Rolling sleeves up: A longitudinal analysis of childhood immunisation uptake in Ireland

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- Literature on socio-economic determinants of vaccine uptake in children is vast
- But most studies to date are **cross-sectional** and focus on **specific** vaccines
- We add to this literature performing a **longitudinal analysis** using data from GUI ‘08 Cohort
- Important to understand how parental decisions:
  - Might differ across vaccines or settings
  - Might change over time as child grows older

VACCINATION DATA IN GUI

VACCINATION DATA IN GUI: 1 MOTHER → 1 CHILD

	Wave 1 @ 9 months	Wave 3 @ 5 years	Wave 6 @ 13 years
Survey period:	September 2008 to April 2009	March to September 2013	September 2021 to June 2022
Vaccination's Questions IN GUI:	Can you tell me whether baby has received (tick all that apply): Their six-week check-up Vaccines at 2 months Vaccines at 4 months Vaccines at 6 months No vaccinations	Can you tell me whether child has received the MMR vaccination (measles/mumps/rubella) *after he/she started school at 4 to 5 years?* Yes, No	Can we check, has the study child received the HPV vaccine? (for information, vaccinations in school are given in 2 different visits usually with a first dose in September and a second one in February): Yes both doses Yes first of 2 doses No, but intend to avail of it No, still thinking about it No, have decided not to avail of it
Our binary outcome variables:	**2-4-6**: 1 if vaccines received @ 2,4 & 6 months; 0 otherwise	**MMR**: 1 if MMR vaccine received; 0 otherwise → Focus on children who started school in August 2012 (70% of sample)	**HPV**: 1 if 1 dose or 2 doses of HPV vaccine received; 0 otherwise

- For these 3 outcomes, parental responses appear to be reliable

- GUI also includes questions on uptake of:
  - First dose of MMR (@ wave 2, 3 years of age)
  - 4-in-1 in first year of primary school (@ wave 3, 5 years of age)
- However, self-reported responses appear to be less reliable for these 2 vaccines
  - Larger difference compared to HPSC uptake rates for corresponding cohorts

METHODOLOGY

MULTIVARIATE PROBIT MODEL

- Enables to model uptake of 1) 2-4-6; 2) MMR; 3) HPV while :
  - Allowing regression coefficients to vary by vaccine
  - Accounting for correlation between error terms in the three different vaccination equations

$$y_{it}^{*} = \beta_t{}' X_{it} + \epsilon_{it} \quad y_{it} = 1 \ \ if \ \ y_{it}^{*} > 0 \text{ and } 0 \text{ otherwise}$$

$$\text{t} = 1,2,3; \ \text{i} = 1, \dots, \mathbf{3,033 \ mothers}$$

$$\epsilon_{it} \sim MVN\ (\mathbf{0}\ , \Sigma) \quad \Sigma = \begin{bmatrix} 1 & \rho_{12} & \rho_{13} \\ & \ddots & \rho_{23} \\ & & 1 \end{bmatrix}$$

Explanatory Variables

- Demographic characteristics:
  - region of residence @ time of interview;
  - maternal: age, ethnicity (Irish or not) & education (degree or not);
  - child: gender; child first-born or not; month of birth

- Maternal health behaviours:
  - smoking & drinking in second/third trimester of pregnancy (yes vs no)

- Child health status:
  - child's (logged) birthweight
  - categorical variable reflecting whether @ time of interview the child had: no health conditions; 1+ non-limiting conditions; 1+ limiting conditions

Explanatory Variables (cont.)

- Economic status:
  - Mother in employment or not @ time of interview
  - (logged) equivalized household income @ time of interview

- Household (HH) composition
  - Number of siblings living in the HH @ time of interview
  - Mother's partner is resident in the HH @ time of interview

DESCRIPTIVE STATISTICS

	2-4-6=1	2-4-6=0	Sig?	MMR=1	MMR=0	Sig?	HPV=1	HPV=0	Sig?
	@ 9 months (wave 1), 2008/09			*@ 5 ys (wave 3), 2013*			*@ 13 ys (wave 6), 2021/22*		
Demographic characteristics:									
MotherAge	30.8	30.3		35.1	35.5		44.1	41.7	***
MotherIrish (0,1)	0.87	0.89		0.87	0.85		0.88	0.80	***
MotherDegree (0,1)	0.21	0.14	***	0.25	0.26		0.31	0.18	***
ChildMale (0,1)	0.49	0.50		0.49	0.48		0.50	0.48	
ChildFirstBorn(0,1)	0.49	0.25	***	0.44	0.43		0.45	0.40	
Maternal health behaviours:									
MotherSmokePreg (0,1)	0.20	0.33	**	0.20	0.27	*	0.18	0.37	***
MotherDrinkPreg (0,1)	0.16	0.13		0.15	0.17		0.16	0.14	
Child Health Status:									
ChildBirthWeight (g)	3458.7	3433.8		3456.7	3466.1		3472.5	3389.0	*
NoConditions	0.76	0.69		0.83	0.78		0.67	0.56	***
Non-limitingConditions	0.19	0.20		0.11	0.11		0.13	0.14	
LimitingConditions	0.06	0.11	**	0.06	0.10		0.21	0.32	***
Economic status:									
MotherEmployed (0,1)	0.54	0.51		0.51	0.43	**	0.74	0.62	***
HH income (€) *equivalised*	20561.0	16789.8	***	16239.5	16356.3		20243.7	16259.1	***
HH Composition:									
NSiblings	0.8	1.2		1.4	1.3	**	1.6	1.6	
PartnerPresent (0,1)	0.80	0.82		0.78	0.84		0.81	0.72	***
N	2,811	222		2,743	290		2,628	405	

Notes: Longitudinal survey weights applied. ***, **, and * denote significant differences by vaccination status at the 1%, 5% and 10% level respectively.
Source: Growing Up in Ireland '08 Cohort, Waves 1, 3 and 6

REGRESSION RESULTS

Estimation Strategy: Multivariate Probit Model ; Estimate: Average Marginal Effect (AME)

Dependent variable: **Measured @:**	**5-in-1** **9 months (wave 1)**	**MMR** **5 years (wave 3)**	**HPV** **13 years (wave 6)**
Correlation Coefficient [p value]:			
$\rho_{MMR,2-4-6}$	0.166** [0.075]		
$\rho_{HPV,2-4-6}$	0.238** [0.066]		
$\rho_{HPV,MMR}$	0.144** [0.067]		

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$\rho_{HPV,MMR}$	0.144** [0.067]		
Demographic characteristics:			
MotherAge	0.002 [0.001]	-0.001 [0.001]	0.009*** [0.002]
MotherIrish	-0.004 [0.018]	0.018 [0.019]	0.099*** [0.025]
MotherDegree	0.009 [0.013]	-0.007 [0.014]	0.09*** [0.016]
ChildMale	-0.001 [0.012]	0.010 [0.014]	-0.003 [0.019]
ChildFirstBorn	0.042** [0.019]	0.022 [0.017]	0.057** [0.023]
Maternal health behaviours:			
MotherSmokePreg	-0.035** [0.015]	-0.045** [0.020]	-0.097*** [0.025]
MotherDrinkPreg	0.017 [0.015]	-0.008 [0.018]	-0.008 [0.027]



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Dependent variable: **Measured @:**	**2-4-6** **9 months (wave 1)**	**MMR** **5 years (wave 3)**	**HPV** **13 years (wave 6)**
Child Health Status:			
Ln ChildBirthWeight	0.008 [0.027]	-0.043 [0.028]	0.010 [0.052]
NoConditions	Ref.	Ref.	Ref.
Non-limitingConditions	-0.008 [0.016]	0.003 [0.020]	-0.029 [0.030]
LimitingConditions	-0.059** [0.030]	-0.039 [0.033]	-0.062** [0.026]
Economic Status:			
MotherEmployed	-0.030 [0.013]	0.032** [0.015]	0.030 [0.024]
Ln HH income *equivalised*	0.037*** [0.013]	-0.005 [0.015]	0.045* [0.025]
HH Composition:			
NSiblings	-0.008 [0.008]	0.028*** [0.009]	0.016 [0.011]
PartnerPresent	-0.029 [0.020]	-0.050** [0.024]	0.011 [0.027]

Notes: standard errors [in parentheses]. Statistical significance levels are: * = p < 10%; ** = p < 5%; and *** = p < 1%. Controls for child month of birth and region of residence are also included. Longitudinal survey weights applied.
Source: Growing Up in Ireland '08 Cohort, Waves 1, 3 and 6

CONCLUSIONS

1. Unobserved factors that increase probability of vaccine uptake at one point in time also increase probability of vaccine uptake at another point in time

2. Smoking in pregnancy and whether child has limiting health conditions decrease the probability of vaccination

3. But also evidence of vaccine-specific predictors, with MMR standing out

→ Important to consider specificities of each vaccine and setting

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EXTRA SLIDES



	Wave 1 @ 9 months	Wave 2 @ 3 years	Wave 3 @ 5 years	Wave 6 @ 13 years
Survey period	September 2008 to April 2009	December 2010 to July 2011	March to September 2013	September 2021 to June 2022
Vaccination's Question:	Can you tell me whether baby has received (tick all that apply): Their six-week check-up Vaccines at 2 months Vaccines at 4 months Vaccines at 6 months No vaccinations	Has child had the Measles/Mumps/Rubella (MMR) vaccination? Yes No	Can you tell me whether child has received the following vaccinations: 1. The 4-in-1 vaccination (diphtheria, tetanus, pertussis and polio) 2. The MMR vaccination (measles/mumps/rubella) after he/she started school at 4 to 5 years	Can we check, has the study child received the HPV vaccine? (for information, vaccinations in school are given in 2 different visits usually with a first dose in September and a second one in February): Yes both doses Yes first of 2 doses No, but intend to avail of it No, still thinking about it No, have decided not to avail of it

	Wave 1 @ 9 months	Wave 2 @ 3 years	Wave 3 @ 5 years	Wave 6 @ 13 years
Survey	Sep 2008 to Apr 2009	Dec 2010 to July 2011	March to Sept 2013	Sept 2021 to June 2022
Vaccine of interest:	Vaccines at 2/4/6 months (5-in-1 + Men-C)	MMR	4-in-1 and MMR in school	HPV (one or two doses) in school
Has GUI child been offered the vaccine?	Yes, at their GP, free of charge	Yes, at their GP, free of charge, when they were 1 year old	Vaccines typically offered in school, in JI, free of charge, in September to December. Child should have been offered the vaccine if started school (JI) in August 2012 (70% of children in the sample)	Vaccines offered in 1st year of secondary school, free of charge. 1st dose in Sept and 2nd in Feb. Children in 2nd year should have received both doses. Children in 1st year at least one dose.

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Survey	Sep 2008 to Apr 2009	Dec 2010 to July 2011	March to Sept 2013	Sept 2021 to June 2022
Vaccine of interest:	Vaccines at 2/4/6 months (5-in-1 + Men-C)	MMR	4-in-1 and MMR in school	HPV (one or two doses) in school
Uptake rate, official statistics	89% for 5-in-1 at 12 months for children born in 2008	90% at 24 months for children born in 2008	90.4% for 4-in-1 89.1% for MMR among JIs in academic year 2012/2013	79.7% for 1+ dose in first year of secondary school in academic year 2020/21
Uptake rate in GUI	91.9% at interview time	97% at interview time	97.1% for 4-in-1 90.9% for MMR among JIs in 2012/2013	84.2% among those who were in first year of secondary school in academic year 2020/21
Difference (GUI – official)	2.9 p.p.	7 p.p.	6.7 p.p. for 4-in-1 1.8 p.p. in MMR	4.5 p.p.



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Vaccination's Question:	Can you tell me whether baby has received (tick all that apply): Their six-week check-up Vaccines at 2 months Vaccines at 4 months Vaccines at 6 months No vaccinations	Has <child ha he Measle abella (MMR) v 2 Yes No	Can you tell me whether <child> has received the following vaccinations: 1.The 4-in-1 vaccination (diphth anus, pert io) 2. th cination (measles/mumps/rubell a) after he/she started school at 4 to 5 years	Can we check, has the study child received the HPV vaccine? (for information, vaccinations in school are given in 2 different visits usually with a first dose in September and a second one in February): Yes both doses Yes first of 2 doses No, but intend to avail of it No, still thinking about it No, have decided not to avail of it

Weighted statistics	5-in-1=1	5-in-1=0	Sig?	MMR=1	MMR=0	Sig?	HPV=1	HPV=0	Sig?
	@ 9 months (wave 1)			*@ 5 ys (wave 3)*			*@ 13 ys (wave 6)*		
Time-invariant characteristics:									
MotherSmokePreg (0,1)	0.19	0.33	***	0.20	0.27	*	0.17	0.35	***
MotherDrinkPreg (0,1)	0.16	0.13		0.16	0.17		0.16	0.14	
MotherIrish (0,1)	0.86	0.90		0.87	0.85		0.88	0.80	***
ChildMale (0,1)	0.49	0.52		0.49	0.47		0.50	0.47	
ChildBirthWeight (g)	3459.4	3457.2		3459.3	3458.8		3471.5	3401.8	
ChildFirstBorn(0,1)	0.46	0.25	***	0.44	0.43		0.45	0.40	
Child Time-varying Characteristics:									
NoConditions	0.76	0.70		0.83	0.78		0.67	0.56	***
Non-limitingConditions	0.19	0.19		0.11	0.13		0.13	0.13	
LimitingConditions	0.05	0.12	**	0.06	0.09		0.20	0.30	***
Mother Time-varying Characteristics:									
Age	30.8	30.5		35.2	35.6		44.2	41.7	***
Degree+ (0,1)	0.22	0.14	***	26.1%	26.0%		0.32	0.18	***
Employed (0,1)	0.55	0.52		52.4%	44.4%	**	0.74	0.63	***
Household Time-varying Characteristics:									
HH income (€) *equivalised*	20666.9	16928.3	***	16351.5	16463.0		20331.1	16283.4	***
PrivateHealthInsurance (0,1)	0.50	0.42	*	0.38	0.38		0.43	0.24	***
NSiblings	0.81	1.20	***	1.44	1.28	**	1.63	1.64	
PartnerPresent (0,1)	0.81	0.83		0.80	0.83		0.82	0.73	***
N (unweighted)	2,947	233		2,880	300		2,749	431	

Notes: $^{*} = p < 10\%$; $^{**} = p < 5\%$; and $^{***} = p < 1\%$ *indicate whether group differences are statistically significant.*

Immunisation Schedule

PROTECT PREVENT IMMUNISE

When	Vaccination	Where	
2 months	6 in 1 MenB PCV Rotavirus	GP	Visit 1
4 months	6 in 1 MenB Rotavirus	GP	Visit 2
6 months	6 in 1 PCV MenC	GP	Visit 3
	No Rotavirus vaccine on or after 8 months 0 days		
12 months	MMR MenB	GP	Visit 4
13 months	Hib/MenC PCV	GP	Visit 5
Junior Infants	4 in 1 MMR	Primary School	4 in 1 & MMR vaccines
1st year	HPV Tdap MenACWY	Secondary School	Given over 2 visits

FIVE GP VISITS COMPLETE

HPV vaccine · Tdap vaccine · MenACWY vaccine

6 in 1 - Diphtheria, haemophilus influenzae type b (Hib), hepatitis B, acellular pertussis, inactivated polio, tetanus vaccine
MenB - Meningococcal B recombinant vaccin
Rotavirus - Rotavirus oral vaccine
PCV - Pneumococcal conjugate vaccine
MenC - Meningococcal C conjugate vaccine
MMR - Measles, mumps, rubella vaccine
Hib/MenC - Haemophilus influenzae type b/meningococcal C conjugate vaccine
4 in 1 - Diphtheria, tetanus, pertussis, polio vaccine
HPV - Human papillomavirus vaccine
Tdap - Low dose diphtheria, tetanus and acellular pertussis vaccine
MenACWY - Meningococcal A, C, W, Y conjugate vaccine