

# Cats, Dogs, and Babies

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# Introduction

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- 2 in 3 households in the U.S. and 1 in 3 in Taiwan own pets
- New pet ownership is now more common than new births
- People often make baseless claims about pets substituting for children
- Lack of empirical research on the relationship b/w fertility and pets

## JD Vance slammed for 'childless cat ladies' comment

Vance smeared Kamala Harris on Fox News in 2021.

By [Julia Reinstein](#)

July 26, 2024, 4:56 AM



## Choosing pets over babies is 'selfish and diminishes us', says pope

Pontiff laments 'denied parenthood' and people who 'substitute cats and dogs for children'

**Harriet Sherwood** and  
*agencies*

Wed 5 Jan 2022 17:57 GMT

 Share



■ Owing cats and dogs instead of having children is selfish, says pope - video

## 解決少子化出奇招 郭台銘：生一個孩子多養一隻寵物

2023/9/1 14:10 (9/21 17:18 更新)

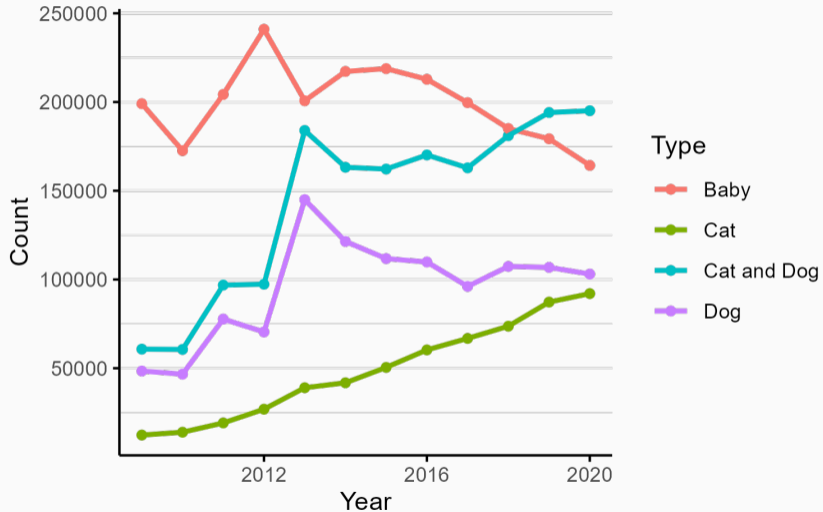


- Are pets and children substitutes or complements?

## What We Do?

- We link admin pet registry data with tax records
- Descriptively examine pet ownership and family and socio-economic status
- Estimate cross elasticity by using child subsidy and receipt lottery
- Examine the dynamic patterns to uncover underlying mechanisms

# Trends for Flows of Pets and Children



## Pets

- Very few papers in economics related to pets and fertility
- Mostly works in sociology or psychology
- Guo et al., 2021; Laurent-Simpson, 2017; Machová and Flegr, 2024 discuss how they could be complements or substitutes

## Low Fertility

- Kim et al., 2024; Myong et al., 2021 discuss potential norms in Korea

Data

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## Registration Rule

- Dogs are required from 1999/09/01 (due to rabies)
- Cats vary by counties
  - e.g., Taipei city from 2016/07/01
  - All cats are required from 2025/08/01

## Pet Registry Data

- Date of register, Dog or cat, Owner ID
- From 1999 to 2020

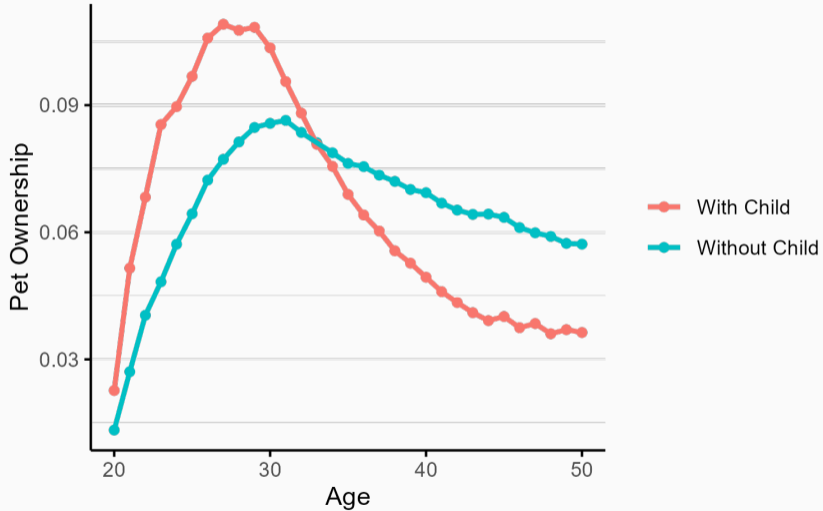
### FIA Data

- All tax data from the Fiscal Information Agency (FIA)
- Individual ID, income, asset, and household and family structure
- Individual panel data from 2009 to 2020
- Link with the pet registry using individual ID

## Descriptive Analysis

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# Individual Level Stock of Pets and Children



## Summary Statistics

Variable	With Dog	Without Dog	With Cat	Without Cat
Men	0.43	0.43	0.37	0.37
Age	48.66	48.66	39.03	39.03
Married	0.57	0.58	0.42	0.45
With Child	0.67	0.66	0.45	0.48
Household Size	3.66	3.87	3.75	3.98
Income (1000 NTD)	532	581	489	512
House Owner	0.49	0.45	0.36	0.32
City Resident	0.71	0.70	0.73	0.70
N	1,068,973	1,068,973	336,999	336,999

## Regression Summary for Dogs $i$

Dependent Variable:	Has Dog			
Model:	(1)	(2)	(3)	(4)
<i>Variables</i>				
Constant	0.0304*** ( $6.04 \times 10^{-5}$ )	0.0207*** ( $7.22 \times 10^{-5}$ )	0.0347*** (0.0001)	0.0267*** (0.0001)
Has Child	0.0257*** ( $8.31 \times 10^{-5}$ )	0.0207*** ( $9.04 \times 10^{-5}$ )	0.0092*** (0.0001)	0.0090*** (0.0001)
Asset		$1.12 \times 10^{-11}$ *** ( $5.81 \times 10^{-13}$ )		$1.08 \times 10^{-11}$ *** ( $5.82 \times 10^{-13}$ )
Real Estate		0.0154*** ( $9.58 \times 10^{-5}$ )		0.0135*** ( $9.96 \times 10^{-5}$ )
Stock Holdings		$6.5 \times 10^{-12}$ ( $4.98 \times 10^{-12}$ )		$-7.72 \times 10^{-12}$ ( $4.98 \times 10^{-12}$ )

## Regression Summary for Dogs ii

Income	$-3.97 \times 10^{-9}***$ ( $8.4 \times 10^{-11}$ )		$-3.57 \times 10^{-9}***$ ( $8.43 \times 10^{-11}$ )
Has Work	0.0178*** ( $9.53 \times 10^{-5}$ )		0.0177*** ( $9.6 \times 10^{-5}$ )
Age		0.0001*** ( $3.13 \times 10^{-6}$ )	$8.09 \times 10^{-5}***$ ( $3.19 \times 10^{-6}$ )
Gender		-0.0235*** (0.0002)	-0.0231*** (0.0002)
Married		0.0116*** (0.0001)	0.0074*** (0.0001)
Household Size		-0.0001*** ( $3.5 \times 10^{-6}$ )	$-9.4 \times 10^{-5}***$ ( $3.5 \times 10^{-6}$ )
Age $\times$ Gender		0.0003*** ( $3.8 \times 10^{-6}$ )	0.0003*** ( $3.8 \times 10^{-6}$ )

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## Regression Summary for Dogs iii

### *Fit statistics*

Observations	24,302,615	24,300,481	24,302,615	24,300,481
R <sup>2</sup>	0.00392	0.00675	0.00571	0.00817
Adjusted R <sup>2</sup>	0.00392	0.00675	0.00571	0.00817

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*IID standard-errors in parentheses*

*Signif. Codes: \*\*\*: 0.01, \*\*: 0.05, \*: 0.1*

## Regression Summary for Cats $i$

Dependent Variable:	Has Cat			
Model:	(1)	(2)	(3)	(4)
<i>Variables</i>				
Constant	0.0161*** ( $3.45 \times 10^{-5}$ )	0.0101*** ( $4.12 \times 10^{-5}$ )	0.0235*** ( $7.48 \times 10^{-5}$ )	0.0169*** ( $7.88 \times 10^{-5}$ )
Has Child	-0.0042*** ( $4.75 \times 10^{-5}$ )	-0.0040*** ( $5.16 \times 10^{-5}$ )	-0.0053*** ( $7.77 \times 10^{-5}$ )	-0.0046*** ( $7.79 \times 10^{-5}$ )
Asset		$-4.68 \times 10^{-12}$ *** ( $3.32 \times 10^{-13}$ )		$-2.52 \times 10^{-12}$ *** ( $3.32 \times 10^{-13}$ )
Real Estate		0.0011*** ( $5.47 \times 10^{-5}$ )		0.0021*** ( $5.69 \times 10^{-5}$ )
Stock Holdings		$-1.1 \times 10^{-11}$ *** ( $2.84 \times 10^{-12}$ )		$-1.7 \times 10^{-11}$ *** ( $2.84 \times 10^{-12}$ )

## Regression Summary for Cats ii

Income	$-1.42 \times 10^{-9***}$ ( $4.8 \times 10^{-11}$ )		$-1.05 \times 10^{-9***}$ ( $4.81 \times 10^{-11}$ )
Has Work	$0.0137***$ ( $5.44 \times 10^{-5}$ )		$0.0134***$ ( $5.48 \times 10^{-5}$ )
Age		$-0.0001***$ ( $1.79 \times 10^{-6}$ )	$-7.63 \times 10^{-5***}$ ( $1.82 \times 10^{-6}$ )
Gender		$-0.0110***$ (0.0001)	$-0.0107***$ (0.0001)
Married		$0.0039***$ ( $6.41 \times 10^{-5}$ )	$0.0015***$ ( $6.49 \times 10^{-5}$ )
Household Size		$-3.92 \times 10^{-5***}$ ( $2 \times 10^{-6}$ )	$-2.52 \times 10^{-5***}$ ( $2 \times 10^{-6}$ )
Age $\times$ Gender		$7.7 \times 10^{-5***}$ ( $2.17 \times 10^{-6}$ )	$5.88 \times 10^{-5***}$ ( $2.17 \times 10^{-6}$ )

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## Regression Summary for Cats iii

### *Fit statistics*

Observations	24,302,615	24,300,481	24,302,615	24,300,481
R <sup>2</sup>	0.00033	0.00342	0.00169	0.00472
Adjusted R <sup>2</sup>	0.00033	0.00342	0.00169	0.00472

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*IID standard-errors in parentheses*

*Signif. Codes: \*\*\*: 0.01, \*\*: 0.05, \*: 0.1*

# Elasticity of Substitution

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- To investigate whether children and pets are substitutes
- We estimate the cross-elasticity of demand
- Let  $d$  denote pets (dogs) and  $c$  denote children
- Consider two gross cross-elasticities:

$$\epsilon_{dc}^M = \frac{\partial \ln x_d}{\partial \ln p_c}, \epsilon_{cd}^M = \frac{\partial \ln x_c}{\partial \ln p_d}$$

- Focus on the  $\epsilon_{dc}^M$  first: need exogenous variation on children's price

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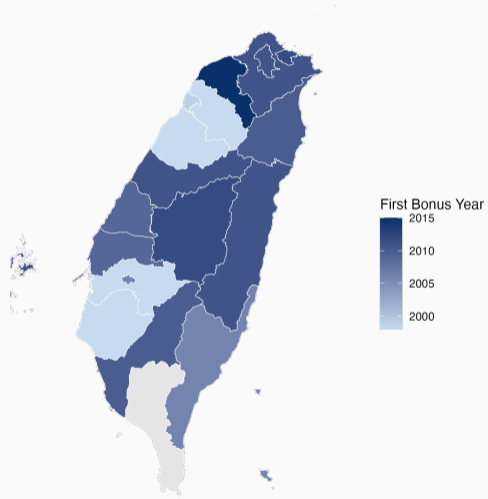
Other Aspects of Substitution

Conclusion

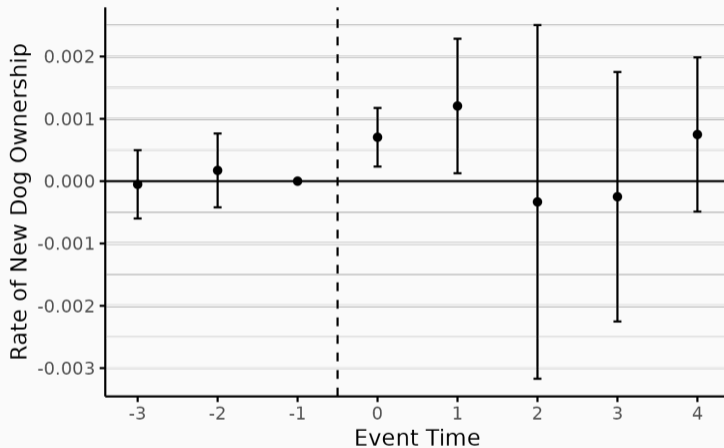
## Identification Strategy – Child Bonus

- Local gov't offer a One-Time Childbirth bonus to support new parents
- The bonus amount differs by municipality, reflecting local financial statuses
- e.g., As of 2022, Taoyuan City provides NT\$30,000 for the first child
- Typically some residence requirement

Year of Childbirth Bonus Introduction by County



# Child Bonus Increases Dog Ownership, Event Time in Years



▶ Drop Decreases

▶ TWFE Results

▶ Specifications Using Tax Deductibles

▶ Border Sample as Wang and Yang, 2022

▶ Permutation Placebo

▶ Effects on Children

## Implied Elasticity of Substitution

- The dog ownership of the first year increases by  $0.0007/0.0033 = 0.2121$
- Assume child's expenditure share = 0.2
- Average subsidy  $\approx 0.1612$  of HH expenditure reduction
- $\epsilon_{dc}^M = \frac{0.2121}{-0.1612} = -1.3158$
- This implies a quite strong **complementarity**

# Theory of Demand

- The two gross elasticities have different policy meanings (Terry Gou):

$$\epsilon_{dc}^M = \frac{\partial \ln x_d}{\partial \ln p_c}, \epsilon_{cd}^M = \frac{\partial \ln x_c}{\partial \ln p_d}$$

- We don't see  $\epsilon_{cd}^M$  but can estimate it
- From adding up and Marshallian symmetry:

$$s_d \epsilon_{dc}^M = s_c \epsilon_{cd}^M + s_d s_c (\eta_c - \eta_d),$$

where  $s_i$  is expenditure share of  $i$ ,  $\eta$  is the income elasticity

- Need to estimate  $\eta_d$ : the income elasticity of dogs
- Also, could it be income effect?

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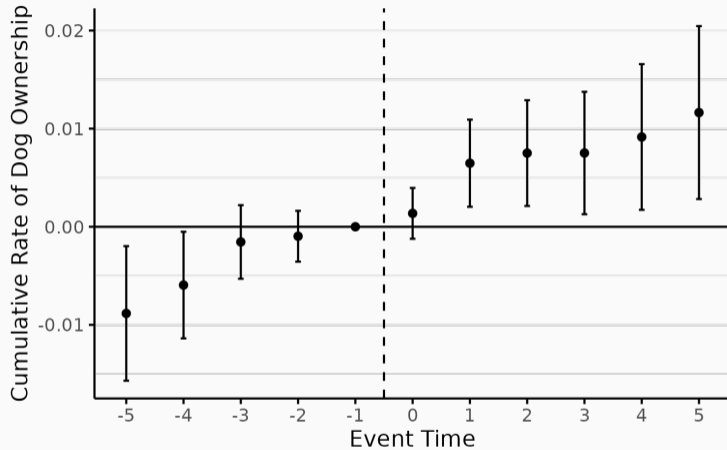
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## Identification Strategy – Lottery

- To identify the income elasticity, we need exog. income shocks
- We use the lottery from the Taiwan receipt lottery
- We use an event study w/ a winning cutoff at \$NT 2,000,000 or above

# Lottery and Dog



► Effects on Children

# Theory of Demand Revisited

- Now we have estimates of  $\epsilon_{dc}^M$  and  $\eta_d$ , we can get  $\epsilon_{cd}^M$
- From our formula:

$$\underbrace{S_d}_{0.032} \underbrace{\epsilon_{dc}^M}_{-1.316} = \underbrace{S_c}_{0.200} \epsilon_{cd}^M + \underbrace{S_d}_{0.032} \underbrace{S_c}_{0.200} \left( \underbrace{\eta_c}_{0.150} - \underbrace{\eta_d}_{0.108} \right)$$

- We obtain  $\epsilon_{cd}^M = -0.214$

## Summary of Findings

- We have found that dogs and children are **complements** (so are cats)
- Decreasing children's prices gives you **more dogs**,  $\epsilon_{dc}^M = -1.316$
- Decreasing dogs' prices gives you more **more children**,  $\epsilon_{cd}^M = -0.214$
- Where does this complementarity come from?

# Mechanism

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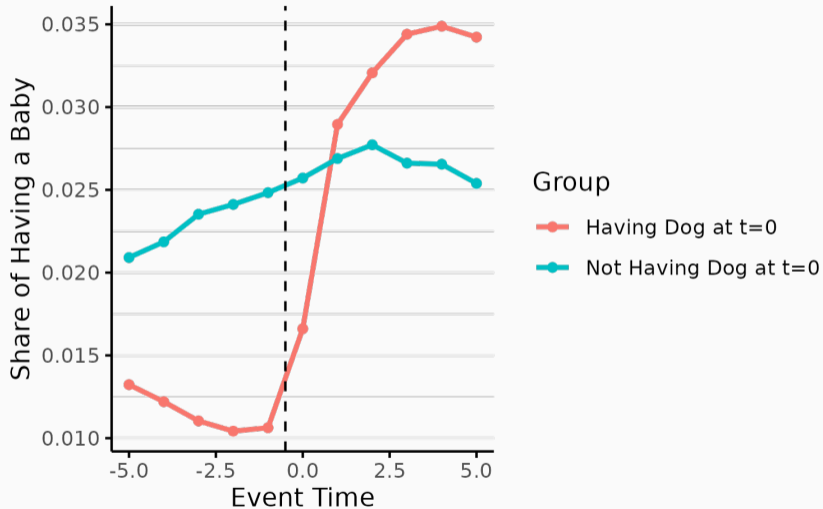
Alternative Explanations

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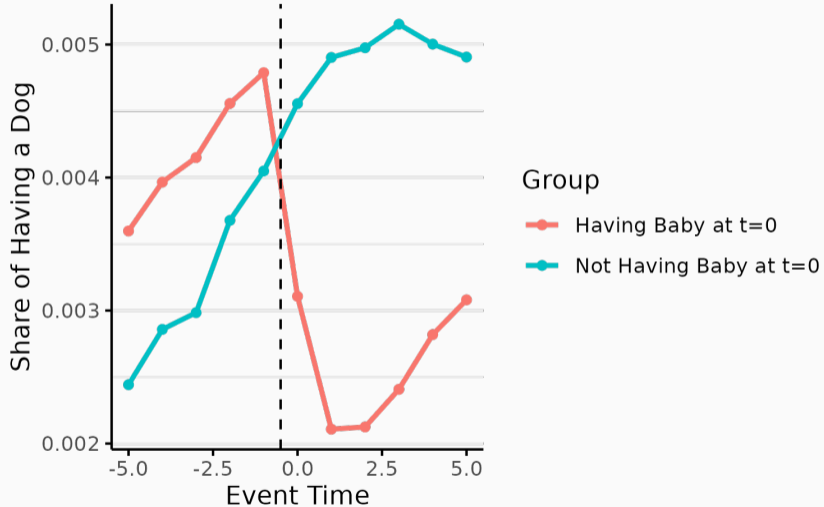
Conclusion

- We leverage the longitudinal information to understand the mechanism
- Look at several event studies as descriptive results
- We pick individuals with similar age and sex as a comparison
- We also use later-treated as a comparison and control for age and sex
- [▶ Detailed Econometric Specifications](#)

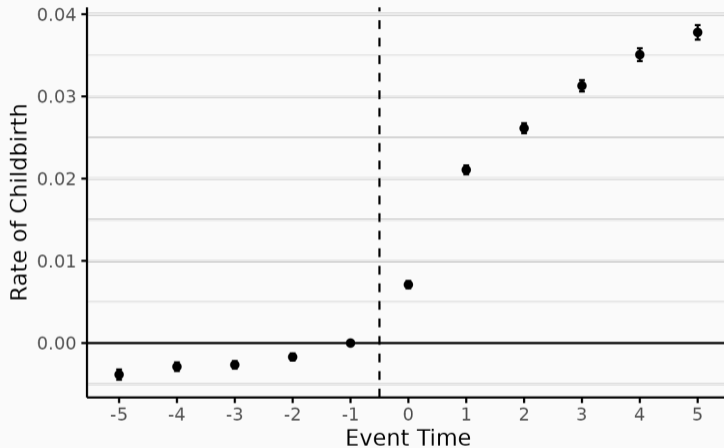
## Event Study: Raw Data



# Event Study: Raw Data



# Event Study: Dog on Child (Later-Treated Design)



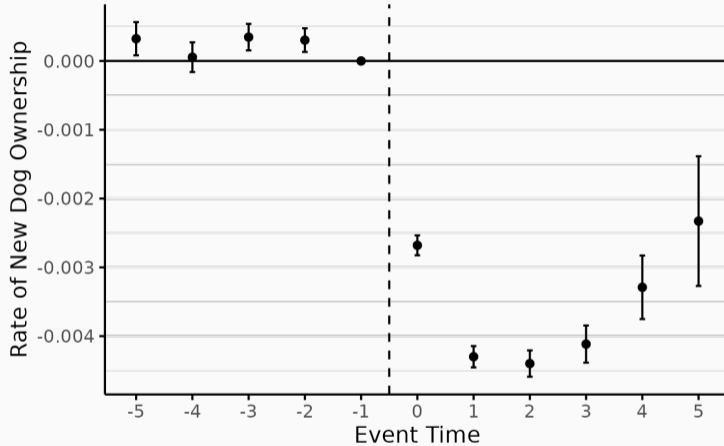
▶ First Dogs

▶ Post 2016 Only

▶ Remove 2013 Spike

▶ HH Results

# Event Study: Child on Dog (Later-Treated Design)



► First Dogs

► Post 2016 Only

► Remove 2013 Spike

► Number of Dogs as Outcome

► HH Results

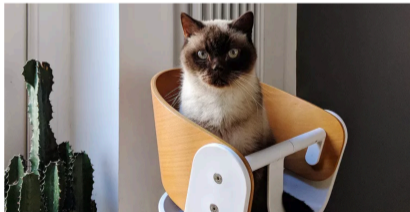
## Summary

- A sharp increase in child flow after having a dog
- A sharp decrease in dog flow after having a child
- Hypothesis: dogs as a practice for children
- Use a dog to learn about child-raising
- Once you have a child, time constraint kicks in
- Test: compare the dog raising event w/ and w/o a child
  - If learning  $\Rightarrow$  should see differences by initial condition
  - as there's little learning if you had a child before

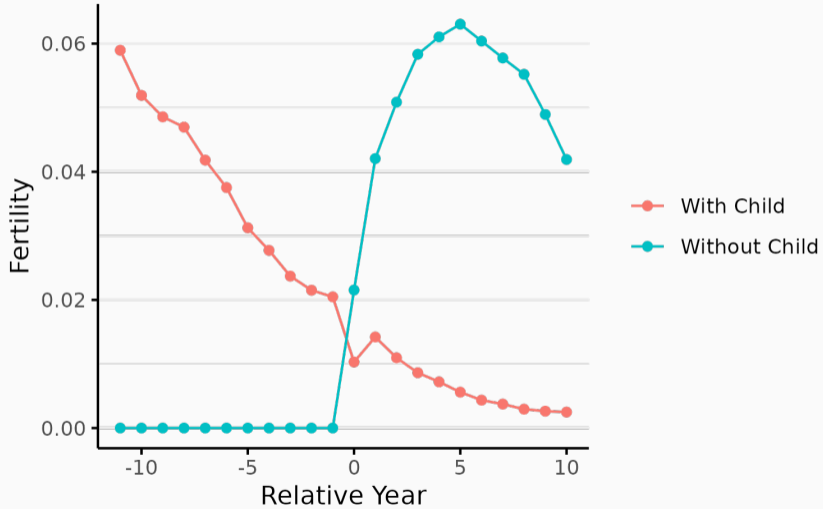
## Over 40 Percent of Pet Parents Look at Their Cat or Dog as a 'Starter Child,' Survey Finds

The same survey also found that pet owners can expect to have an average of 231 'mini-panics' about their pet's health and safety each year

By **People Staff** | Published on April 27, 2021 02:04PM EDT



# Dog on Child by Number of Children



# Dogs and Children: Static Complementarity

- Observationally:
  - Households with dogs are often **more likely** to have a child
  - Having a dog is correlated with traits of having a child
  - e.g., better economic conditions, having a house, ...
- Causally:
  - Dogs and children are **complements**
  - Decreasing the prices of children leads to more pets
  - Decreasing the prices of pets also leads to more children

# Dogs and Children: Dynamic Complementarity

- Dynamically, dog ownership may **increase the likelihood** of having children:
  - Dogs may serve as a “*starter family*” or satisfy nurturing instincts.
- Child ownership may **decrease the likelihood** of having a dog:
  - Don't have additional time to raise a dog
- Fertility responses differ by whether one has a child already
  - Increase fertility if one does not have a child
  - If anything, a decrease in fertility if one already has a child

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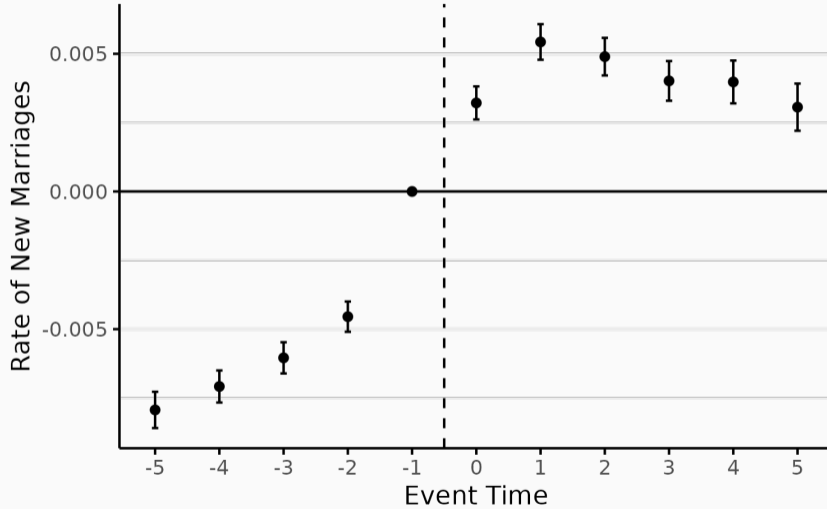
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# Marriage Market Outcomes



## Marriage Market Outcomes

- It seems that the increasing trend already started before the dog
- Those who have a dog or not already on different marriage trajectory
- But there are some evidence on assortative matching
- Those with pets are 5.78 times more likely to match with those with pets

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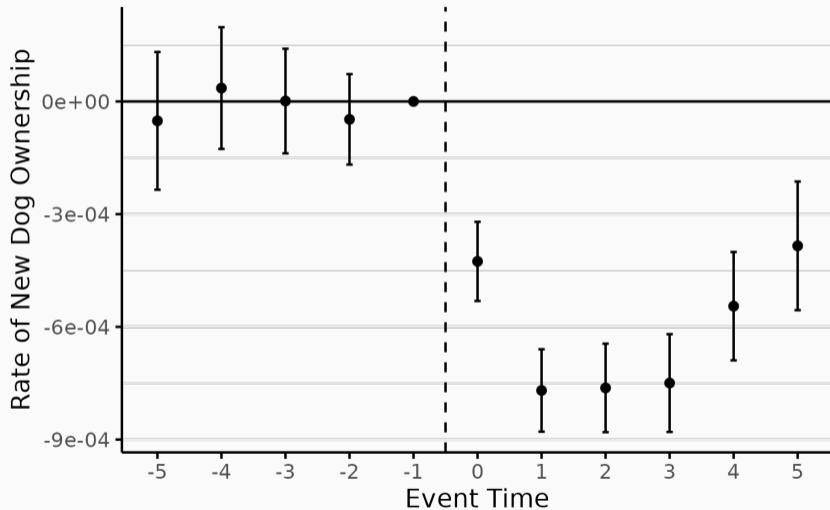
Other Aspects of Substitution

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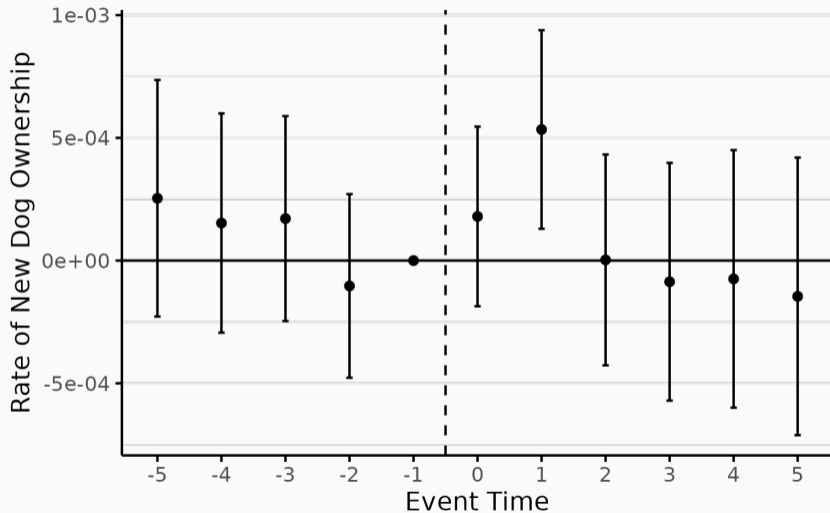
## Other Aspects of Substitution/Complements

- Newborn child is only one specific aspect of substitution
- Pets are an important form of company
  - Similar decrease in pets ownership after a new grandchild
  - Increase in pet ownership after child's death
  - Increase in pet ownership after spouse's death

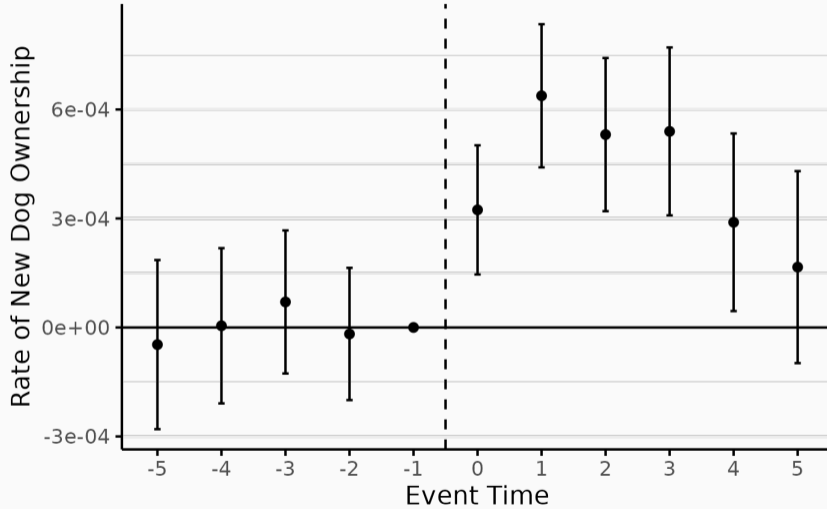
## Other Study: Grandchild on Dog



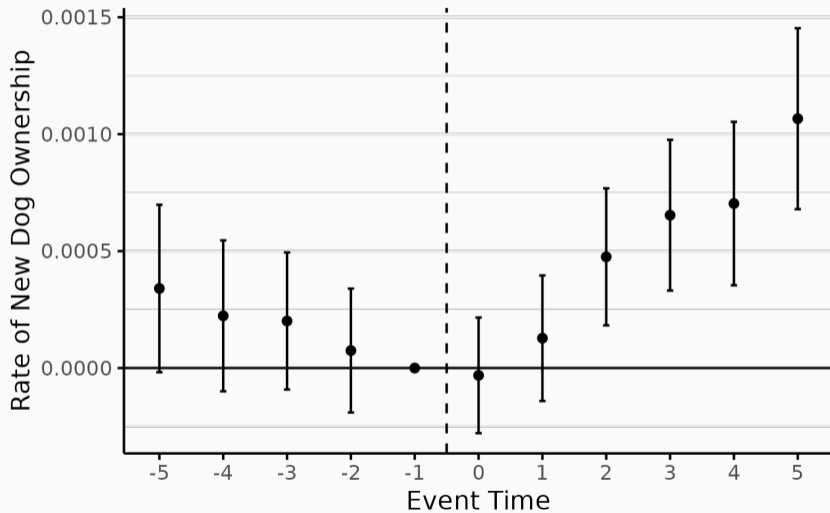
## Other Event: Child's Death on Dog



## Other Event: Spouse's Death on Dog



## Other Event: Divorce on Dog



## Conclusion

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## Conclusion

- With an administrative individual-level pet registry and tax data,
  - we study whether children and pets are complements
- Cross-sectionally, we find a positive correlation even with rich controls
- Exploiting exogenous variation from the child subsidy and receipt lottery,
  - we find children and dogs are **complements**
- Examining the dynamic patterns with event study, we find
  - a sharp increase in child flow after having a dog
  - a sharp decrease in dog flow after having a child
- Our findings suggest that **dogs may be starter family members**

# Theory

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## Overview of the Model

- Households live for 3 periods: young, prime, and late.
- Each period, choose whether to adopt a dog ( $d_t$ ), a cat ( $k_t$ ), or a child ( $c_t$ ).
- Choices are discrete and mutually exclusive:  $A_t = (d_t, k_t, c_t) \in \{0, 1\}^3$ .
- Households differ in permanent income  $Y$  and latent child preference  $\theta$ .
- Flow utility combines cons., leis., and the joy from pets & children.

## Key Mechanisms and Trade-offs

- **Budget constraint:** adoption costs and maintenance reduce consumption.
- **Leisure constraint:** children and pets consume time.
- **Learning:** adopting a pet may reveal info about  $\theta$  (preference for children).
- **Crowd-out effects:** pets reduce effective leisure when raising children.

## Intuition: Option Value of a Dog

- First-time adoption of a dog reveals a signal about  $\theta$  (child preference).
- This improves future decisions about whether to have a child.
- Option value of learning is largest when uncertain (posterior variance high).
- Hence, dogs are adopted **early** in life to maximize the value of learning.
- This timing mechanism explains observed dog-first behavior.

## Key Predictions and Implications

- **Income effects:** higher  $Y \uparrow$  prob. of adopting pets and children.
- **Substitution:** raising pet prices lowers child adoption probability (structural).
- **Cross-sectional correlations:** dog-child positive, cat-child negative.
- **Dog adoption peaks early**, cat adoption less sensitive.
- **IV strategy:** latent preference  $Z$  biases OLS; valid IV recovers true substitution.

## Why This Model Matters

- Fertility, pet, leisure, and learning in a simple dynamic framework.
- Transparent choice structure: tractable yet rich implications.
- Empirically consistent with timing and substitution facts.
- Highlights the importance of early-life experimentation (“dog as a practice”).
- Offers policy insights into fertility, family support, and pet subsidies.

# Robustness

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## Drop Decreases

- Hsinchu, Miaoli, and Tainan experience drops in subsidy
- We re-run the analysis dropping these three counties
- Results are virtually unchanged
- (Results in the review and takeout process)
- [◀ Back](#)

- We run the canonical two-way fixed effect specification

$$Y_{it} = \alpha_i + \phi_t + \sum_{r \neq 0} \mathbf{1}\{R_{it} = r\} \beta_r + \epsilon_{it},$$

where  $i$  is individual,  $R_{it}$  is the time relative to starting subsidy

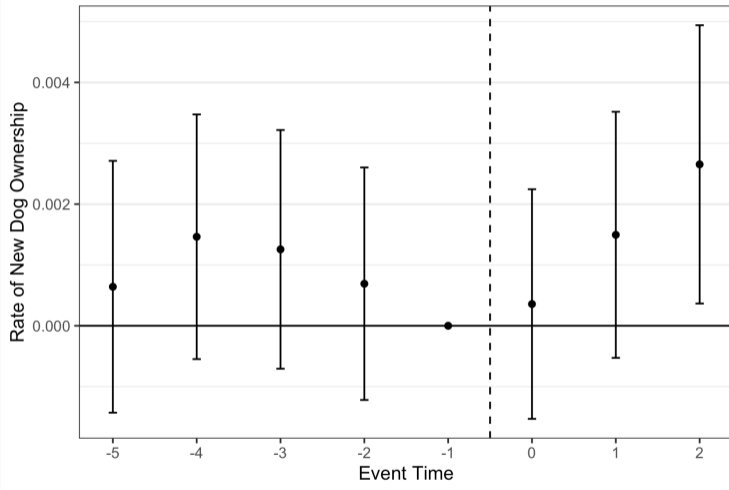
- Signs and significance of the results remain similar
- (Results in the review and takeout process)

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## Specifications Using Tax Deductibles

- In 2018, the gov't expanded the tax deductibles for young children
- We use those who are always eligible as control group
- Those who are eligible only after the expansion as treatment group
- Sample: Year  $\geq 2013$ , age  $\in [20, 44]$
- We include individual, county, and year fixed effects
- Harder to quantify the elasticity, but show a consistent sign

# Specifications Using Tax Deductibles



# Border Sample as Wang and Yang, 2022

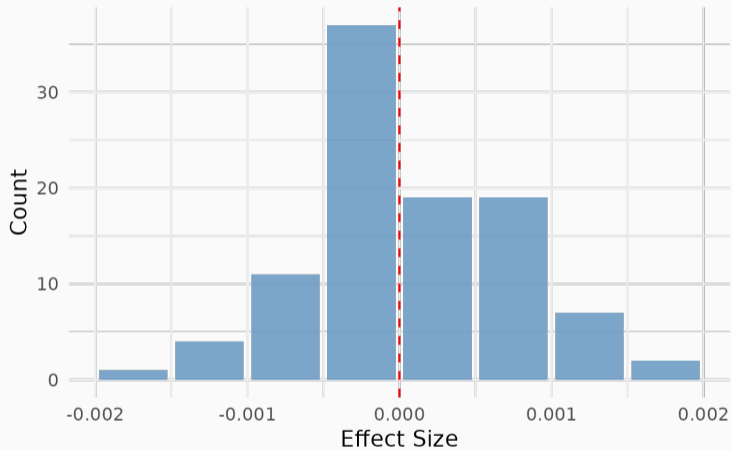
Dependent Variables: Model:	Child Birth (1)	Has Dog (2)	Has Cat (3)
<i>Variables</i>			
Age <sup>2</sup>	-0.0001** (4.87 × 10 <sup>-5</sup> )	-3.85 × 10 <sup>-6</sup> (5.91 × 10 <sup>-6</sup> )	-1.61 × 10 <sup>-5***</sup> (9.98 × 10 <sup>-7</sup> )
Asset	8.83 × 10 <sup>-12</sup> (1.12 × 10 <sup>-11</sup> )	-2.72 × 10 <sup>-12</sup> (2.19 × 10 <sup>-12</sup> )	8.76 × 10 <sup>-13</sup> (3.93 × 10 <sup>-12</sup> )
Real Estate	0.0163*** (0.0020)	0.0005** (0.0002)	0.0009** (0.0004)
Treat × Post	0.0027 (0.0031)	0.0010 (0.0013)	0.0002 (0.0010)
<i>Fixed-effects</i>			
Ind.	Yes	Yes	Yes
Year	Yes	Yes	Yes
County	Yes	Yes	Yes
<i>Fit statistics</i>			
Observations	2,223,171	2,223,171	2,223,171
R <sup>2</sup>	0.16132	0.14728	0.16892
Within R <sup>2</sup>	0.00096	1.38 × 10 <sup>-5</sup>	5.34 × 10 <sup>-5</sup>

Clustered (County × Year) standard-errors in parentheses

Signif. Codes: \*\*\*: 0.01, \*\*: 0.05, \*: 0.1

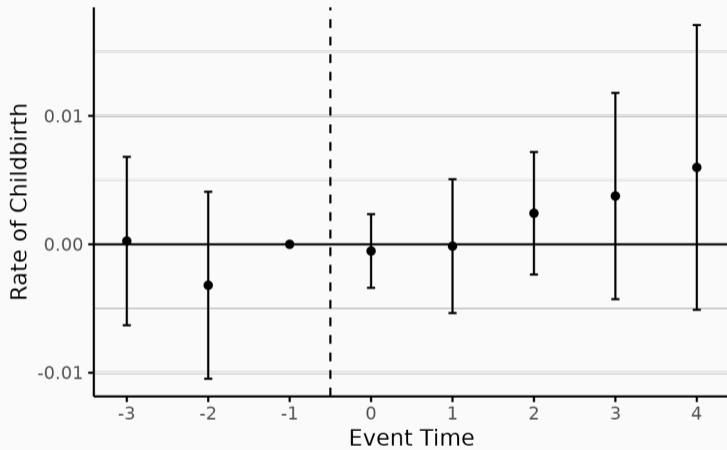
- Specification as in Wang and Yang, 2022, except for some inaccessible variables
- Only uses the sample in the border and with children, same sign

# Subsidy Permutation Tests



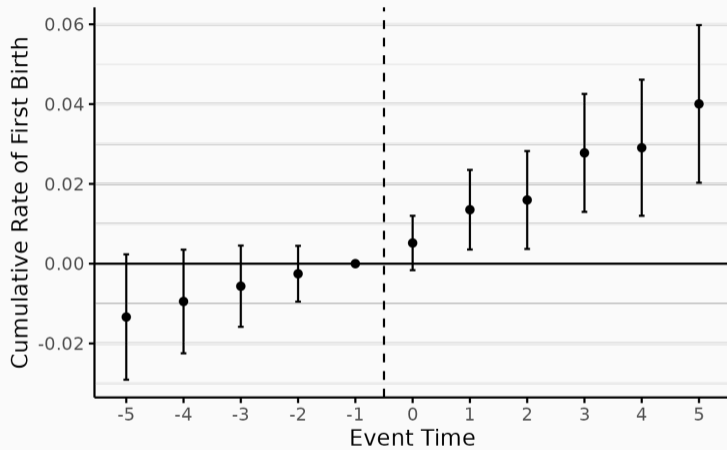
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# Subsidy Effects on Children

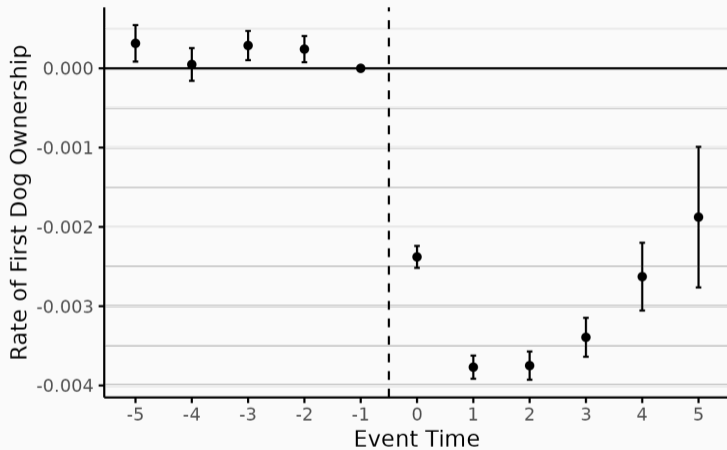


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# Lottery Effects on Children

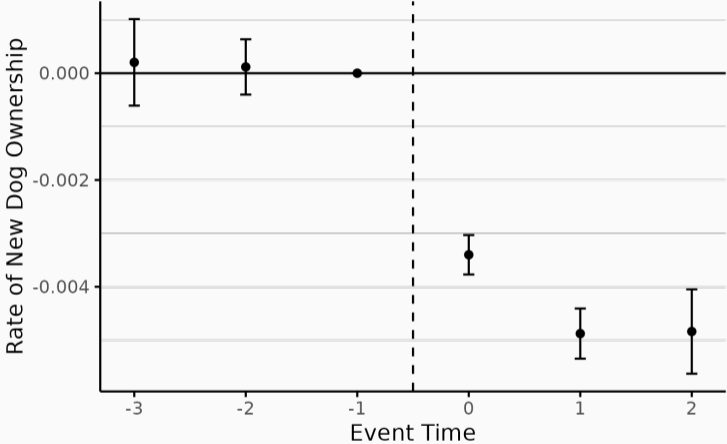


# First Dogs

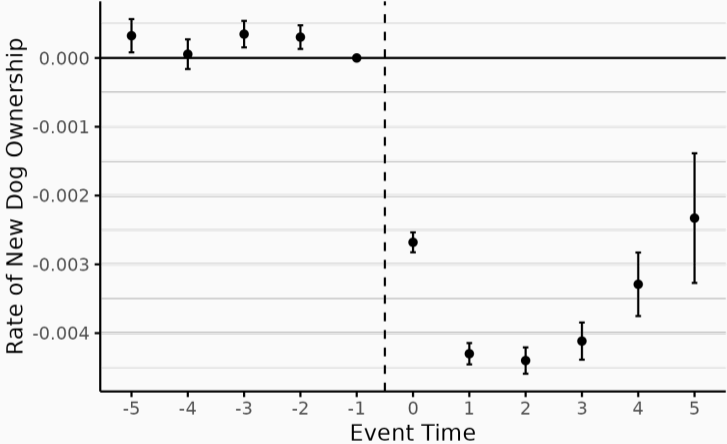


◀ Back

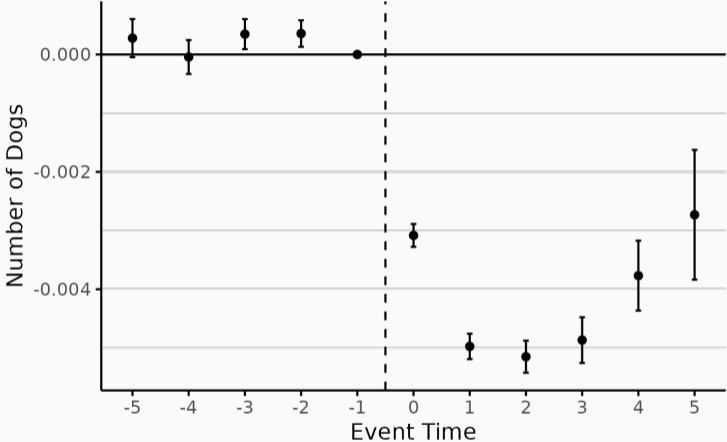
# Post 2016 Only



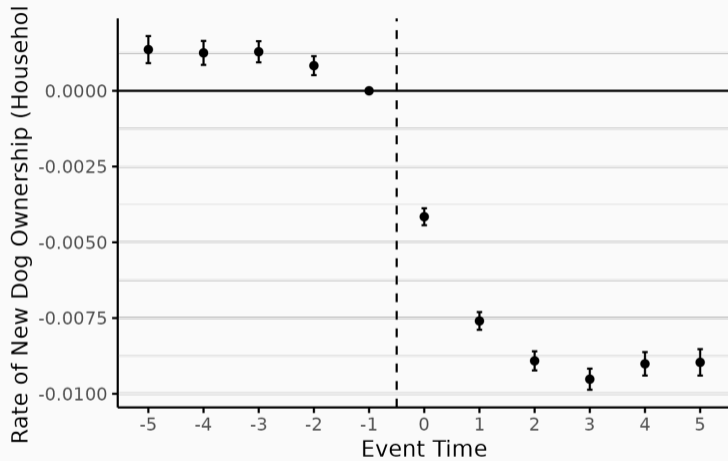
# Remove 2013 Spike



# Number of Dogs as Outcome

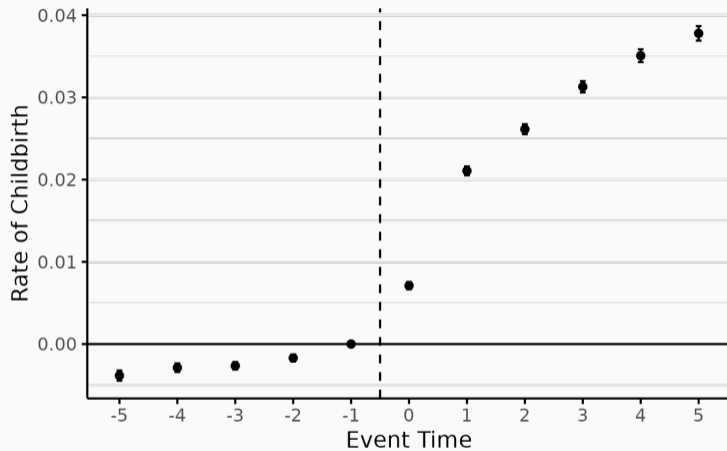


# HH Results



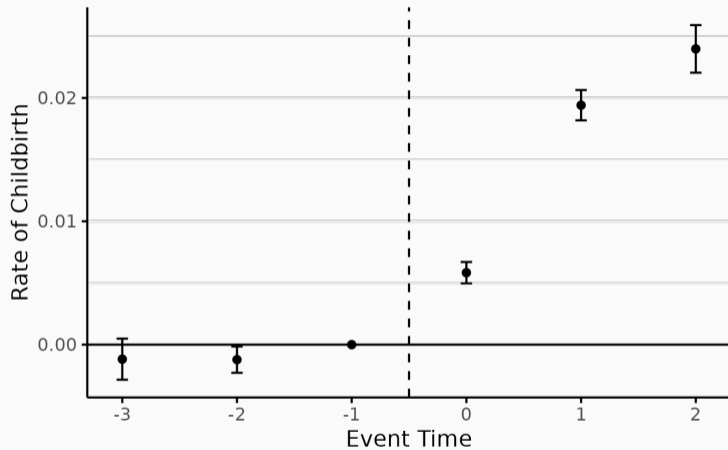
◀ Back

# First Dogs



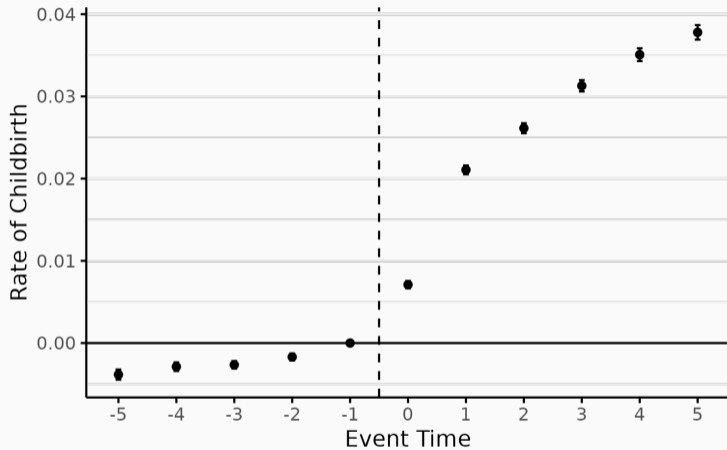
◀ Back

# Post 2016 Only



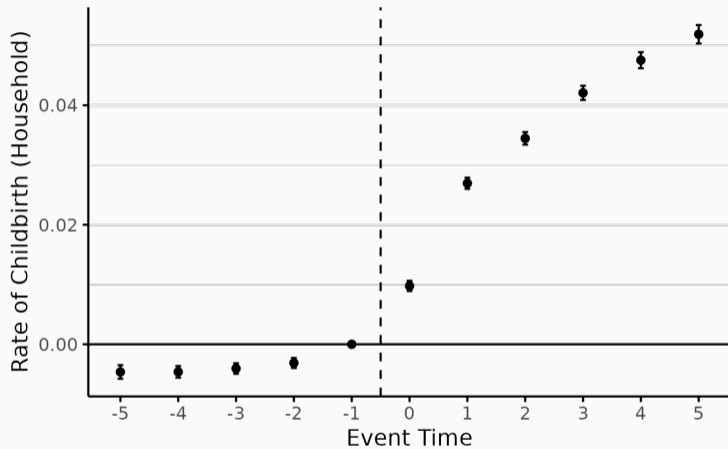
◀ Back

## Remove 2013 Spike



◀ Back

# HH Results

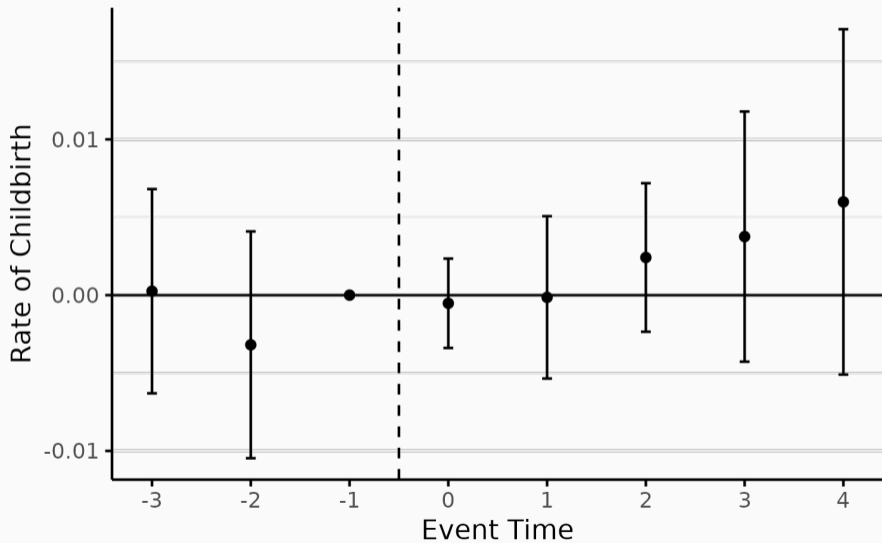


◀ Back

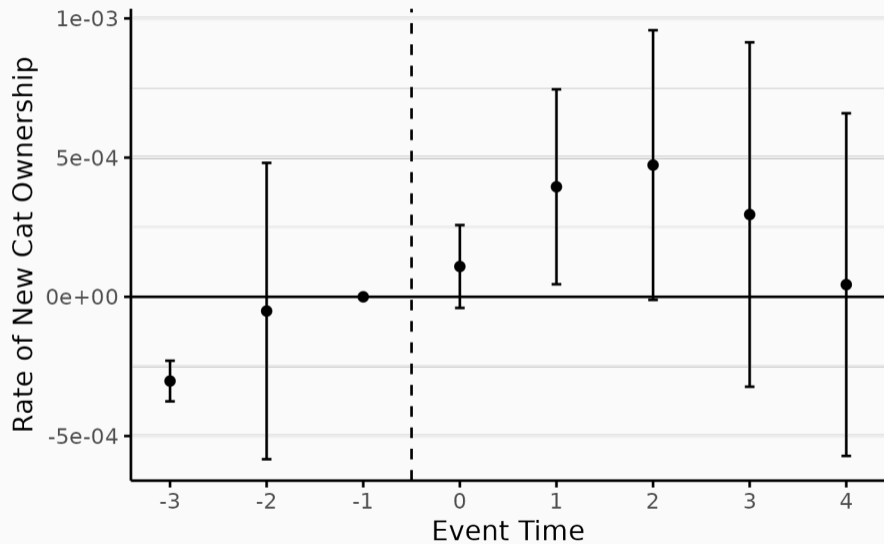
## Results on Cats

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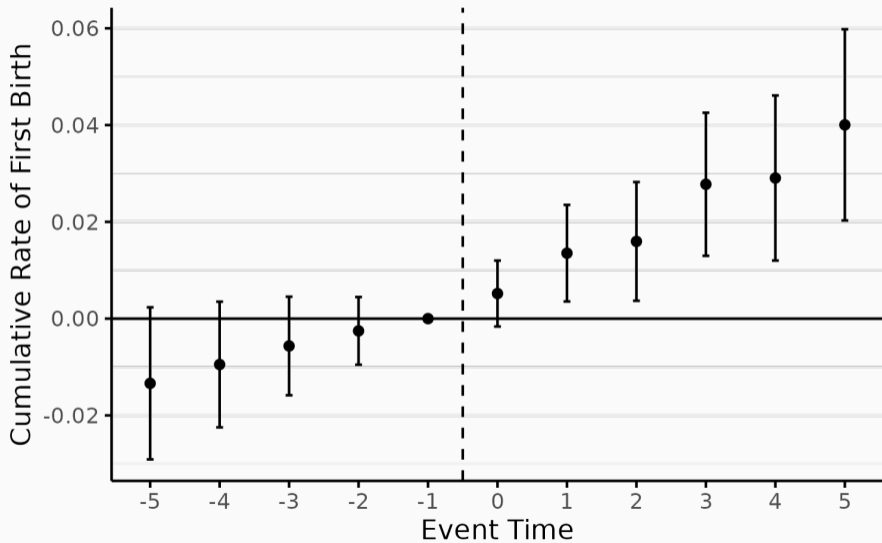
# Subsidy on Fertility



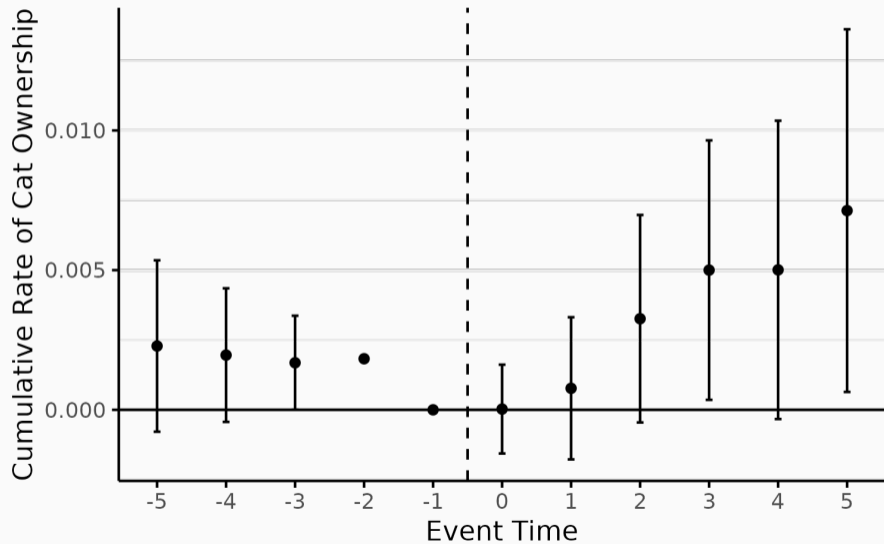
# Subsidy on Cat Ownership



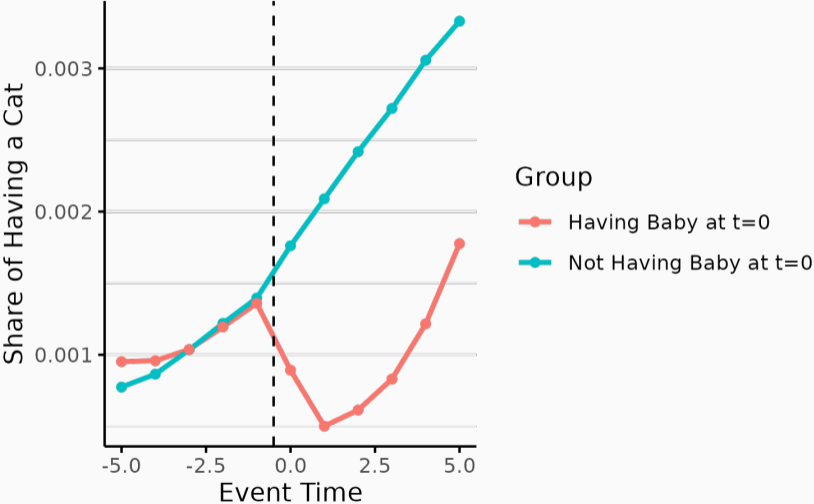
# Lottery and Fertility



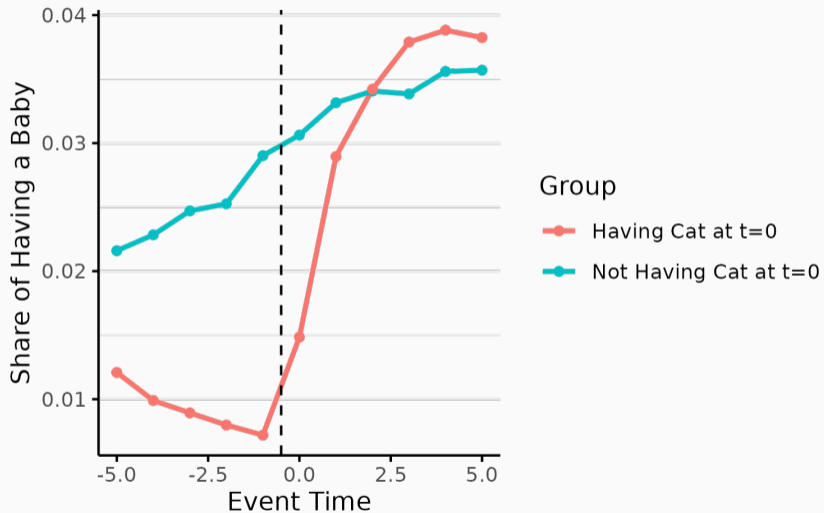
# Lottery and Cat



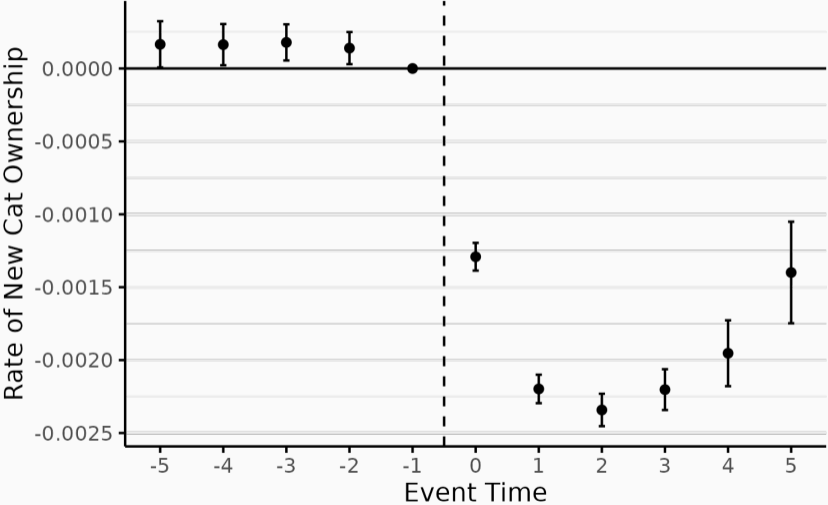
# Event Study: Raw Data



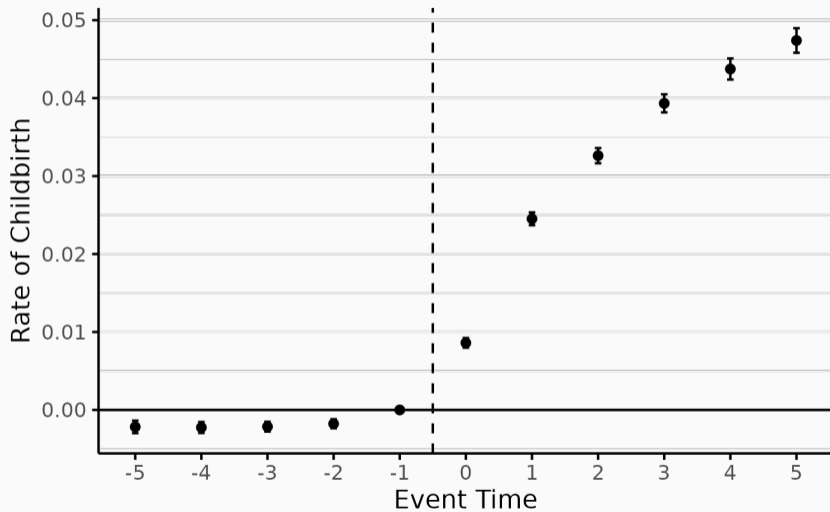
## Event Study: Raw Data



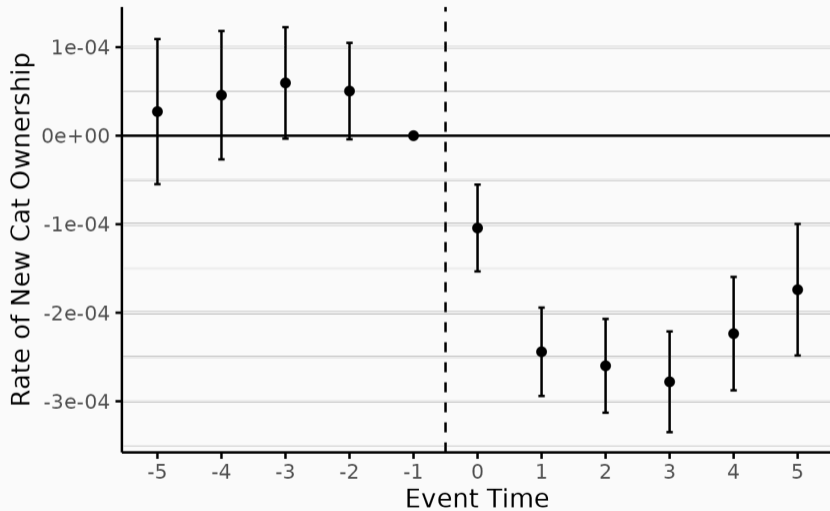
# Event Study: Child on Cat



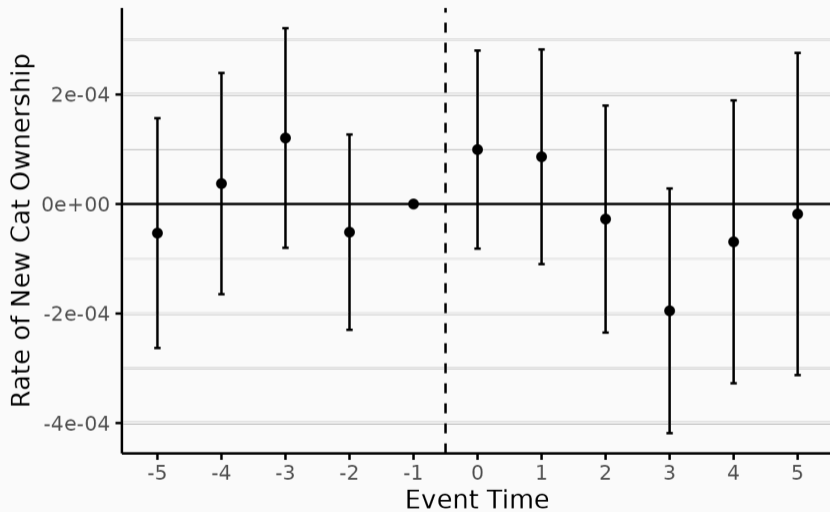
# Event Study: Cat on Child



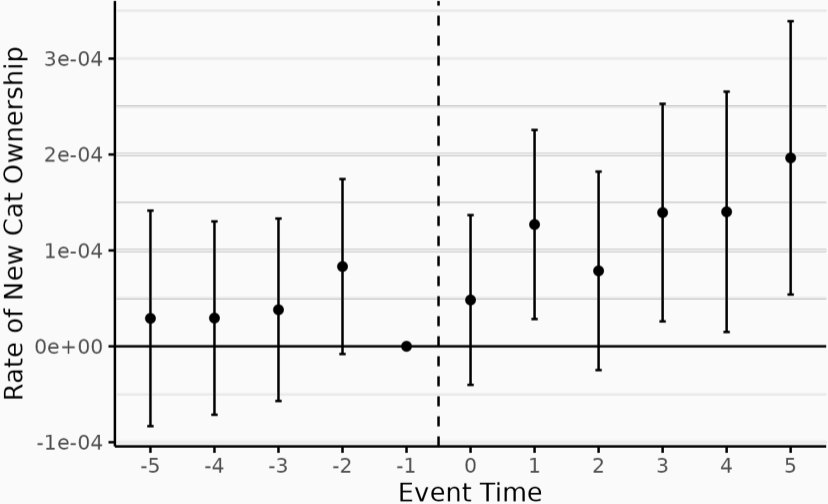
## Other Event: Grandchild on Cat



## Other Event: Child's Death on Cat



# Other Event: Spouse's Death on Cat



## Other Details

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## Detailed Econometric Specifications

$$Y_{ict}^g = \alpha_i^g + \theta^{g,r} \mathbf{1}\{t = g + r\} + \gamma^{g,r} D_i^g \mathbf{1}\{t = g + r\} + \epsilon_{ict}^g,$$

- $Y_{ict}^g$ : Pet ownership outcome for individual  $i$  in county  $c$  and year  $t$ .
- $D_i^g$ : Indicator for whether individual  $i$  has a child in cohort  $g$ .
- $\alpha_i^g$ : Individual fixed effects, absorbing time-invariant heterogeneity.
- $\theta^{g,r}$ : Effect for cohort  $g$  at event time  $r$ .
- $\gamma^{g,r}$ : Treatment effect for cohort  $g$  at event time  $r$  among those with a child.
- ATT is estimated separately for each cohort–event time pair and averaged using cohort sizes as weights.

## Expenditure Share

- Annual expenses in 2023: dogs 30,093 NTD, cats 24,577 NTD.
- Estimated average household income for pet owners: 1,116,195 NTD.
- Using the expenditure survey, total consumption for such households averages 930,374 NTD.
- Dog expenditure share:  $\frac{30,093}{930,374} \approx 3.23\%$ .
- Estimating the expenditure share for children is more complex:
  - Using an equivalence scale, a child under 14 is weighted at 0.3.
  - For a household with two adults and one child:  $\frac{0.3}{1.8} \approx 17\%$ .
  - Some U.S. estimates put this as high as 22%.

## References

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