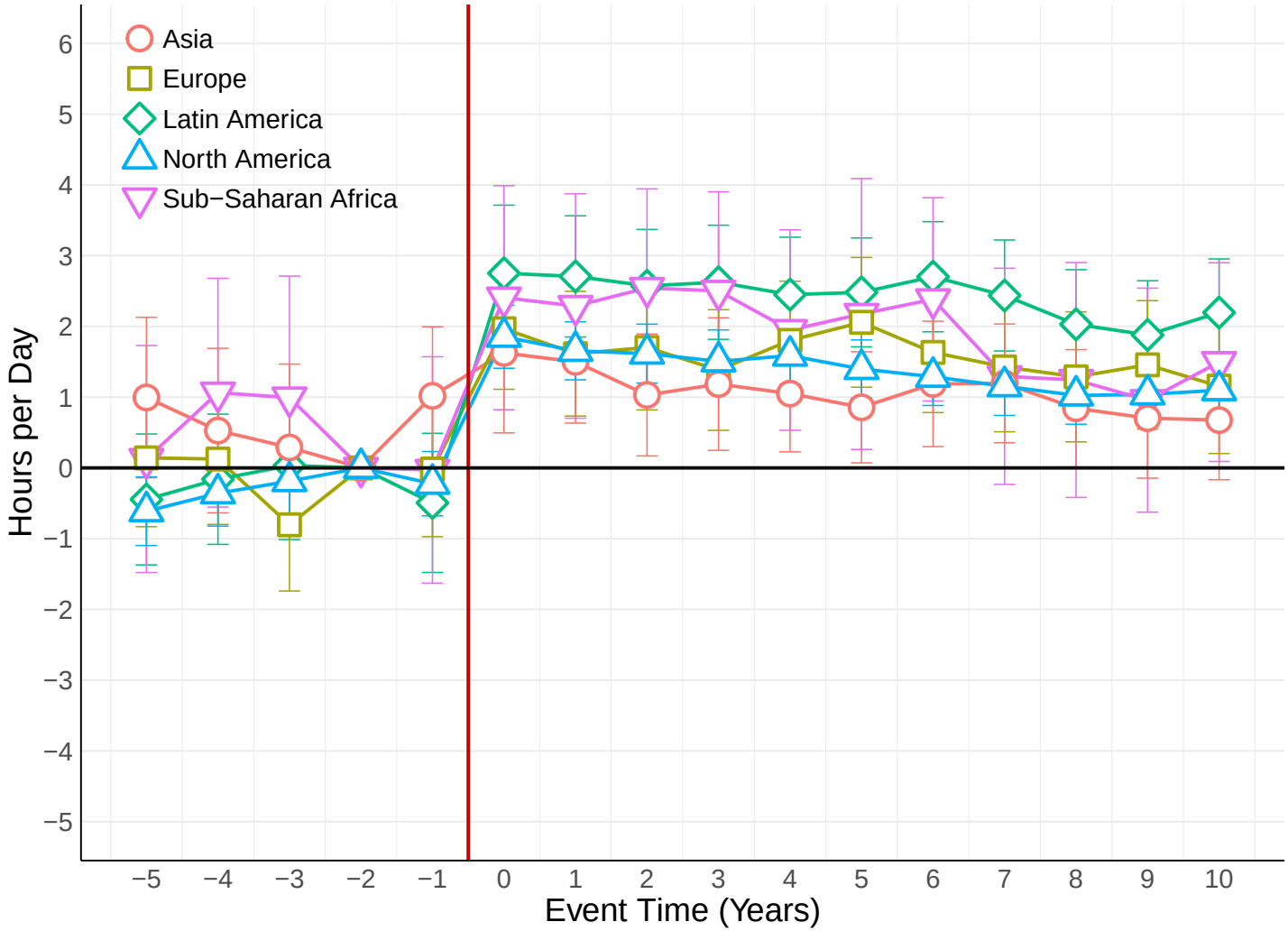
Evolution of Parents' Active Time: Women



Back

Evolution of Parents' Active Time

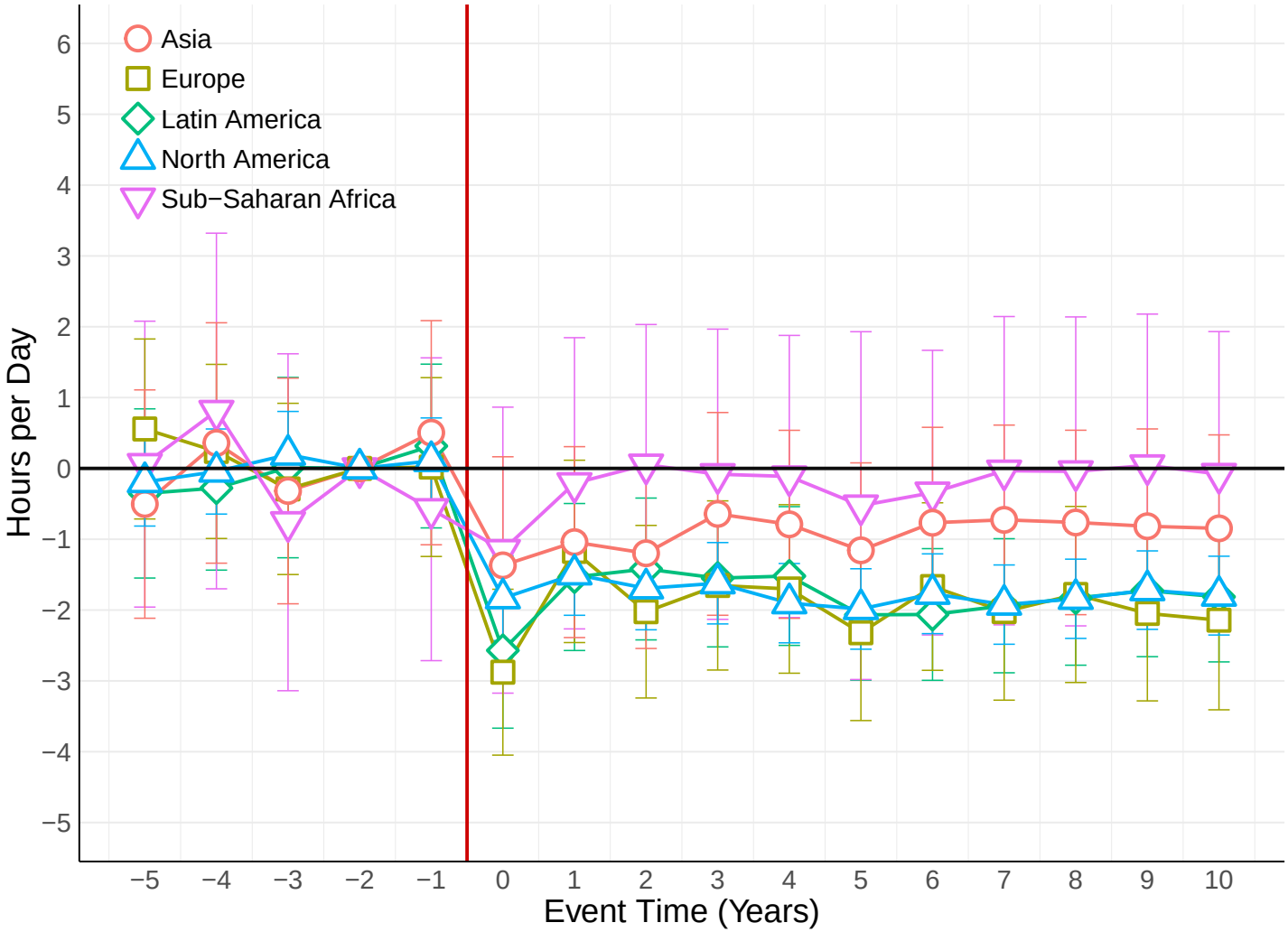
Evolution of Parents' Active Time: Men



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Active Time decomposition: Paid Work

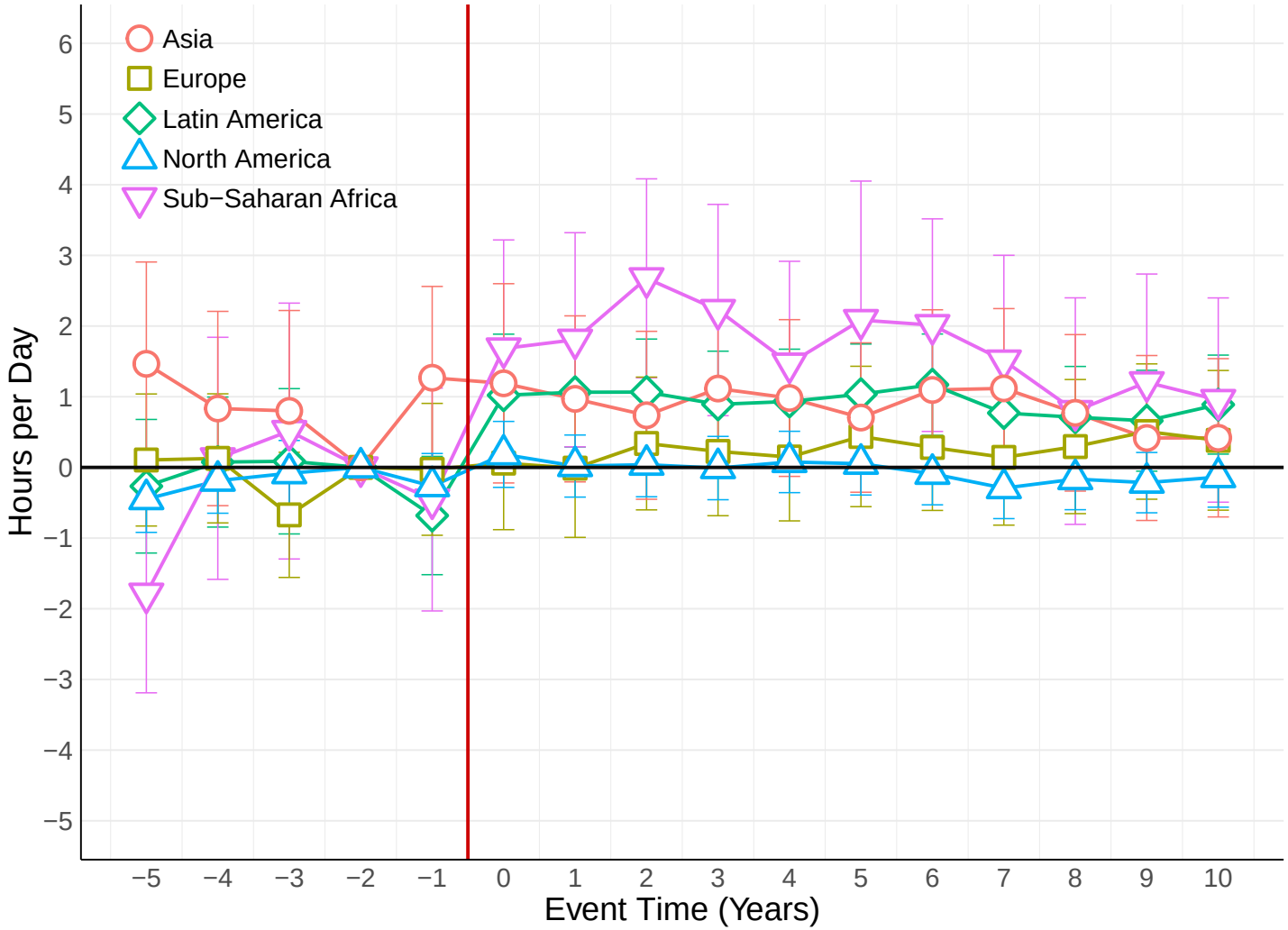
Active Time decomposition: Paid Work: Women



Back

Active Time decomposition: Paid Work

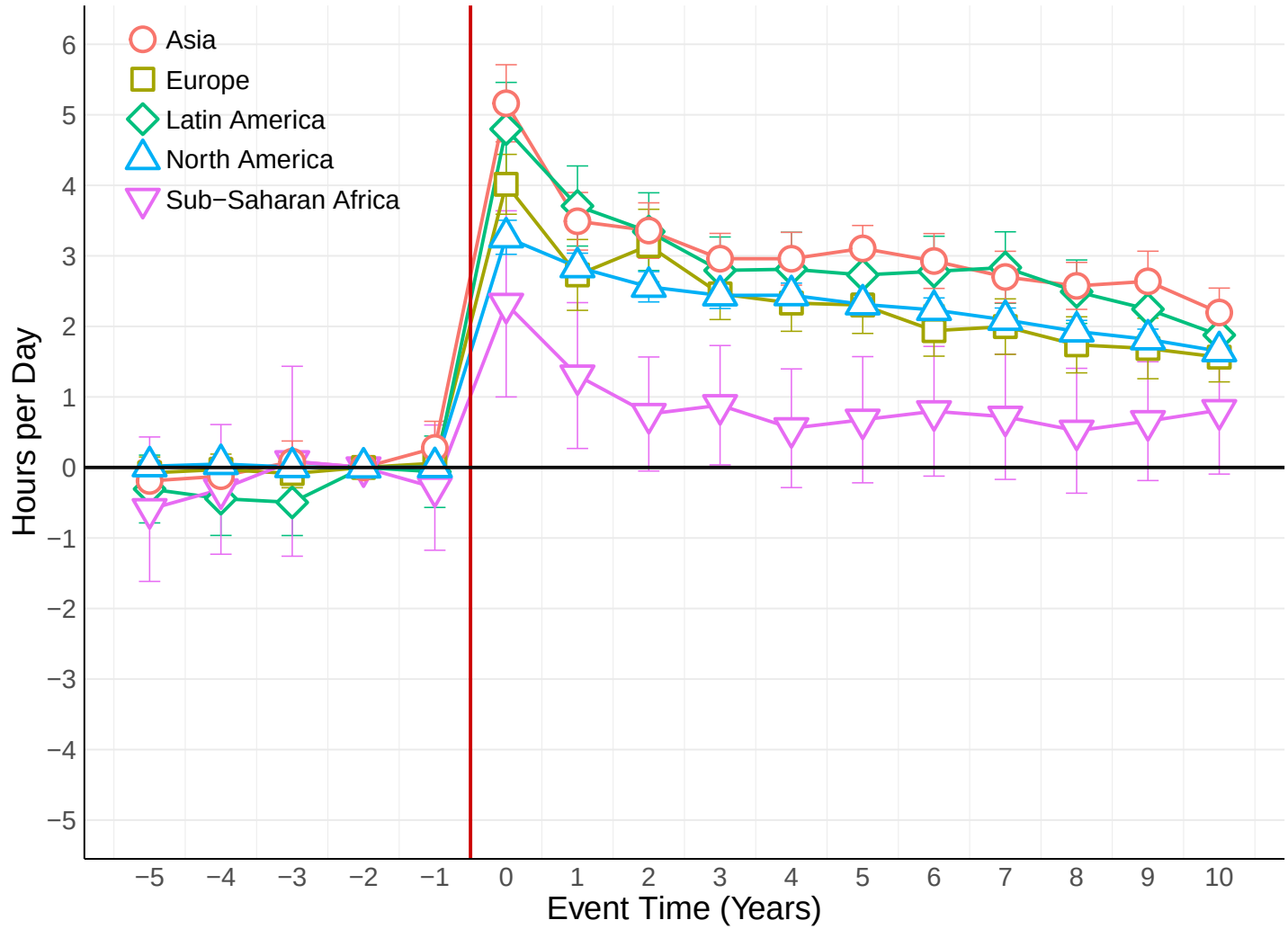
Active Time decomposition: Paid Work: Men



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Active Time decomposition: Dependent Child Care

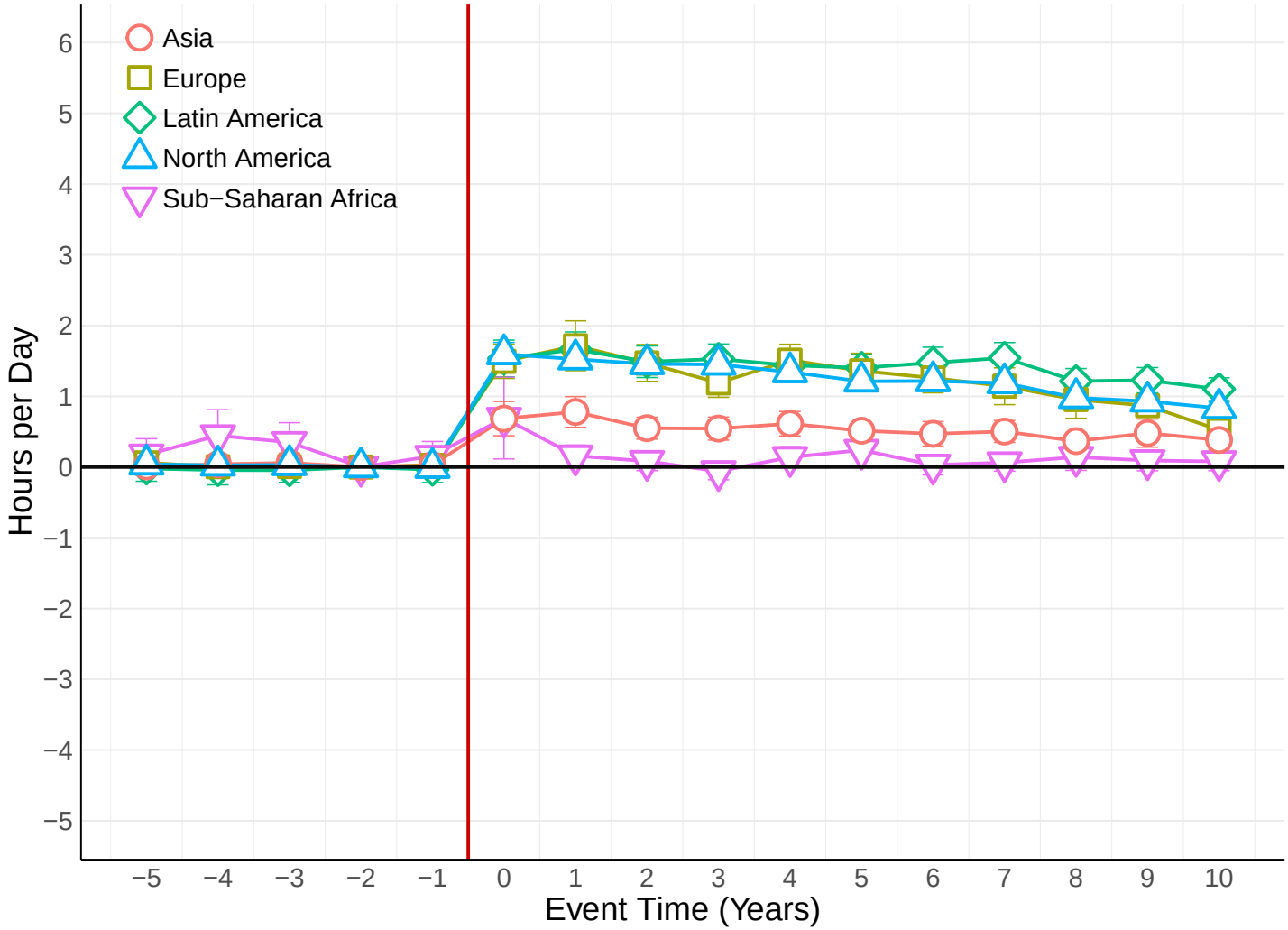
Active Time decomposition: Dependent Child Care: Women



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Active Time decomposition: Dependent Child Care

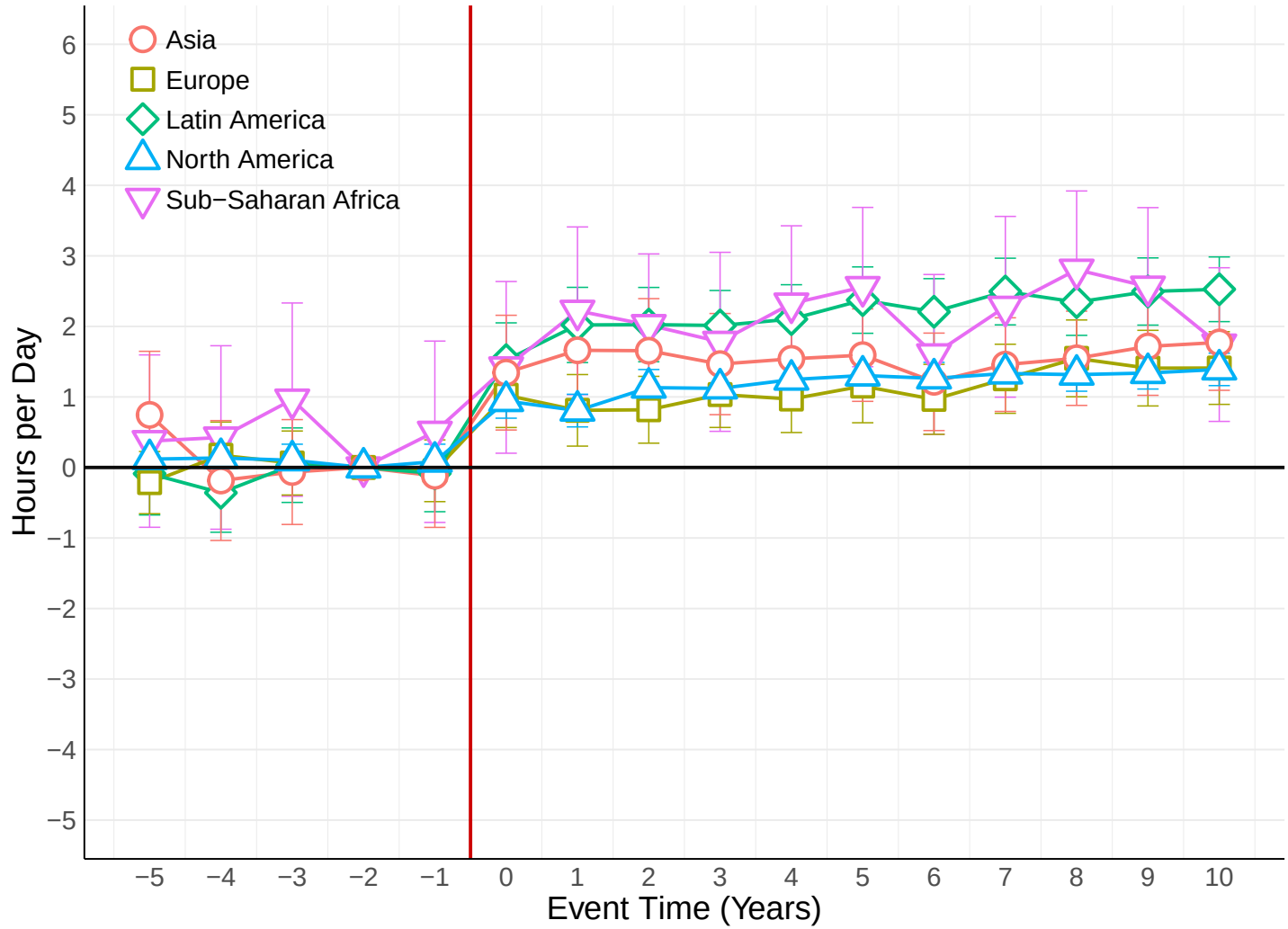
Active Time decomposition: Dependent Child Care: Men



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Active Time decomposition: Unpaid Domestic Work

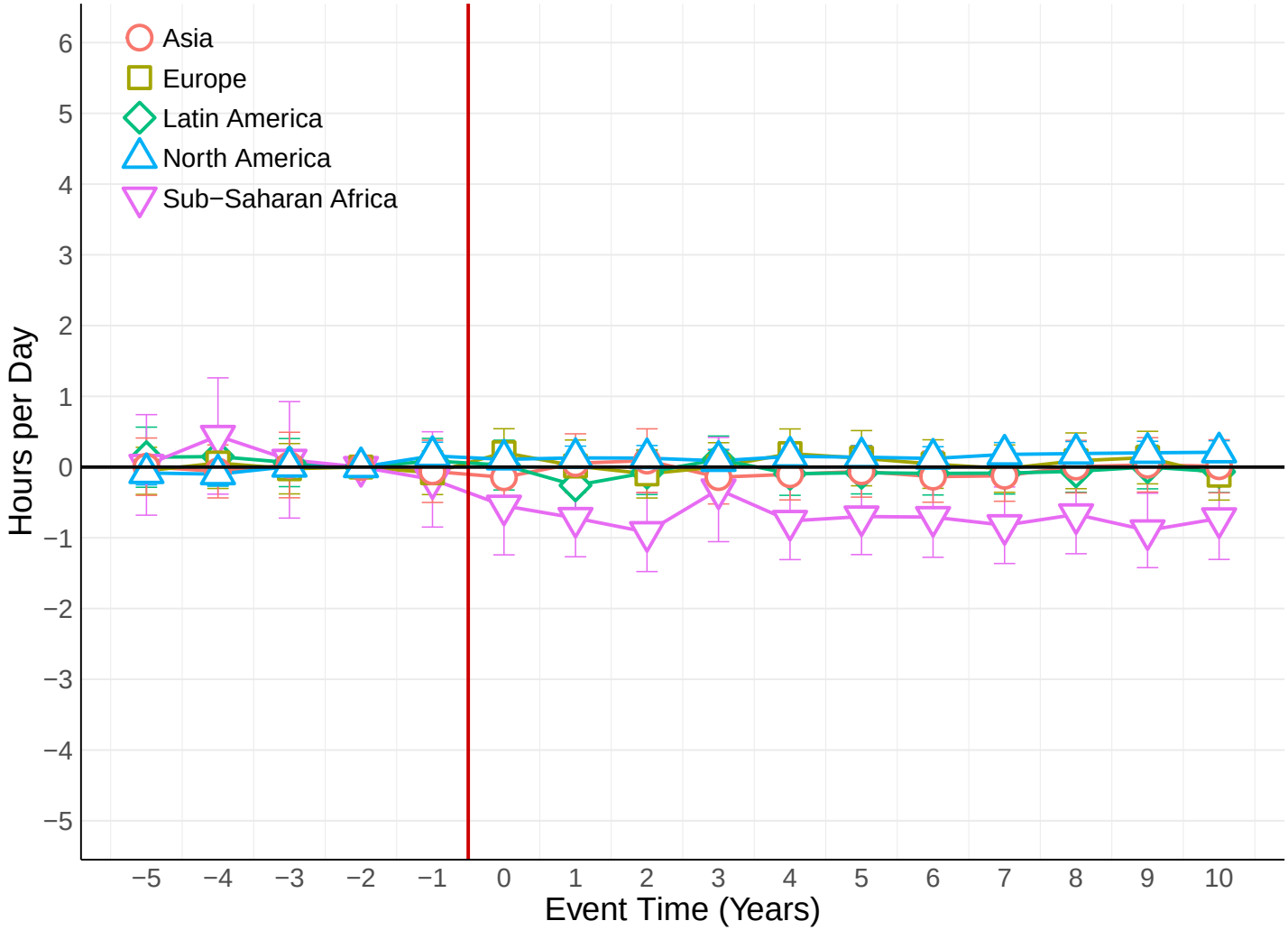
Active Time decomposition: Unpaid Domestic Work: Women



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Active Time decomposition: Unpaid Domestic Work

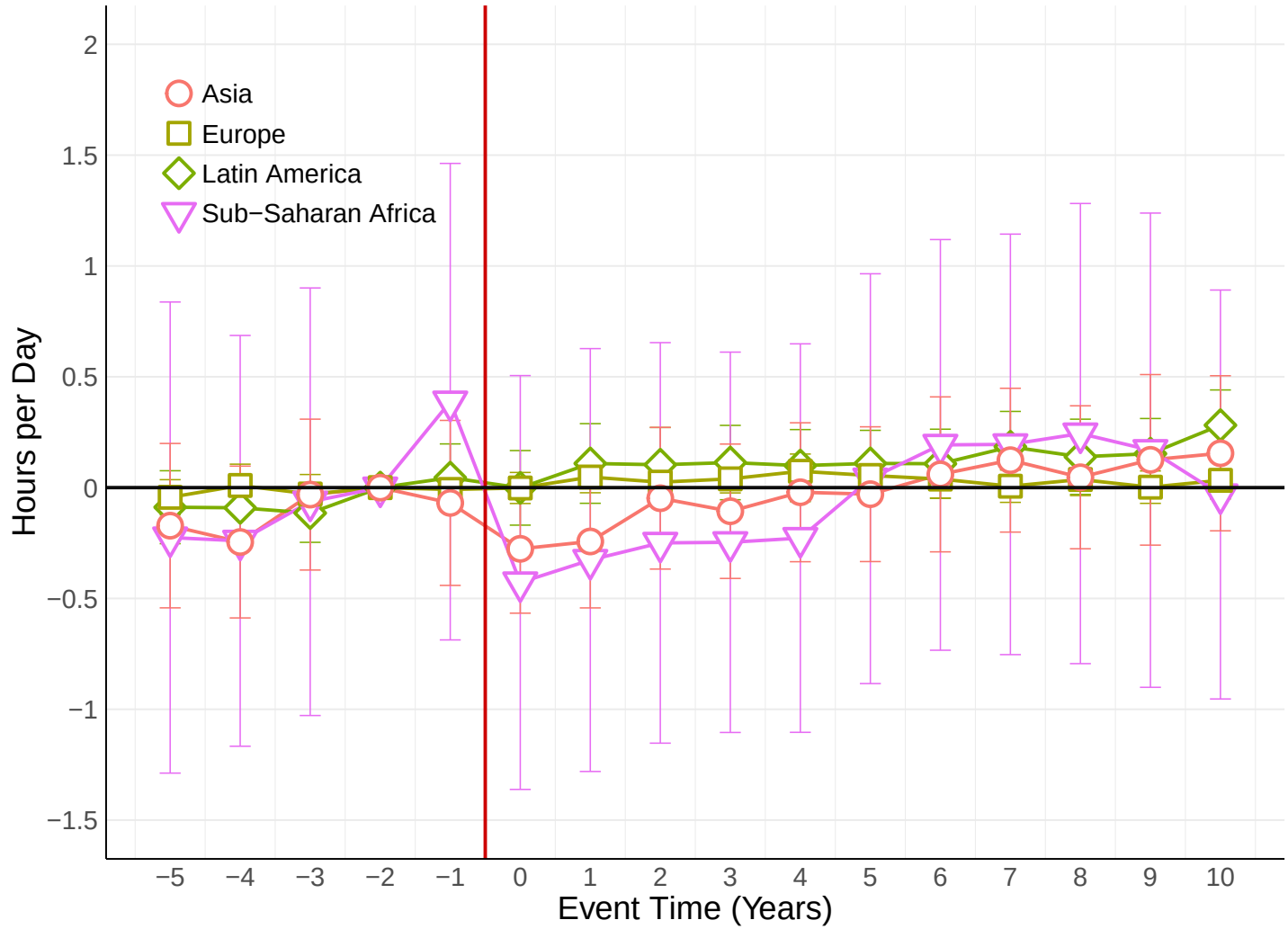
Active Time decomposition: Unpaid Domestic Work: Men



Back

Active Time decomposition: Production of good for own use

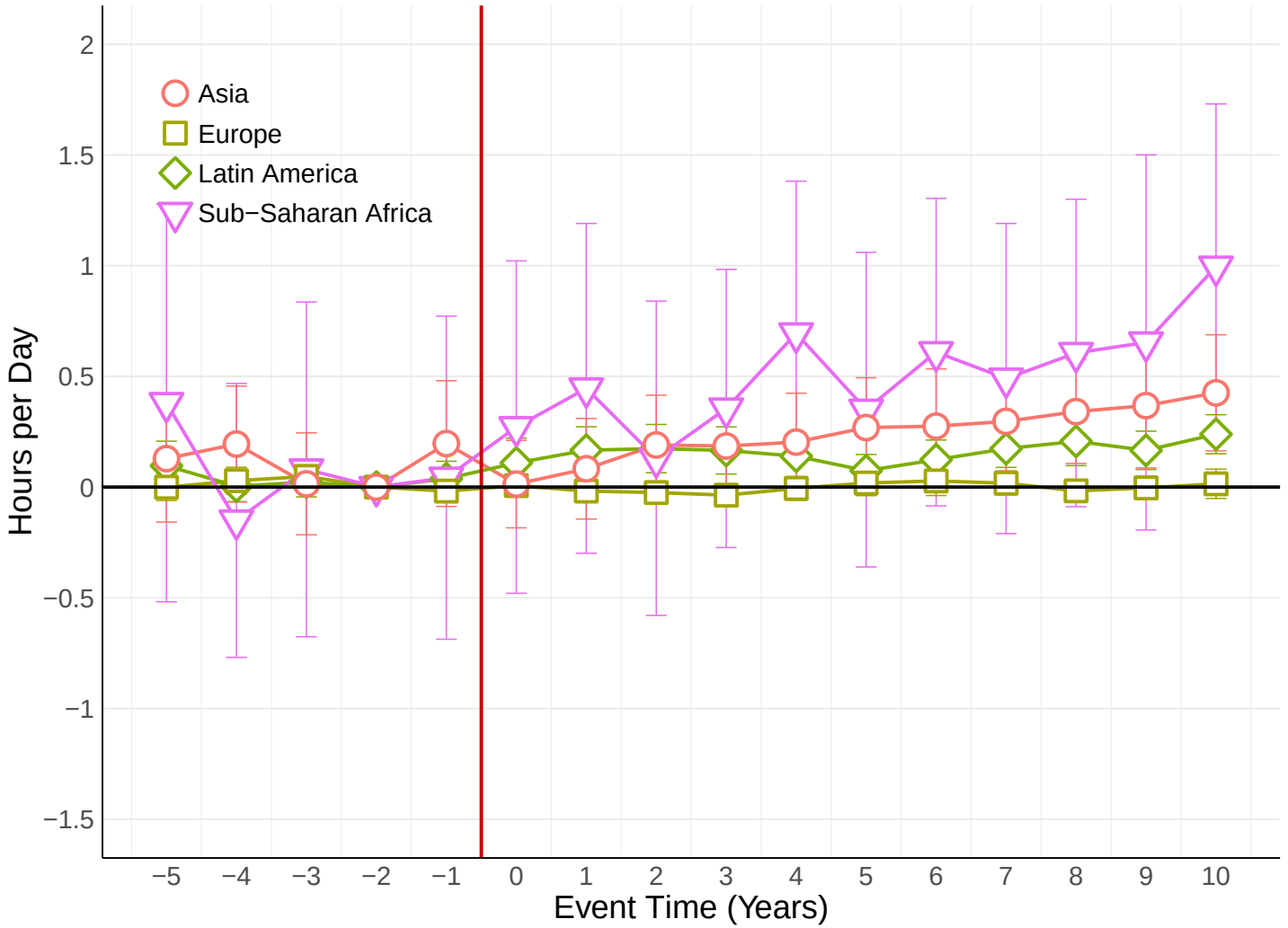
Active Time decomposition: Production of good for own use: Women



Back

Active Time decomposition: Production of good for own use

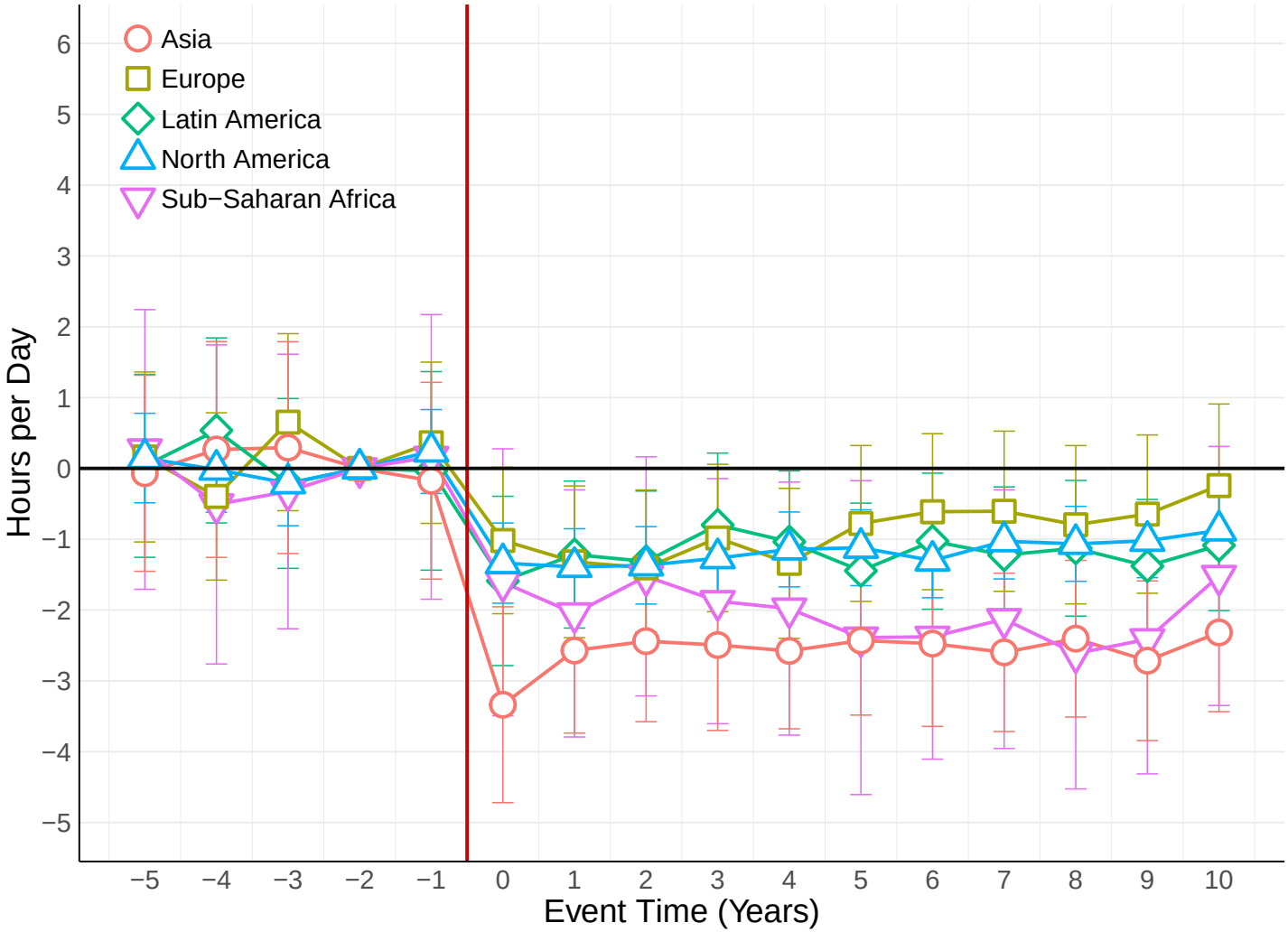
Active Time decomposition: Production of good for own use: Men



Back

Active Time decomposition: Leisure

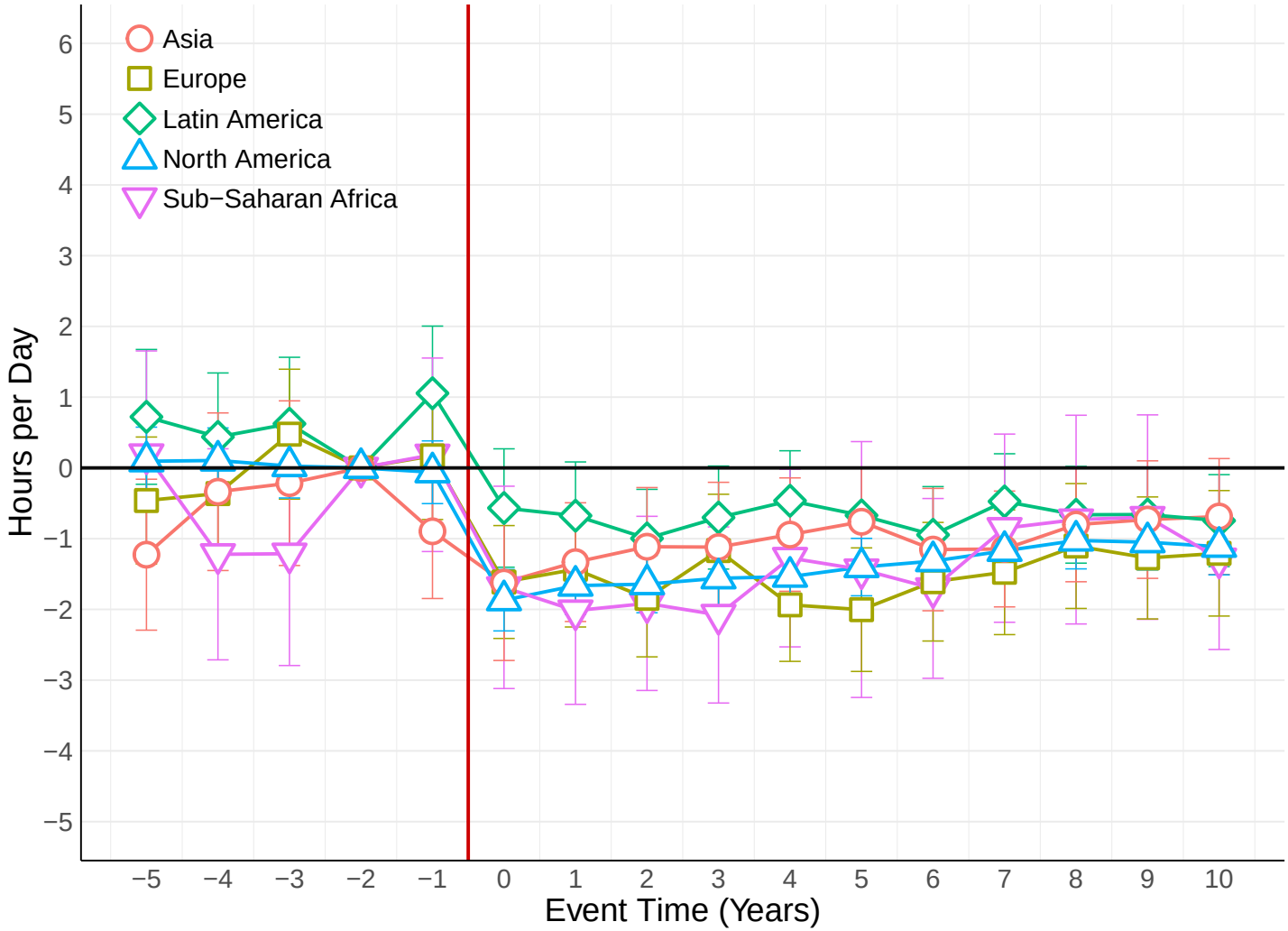
Active Time decomposition: Leisure: Women



Back

Active Time decomposition: Leisure

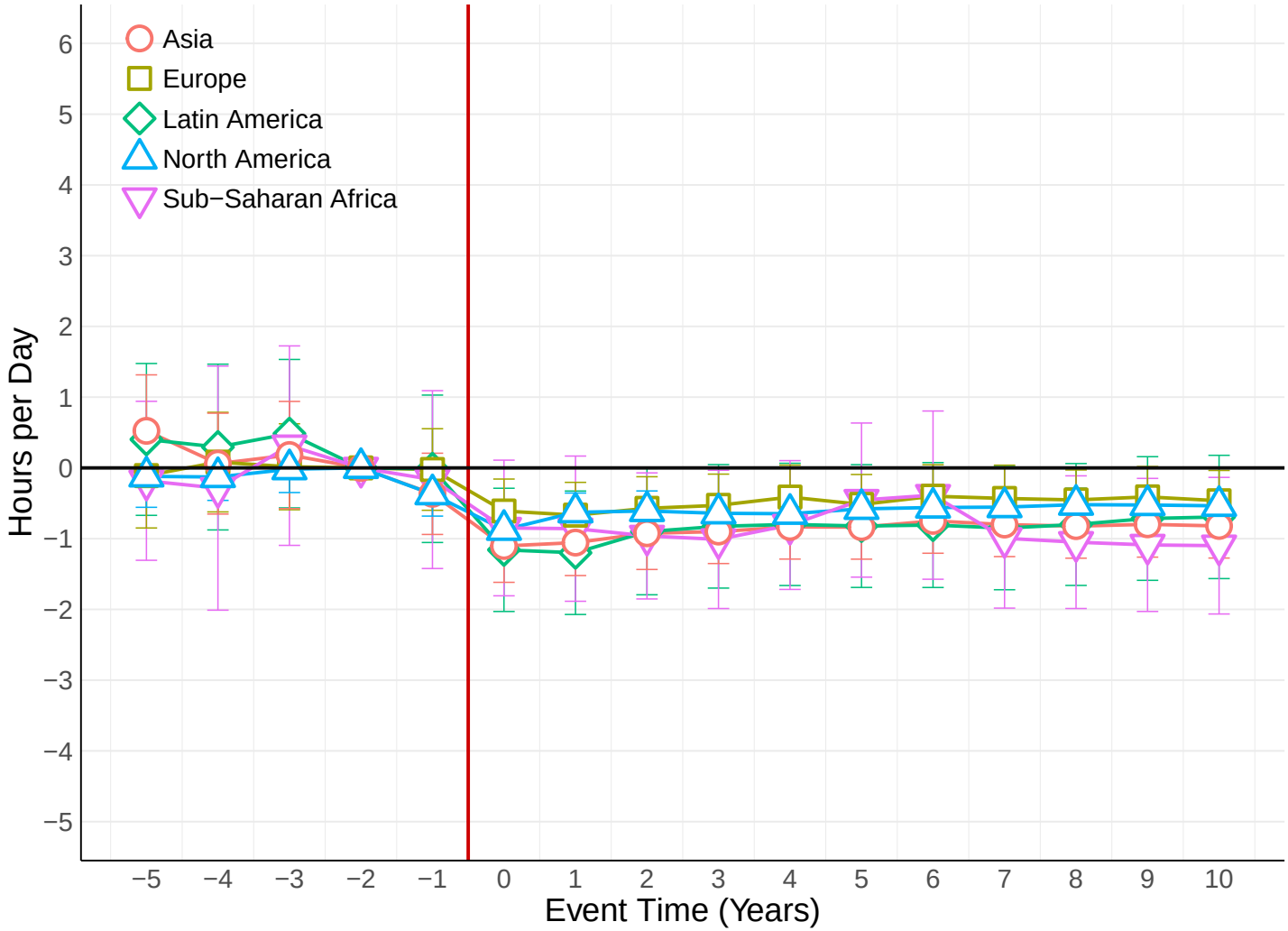
Active Time decomposition: Leisure: Men



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Active Time decomposition: Education

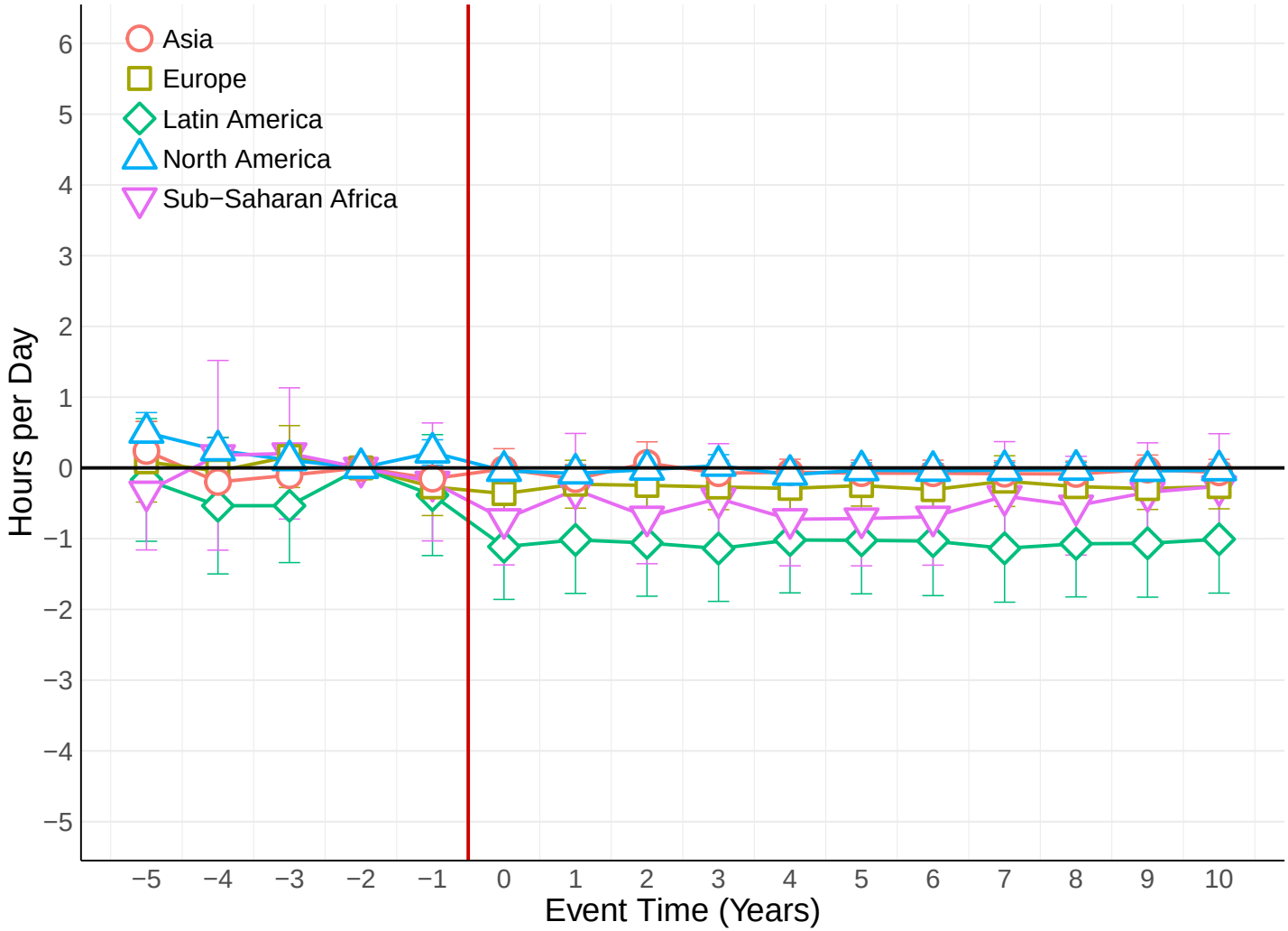
Active Time decomposition: Education: Women



Back

Active Time decomposition: Education

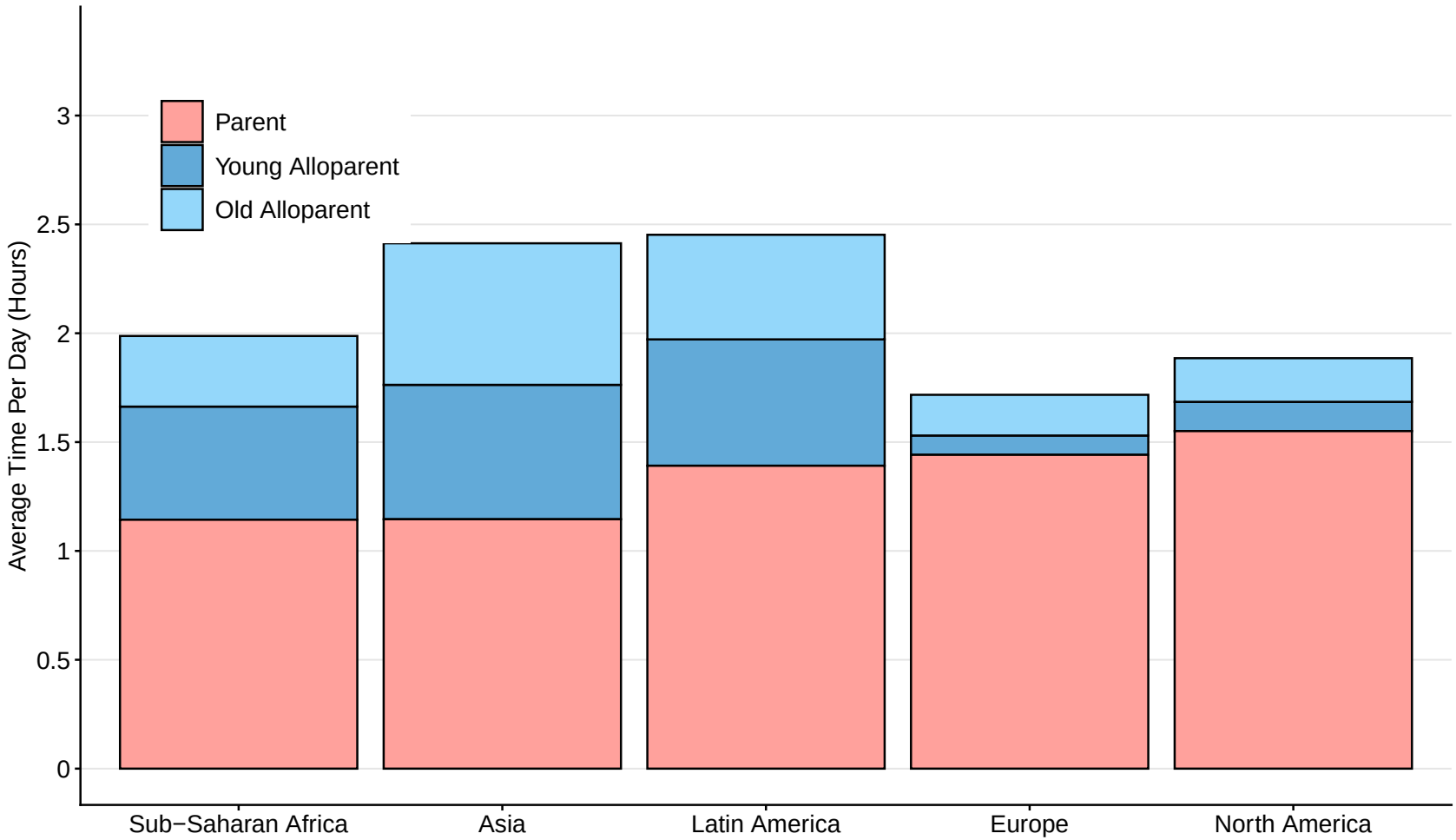
Active Time decomposition: Education: Men



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Parental vs Alloparental Child Care

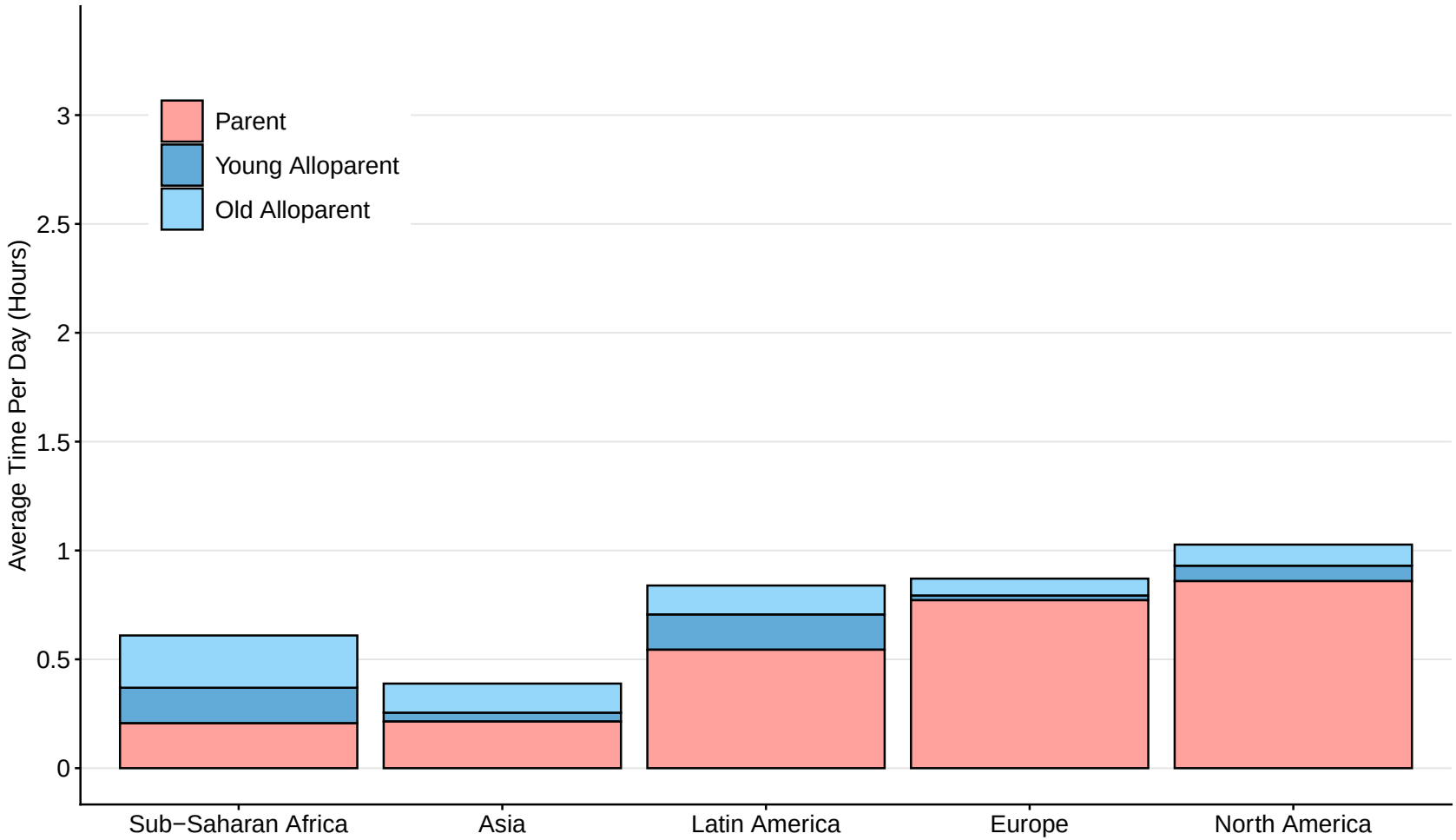
Average time spent on child care per day: Women



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Parental vs Alloparental Child Care

Average time spent on child care per day: Men



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