State Dependence in Immunization and the Role of Discouragement

Kabir Dasgupta (Federal Reserve Board)
Gail Pacheco (AUT)
Alexander Plum (AUT)

Centre for Longitudinal Research Conference 2022 (Auckland)

November 29, 2022

AUT

NEW ZEALAND
WORK RESEARCH INSTITUTE

Introduction

The paper in a nutshell

- Benefits of vaccination on child health and mortality are well-documented (vaccine-preventable disease ↓)
- Under-immunization on the rise:
  - vaccine safety concerns
  - COVID-19 pandemic
- This study: does the experience of having a child immunized *genuinely* influence future immunization decisions
- GUiNZ survey and a dynamic random-effects probit model (initial conditions problem; unobserved heterogeneity)
- Finding: considerable degree of state dependence in child immunization (21 percentage points)

Introduction

The paper in a nutshell

- Benefits of vaccination on child health and mortality are well-documented (vaccine-preventable disease ↓)
- Under-immunization on the rise:
  - vaccine safety concerns
  - COVID-19 pandemic
- This study: does the experience of having a child immunized *genuinely* influence future immunization decisions
- GUiNZ survey and a dynamic random-effects probit model (initial conditions problem; unobserved heterogeneity)
- Finding: considerable degree of state dependence in child immunization (21 percentage points)

Introduction
The paper in a nutshell

- Benefits of vaccination on child health and mortality are well-documented (vaccine-preventable disease ↓)
- Under-immunization on the rise:
  - vaccine safety concerns
  - COVID-19 pandemic
- This study: does the experience of having a child immunized *genuinely* influence future immunization decisions
- GUiNZ survey and a dynamic random-effects probit model (initial conditions problem; unobserved heterogeneity)
- Finding: considerable degree of state dependence in child immunization (21 percentage points)

Introduction

The paper in a nutshell

- Benefits of vaccination on child health and mortality are well-documented (vaccine-preventable disease $\downarrow$)
- Under-immunization on the rise:
  - vaccine safety concerns
  - COVID-19 pandemic
- This study: does the experience of having a child immunized *genuinely* influence future immunization decisions
- GUiNZ survey and a dynamic random-effects probit model (initial conditions problem; unobserved heterogeneity)
- Finding: considerable degree of state dependence in child immunization (21 percentage points)

Introduction

The paper in a nutshell

- Benefits of vaccination on child health and mortality are well-documented (vaccine-preventable disease $\downarrow$)
- Under-immunization on the rise:
  - vaccine safety concerns
  - COVID-19 pandemic
- This study: does the experience of having a child immunized *genuinely* influence future immunization decisions
- GUiNZ survey and a dynamic random-effects probit model (initial conditions problem; unobserved heterogeneity)
- Finding: considerable degree of state dependence in child immunization (21 percentage points)

Introduction

The paper in a nutshell

- Benefits of vaccination on child health and mortality are well-documented (vaccine-preventable disease $\downarrow$)
- Under-immunization on the rise:
  - vaccine safety concerns
  - COVID-19 pandemic
- This study: does the experience of having a child immunized *genuinely* influence future immunization decisions
- GUiNZ survey and a dynamic random-effects probit model (initial conditions problem; unobserved heterogeneity)
- Finding: considerable degree of state dependence in child immunization (21 percentage points)

Data and Descriptive Statistics

GUiNZ

- Growing Up in New Zealand (GUiNZ) survey
- Two sets of immunization-related information:
  - immunization status of the child (6 weeks, 3 months, 5 months, 15 months, and 48 months)
  - received discouraging information before child birth

Data and Descriptive Statistics
GUiNZ

- Growing Up in New Zealand (GUiNZ) survey
- Two sets of immunization-related information:
  - immunization status of the child (6 weeks, 3 months, 5 months, 15 months, and 48 months)
  - received discouraging information before child birth

Data and Descriptive Statistics
GUiNZ

- Growing Up in New Zealand (GUiNZ) survey
- Two sets of immunization-related information:
  - immunization status of the child (6 weeks, 3 months, 5 months, 15 months, and 48 months)
  - received discouraging information before child birth

Data and Descriptive Statistics

Mother's characteristics and immunisation behavior

	Child immunized	
	No	Yes
Age	31.28	30.70
Disability	6.54	5.91
First child	26.23	41.30
Child planned	60.25	65.82
Household income		
$\leq$$20k	3.52	3.51
$20k-$30k	4.81	5.06
$30k-$50k	14.76	12.74
$50k-$70k	20.88	16.21
$70k-$100k	25.37	23.56
$100k-$150k	20.06	23.50
$>$$150k	10.60	15.42
Highest education		
No sec education	5.19	4.66
NCEA 1-4	21.25	20.93
NCEA 5-6	33.69	30.06
Bachelor's degree	25.04	25.55
Higher degree	14.82	18.80
Self prioritised ethnicity		
NZ European	71.50	61.98
Māori	16.39	12.09
Pasifika	6.92	11.64
Asian	5.19	14.29
Intention to immunise child		
Immunize	52.41	87.30
No immunization	26.61	0.29
Not decided yet	20.98	12.40
Sample	1 849	21 457

Data and Descriptive Statistics

Discouraging information on immunisation

	Full sample	NZ European	Māori	Pasifika	Asian
Received discouraging information before child birth					
Share	15.05	18.28	15.77	7.55	6.30
Individuals	4 778	2 958	597	556	667
Child immunised at t					
No discouraging information	93.41	92.62	90.83	95.28	97.16
Discouraging information	84.52	83.48	82.61	93.17	94.00
Total	92.07	90.96	89.54	95.12	96.96
Sample	23 306	14 621	2 897	2 625	3 163

Data and Descriptive Statistics

Transition matrix of immunisation

immunized at $t-1$	immunized at t No	Yes	Total_{t-1}
No	71.41	28.59	6.57
	(81.64)	(18.36)	(14.28)
Yes	4.40	95.60	93.43
	(5.74)	(94.26)	(85.72)
Total_t	8.80	91.20	
	(16.58)	(83.42)	

Empirical strategy
State-dependence models

Dynamic reduced form model on the decision to immunize:

$$y_{it} = 1\Big(\beta y_{i(t-1)} + X'_{i(t=-1)}\rho + \nu_{it} > 0\Big) \tag{1}$$

with $\nu_{it} \sim N(0, \sigma^2_{\nu})$.

$$\nu_{it} = \alpha_i + u_{it} \tag{2}$$

with $\alpha_i \sim N(0, \sigma^2_{\alpha})$ and $u_{it} \sim N(0, \sigma^2_u)$. The correlation is represented by:

$$corr(\nu_{it}, \nu_{is}) = \lambda = \frac{\sigma^2_{\alpha}}{\sigma^2_{\alpha} + \sigma^2_u} \tag{3}$$

for $t, s = 1, \ldots, T$ and $t \neq s$.

Empirical strategy

State-dependent models

$$\alpha_i = a_0 + a_1 y_{i(t=0)} + \gamma_i \tag{4}$$

Using Equation (4), the Equation (1) can be re-written as:

$$y_{it} = 1\Big(\beta y_{i(t-1)} + X'_{i(t=-1)}\rho + a_0 + a_1 y_{i(t=0)} + \gamma_i + u_{it} > 0\Big) \tag{5}$$

Note that y_{it} is binary and we chose as normalization $\sigma_u^2 = 1$. The outcome probability is:

$$P_{it}(\gamma^*) = \Phi\Big([\beta y_{i(t-1)} + X'_{i(t=-1)}\rho + a_0 + a_1 y_{i(t=0)} + \sigma_\gamma \gamma^*)(2y_{it} - 1)\Big]$$

The respective likelihood function is:

$$L = \prod_{i=1}^{N} \int_{\gamma^*} \Big\{ \prod_{t=1}^{T} P_{it}(\gamma^*) \Big\} \mathrm{d}F(\gamma^*) \tag{6}$$

Empirical strategy

Partial effects

$$PE_i = \Phi\left(\left[\hat{\beta} + X'_{i(t=-1)}\hat{\rho} + \hat{a}_0 + \hat{a}_1 y_{i(t=0)}\right]\left[\sqrt{1-\hat{\lambda}}\right]\right) - \Phi\left(\left[X'_{i(t=-1)}\hat{\rho} + \hat{a}_0 + \hat{a}_1 y_{i(t=0)}\right]\left[\sqrt{1-\hat{\lambda}}\right]\right) \quad (7)$$

Empirical strategy

Discouraging information

$$y_{it} = 1\Big(\beta_j y_{i(t-1)} \times D_i + X'_{i(t=-1)}\rho + a_0 + a_1 y_{i(t=0)} + \gamma_i + u_{it} > 0\Big) \quad (8)$$

The partial effects are calculated accordingly:

$$\begin{aligned} PE_i = & \Phi\Big(\Big[\hat{\beta}_j + X'_{i(t=-1)}\hat{\rho} + \hat{a}_0 + \hat{a}_1 y_{i(t=0)}\Big]\Big[\sqrt{1-\hat{\lambda}}\Big]\Big) - \\ & \Phi\Big(\Big[X'_{i(t=-1)}\hat{\rho} + \hat{a}_0 + \hat{a}_1 y_{i(t=0)}\Big]\Big[\sqrt{1-\hat{\lambda}}\Big]\Big) \end{aligned} \quad (9)$$

Results

Regression results

	Coef.	Std. Err.
Age	0.017	0.033
Age squared	-0.000	0.001
Disability	0.005	0.075
First child	0.361***	0.047
Child planned	0.134***	0.042
Household income		
$\leq$\$20k	*reference*	
\$20k-\$30k	0.037	0.124
\$30k-\$50k	-0.055	0.108
\$50k-\$70k	-0.088	0.107
\$70k-\$100k	-0.049	0.106
\$100k-\$150k	-0.036	0.109
$>$\$150k	0.125	0.117
Highest education		
No sec education	*reference*	
NCEA 1-4	-0.028	0.086
NCEA 5-6	0.004	0.0842
Bachelor's degree	-0.032	0.090
Higher degree	0.024	0.0957
Self prioritised ethnicity		
NZ European	*reference*	
Māori	-0.171***	0.053
Pasifika	0.189***	0.064
Asian	0.395***	0.069
Intention to immunise child		
Immunise	*reference*	
No immunisation	-1.328***	0.141
Not decided yet	-0.388***	0.055
immunised_{t-1}	1.135***	0.091
$\text{immunised}_{t=0}$	1.459***	0.134
$\hat{\lambda}$	0.120***	0.039
Sample	23 306	

Results

Regression results (average partial effects)

	Full sample	By mother's ethnicity			
		NZ European	Māori	Pasifika	Asian
Basic specification	0.209***	0.196***	0.246***	0.218***	0.213***
	(0.035)	(0.043)	(0.078)	(0.121)	(0.093)
Individuals	4 778	2 958	597	556	667
w/o intent to immunise	0.220***	0.210***	0.347***	-	-
	(0.076)	(0.086)	(0.128)		
Individuals	733	574	81		
Mother's age ≤ 25	0.136***	0.130**	0.143*	-0.004	0.064
	(0.440)	(0.061)	(0.077)	(0.051)	(0.099)
Individuals	904	407	212	154	81

Results

Received discouraging information D_i before childbirth

	Full sample	NZ European	Māori	Pasifika	Asian
$y_{i(t-1)} = 0$ & $D_i = 0$			*reference category*		
$y_{i(t-1)} = 0$ & $D_i = 1$	-0.099***	-0.085**	-0.104	-0.073	-0.192
	(0.035)	(0.041)	(0.085)	(0.209)	(0.232)
$y_{i(t-1)} = 1$ & $D_i = 0$	0.194***	0.180***	0.238***	0.217*	0.195**
	(0.034)	(0.042)	(0.079)	(0.121)	(0.091)
$y_{i(t-1)} = 1$ & $D_i = 1$	0.177***	0.165***	0.194**	0.219*	0.182**
	(0.034)	(0.042)	(0.080)	(0.123)	(0.089)
Individuals	4 778	2 958	597	556	667

Conclusion

- Research question: does immunizing a child at a prior schedule *genuinely* influence the likelihood of vaccinating the child at the following schedule?
- Growing Up in NZ study which provides immunization status across various schedules
- Random-effects probit model controlling for the initial conditions problem (the effect of the first decision) and unobserved heterogeneity (via individual-specific time-invariant differences).
- Findings:
  - Strong state dependence in child immunization (21 percentage points)
  - Ethnic differences (state dependence playing a larger role for Māori)

Conclusion

- Research question: does immunizing a child at a prior schedule *genuinely* influence the likelihood of vaccinating the child at the following schedule?
- Growing Up in NZ study which provides immunization status across various schedules
- Random-effects probit model controlling for the initial conditions problem (the effect of the first decision) and unobserved heterogeneity (via individual-specific time-invariant differences).
- Findings:
  - Strong state dependence in child immunization (21 percentage points)
  - Ethnic differences (state dependence playing a larger role for Māori)

Conclusion

- Research question: does immunizing a child at a prior schedule *genuinely* influence the likelihood of vaccinating the child at the following schedule?
- Growing Up in NZ study which provides immunization status across various schedules
- Random-effects probit model controlling for the initial conditions problem (the effect of the first decision) and unobserved heterogeneity (via individual-specific time-invariant differences).
- Findings:
  - Strong state dependence in child immunization (21 percentage points)
  - Ethnic differences (state dependence playing a larger role for Māori)

Conclusion

- Research question: does immunizing a child at a prior schedule *genuinely* influence the likelihood of vaccinating the child at the following schedule?
- Growing Up in NZ study which provides immunization status across various schedules
- Random-effects probit model controlling for the initial conditions problem (the effect of the first decision) and unobserved heterogeneity (via individual-specific time-invariant differences).
- Findings:
  - Strong state dependence in child immunization (21 percentage points)
  - Ethnic differences (state dependence playing a larger role for Māori)

Conclusion

- Research question: does immunizing a child at a prior schedule *genuinely* influence the likelihood of vaccinating the child at the following schedule?
- Growing Up in NZ study which provides immunization status across various schedules
- Random-effects probit model controlling for the initial conditions problem (the effect of the first decision) and unobserved heterogeneity (via individual-specific time-invariant differences).
- Findings:
  - Strong state dependence in child immunization (21 percentage points)
  - Ethnic differences (state dependence playing a larger role for Māori)

Conclusion

- Research question: does immunizing a child at a prior schedule *genuinely* influence the likelihood of vaccinating the child at the following schedule?
- Growing Up in NZ study which provides immunization status across various schedules
- Random-effects probit model controlling for the initial conditions problem (the effect of the first decision) and unobserved heterogeneity (via individual-specific time-invariant differences).
- Findings:
  - Strong state dependence in child immunization (21 percentage points)
  - Ethnic differences (state dependence playing a larger role for Māori)

Conclusion

Thank you for your attention!!!

☞ alexander.plum@aut.ac.nz