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POLICY PAPER

An Analysis of Antenatal Care Pathways to Mode of Birth in Ireland

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Abstract: This paper explores the role of antenatal care in determining mode of birth in the Irish healthcare system using data from the *Growing Up in Ireland* study. Results indicate that midwifery-led antenatal care is independently associated with significantly higher rates of normal delivery and significantly lower rates of elective caesarean section relative to consultant-led care in both the public and private sectors. Given concerns over increasing rates of caesarean section, our results are consistent with calls nationally and internationally for further investment in midwifery-led antenatal care services, and for stricter regulation of the actors, both providers and patients, engaged in the private antenatal care pathway.

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I INTRODUCTION

Amid the global rise in caesarean section rates (WHO, 2009), a field of research has emerged that examines the drivers and outcomes of mode of birth. Importantly, the evidence indicates that caesarean section delivery in the presence of a clinically defined need significantly improves health outcomes by reducing infant and maternal mortality (Stephenson *et al*., 1993). However, when performed in the absence of such clinical need, it may be associated with negative health outcomes for mothers and infants (Molina *et al*., 2015; D'Alton and Hehir, 2015; Souza *et al*., 2010; Black *et al*., 2015), as well as unnecessary costs for healthcare systems (Main *et al.,* 2012; Eckerlund and Gerdtham, 1998). While the World Health Organisation (WHO) historically recommended population-level caesarean section rates of between 10 per cent and 15 per cent, they have since moved away from identifying such a target range (WHO, 2015). Instead, the WHO now recommends that every effort should be made to provide caesarean sections to women in need (WHO, 2015); that is, clinically defined need should be the fundamental principle in determining mode of birth. This notwithstanding, the caesarean section rate reported for Ireland was 31.4 per cent for 2016 (OECD, 2017). Moreover, the trend of the caesarean section rate for Ireland has exhibited a steady and continued increase from, for example, 20.8 per cent in 2000 and 26.0 per cent in 2010 (OECD, 2017). The comparative OECD averages were 16.1 per cent for 2000, 25.1 per cent for 2010 and 26.1 per cent for 2016 (OECD, 2017). Given these figures, questions may be raised as to the extent to which the observed increase in the caesarean section rate for Ireland reflects an increase in clinically defined need over time. Moreover, if the increase in the observed caesarean section rate cannot be wholly attributed to an increase in clinically defined need, there is a requirement for evidence to inform policy and practice aimed at addressing higher than necessary caesarean section rates, which in turn may potentially reduce associated negative health outcomes and excess costs. In this context, this paper uses data from a nationally representative sample of mothers to examine the role of mode of antenatal care in determining mode of birth in the Irish healthcare setting.

The drivers of increased caesarean section rates are multiple and complex. Internationally, the increasing rates of caesarean section have been linked to, for example, variations in clinical factors, such as increasing rates of women becoming pregnant at older ages, maternal obesity and medical comorbidities (Bayrampour and Heaman, 2010), as well as variations in non-clinical factors. The latter include improvements in the relative safety of caesarean section delivery (Keeler and Brodie, 1993) and shifts in maternal preferences towards caesarean section delivery (Fuglenes *et al*., 2013), though evidence on this is somewhat mixed. In addition, the role of institutional and organisational level factors is also relevant. For example, a number of studies have shown a significant association between private sector

antenatal and delivery care and higher rates of caesarean section delivery (Movsas *et al*., 2012; Lipkind *et al*., 2009; Einarsdóttir *et al*., 2013; Hoxha *et al*., 2017). While the generalisability of these international findings to the Irish context may be questioned, it is evident that similar patterns have been observed for Ireland, where mothers who chose private consultant-led care were significantly more likely to have a caesarean section than those with public consultant-led care (Brick and Layte, 2011; Murphy and Fahey, 2013; Lutomski *et al*., 2014; Layte *et al*., 2015; Sinnott *et al.*, 2016.; Brick *et al*., 2016). Such studies have also explored the drivers of these higher caesarean section rates within the private sector in Ireland, citing factors such as differing financial incentives (Grant, 2009; Gruber and Owings, 1996), the ability to be able to schedule deliveries (Tussing *et al*., 1992), and the increasingly litigious nature of Irish society (Lutomski *et al*., 2014). These findings have led to calls for stricter regulation of the public and private maternity care sectors in Ireland (Brick *et al*., 2016), reflecting similar appeals internationally (Hoxha *et al*., 2017).

A further consideration in the context of the relationship between mode of antenatal care and mode of birth is the potential role of midwifery-led care as an alternative to the consultant-led models in both the public and private sectors. Notably, a recent systematic review found that the relationship between midwifery-led antenatal care and mode of birth is not well established (Homer *et al*., 2012), with some evidence of reduced caesarean section rates for low-risk pregnant women (McLachlan *et al*., 2012), though this was not consistent across the full population (Tracy *et al*., 2013; Beckmann *et al*., 2012). This reflects the findings from the most recently published Cochrane Review which suggested that women who received midwifery-led care were more likely to have a normal birth, but there was no difference in respect of caesarean section delivery (Sandall *et al*., 2016). Similarly, in the Irish context, a randomised controlled trial comparing midwifery-led care with consultant-led care found no significant differences with respect to mode of birth (Begley *et al*., 2011). That said, there appears to be a growing demand for this form of antenatal care at public policy level in countries including Ireland, where in an effort to improve maternal choice, the Government has pledged to expand midwifery-led care throughout the country (Department of Health and Children, 2016). This policy shift has been informed by the view that midwifery-led antenatal care is a woman-centred, safe and cost effective alternative to consultant-led care (Begley *et al*., 2009). Nonetheless, from both an Irish and international perspective, further evidence is required on the role of midwifery-led antenatal care on mode of birth, and on its potential to combat the rising rates of caesarean section by increasing the proportion of normal births.

Thus, this paper adds to the evidence base by exploring the role of three different modes of antenatal care in determining mode of birth in the Irish healthcare setting. In particular, we provide an empirical analysis of the impact, relative to standard public consultant-led care, of private consultant-led care and midwifery-

led care on mode of delivery, controlling for a wide range of other factors. In doing so, we explore the potential pathways between private consultant-led care and midwifery-led care and normal birth (*NB*), assisted normal birth (*ANB*), elective caesarean section (*ELCS*) and emergency caesarean section (*EMCS*). First, in respect of private consultant-led antenatal care, we suggest that the choice of mode of birth is likely to be influenced by the pregnant woman and her attending health professional caregivers. In this case, the existence of a financial transaction between a patient and provider may directly influence mode of birth. Indeed, there is increasing evidence that financial incentives and private sector pressures play an important role in the context of increasing caesarean section rates internationally (Hoxha *et al*., 2017). Additionally, non-financial incentives, such as time and legal factors may also influence the private consultant and the delivery care team in their prescription of an *ELCS* delivery. There is also a role for patient preferences in this pathway, whereby if a woman has a preference for an *ELCS*, and she has the financial or other non-financial means to do so, she may select private antenatal care in an attempt to influence the mode of birth prescribed. In such cases, women might explicitly state their preferences to their healthcare providers, who in turn, reflect these preferences in the prescribed mode of birth. Indeed, this channel of influence may inform the choice of mode of antenatal care in the first place. Second, in respect of midwifery-led antenatal care, the choice of mode of birth is once again likely to be influenced by the pregnant woman and her attending health professional caregivers. In this case, financial incentives do not exist for the provider with respect to the different modes of birth. However, if the midwifery-led care team have an explicit preference for *NB*, this is likely to influence the mode of birth prescribed. Additionally, if the patient has a preference for a *NB*, this may reflect the choice of midwifery-led care in the first instance. In other words, a woman who wishes to have a *NB* may be more likely to choose midwifery-led antenatal care to directly influence this outcome.

Taking all of the above together, we attempt to tease out these possible mechanisms that could be driving the patterns of results that we observe and, in the context of the limitations of our work, we present tentative implications for policymakers and healthcare providers seeking to impact upon mode of birth practices.

II HEALTHCARE CONTEXT

Ireland provides an interesting case study for considering mode of birth and the role of institutional and organisational level factors such as mode of antenatal care. Healthcare services, including maternity care, are jointly financed and delivered by the public and private sectors. There are two categories of public healthcare eligibility in Ireland, which are determined primarily on the basis of income or ill-

health, and which provide different levels of access, via their associated pricing arrangements, for public services (Evetovits *et al*., 2012). In addition, individuals may access privately delivered health services in private and public hospitals, as well as in the primary and community care setting. These services are funded through a combination of out-of-pocket payments and supplementary private health insurance (PHI) (Evetovits *et al*., 2012). With respect to maternity services specifically, all women are entitled to free public antenatal and delivery care in the public healthcare system through the maternity and infant scheme. There are three broad modes of antenatal care available to women in Ireland, which we describe in our analysis as follows: (1) standard care, (2) private consultant-led care, and (3) midwifery-led care. Provision is predominantly consultant-led and delivered in the public hospital setting, as the three modes of antenatal care are not universally available and there exists regional variation across the island of Ireland. Within the public system, 19 maternity units, two midwifery-led units, and a number of domiciliary care in and out of hospital (domino) units are in operation nationwide, while there are no solely private maternity hospitals in existence. Finally, a unique feature of the Irish maternity care system is that women accessing private care are treated in the same hospitals, and by the same staff, as women accessing public care. Nonetheless, the same clinical guidelines are applied across modes of antenatal care (Brick *et al*., 2016) and care is not differentiated on the basis of quality.

The standard care model of antenatal care, and the dominant form in Ireland, is led by a public consultant obstetrician and shared across a team of doctors, midwives, general practitioners and other healthcare professionals. In this case, care during labour and at birth is provided in a public hospital by a team of qualified and student midwives, under the supervision of obstetricians, and care during the postnatal period is provided in a public hospital ward (Begley *et al*., 2011). As a supplement to standard care, women may avail of semi-private care, in which antenatal care is provided by a non-consultant qualified obstetrician, care in labour and at birth is provided by a team of qualified and student midwives, under the supervision of the obstetrician on call, and postnatal care is provided in a semi-private ward, if available, in a public hospital (Begley *et al*., 2011).

Within the private consultant-led model of antenatal care, the woman receives antenatal care from her chosen private consultant obstetrician. In this case, care during labour and at birth is provided by a team of qualified and student midwives, under the supervision of the private consultant obstetrician or their designated replacement, who will often be present for the birth, and care during the postnatal period is provided in a private room if available, in a public hospital (Begley *et al*., 2011). Providers receive 'fee-for-service' payments for private care, in terms of hospital accommodation fees and consultant fees, which are paid for in the majority of cases via a combination of maternity clauses in PHI policies and out-of-pocket payments. These are also typically required to cover consultant fees (Brick and Layte, 2011). It is possible for a woman to choose the private consultant-led model

of antenatal care without PHI, but this requires out-of-pocket payments to cover the full cost of antenatal and intrapartum care. For those with PHI, the nature of their policy dictates the range of services covered and the extent of co-payments for antenatal and intrapartum care, be that semi or fully private. Notably, PHI polices only cover 'medically necessary' caesarean section so it is not the case that those with PHI can simply choose to have an elective procedure.

Finally, reflecting trends internationally, the midwifery-led model of antenatal care has emerged as an alternative to the standard, consultant-led public models of antenatal care in Ireland. Under the midwifery-led care model, the midwife, in partnership with the woman, acts as the lead professional with responsibility for the assessment of her needs, planning her care, referral to other professionals as appropriate, and for ensuring provision of maternity services (Sandall *et al*., 2016). This model tends to be less prescriptive and is founded on the principle of childbirth being a normal, physiological yet life-changing event (Sandall *et al*., 2016). In the Irish case, the woman's antenatal care is managed by a team of midwives and all care takes place in a public hospital or in the community. Notably, while no doctors form part of the team, such services can be accessed in the event of a complication or emergency. At present in Ireland, access to this option is limited (Fawsitt *et al*., 2017a) but policy commitments have been made to expand this element of the maternity care system (Department of Health and Children, 2016).

III DATA AND METHODS

The data analysed are from the first wave of the infant cohort of the *Growing Up in Ireland* (GUI) study, a nationally representative survey of over 11,000 children and their parents selected randomly from Ireland's Child Benefit Register. The data were collected during 2008/2009 and include approximately one-quarter of all nine-month old babies born between December 2007 and June 2008. The purpose of the GUI study is to provide data that describe the lives of Irish children in order to inform public policy and service delivery. Further details of the survey, including the sampling procedures, are discussed in Greene *et al*. (2010). After excluding observations where the primary carer was not the birth mother of the child, as well as observations with missing data, our final analysis focuses on 9,083 birth mothers of nine-month old infants.

The dependent variable captures the mode of birth in pregnancy for mothers in the sample, which comprises four categories: *NB*, *ANB*, *ELCS* and *EMCS*. Table 1 illustrates that 58.67 per cent of mothers in the sample had a *NB;* 15.02 per cent had an *ANB;* 12.85 per cent had an *ELCS;* and 13.46 per cent had an *EMCS*. The main independent variable of interest – mode of antenatal care – is a three-category variable identifying those who had standard care, private consultant-led care and midwifery-led care. In this case, 85.31 per cent of the estimation sample had

standard care, 12.58 per cent private consultant-led care, and 2.07 per cent midwifery-led care. Notably, 59.96 per cent of women with standard care had a *NB*, compared to 47.64 per cent of women with private consultant-led care and 72.87 per cent of women with midwifery-led care. Moreover, 11.78 per cent of women with standard care had an *ELCS*, compared to 21.64 per cent of women with private consultant-led care and 3.19 per cent of women with midwifery-led care. Details of other explanatory variables included in the analysis, along with descriptive statistics for the estimation sample, are provided in Table 1. The final set of independent variables was informed by the existing evidence base, as well as a review of available variables in the dataset by an expert clinician within the study team.

To analyse how the mode of antenatal care relates to the mode of birth, we employ a multinomial probit (MNP) model. While the multinomial logit (MNL) model is commonly used to analyse discrete choice or categorical outcome data (Wooldridge, 2000), one of the criticisms of the model is the strong assumption of independence of irrelevant alternatives (IIA). This implies that the ratio of the probabilities of choosing any two alternatives is independent of the availability of other alternatives (Hausman and Mc Fadden, 1984). In other words, an individual's choice of an alternative relative to another would not change if another feasible alternative is added or removed. When the IIA assumption is violated, MNL is not correctly specified, and the estimated coefficients are biased and inconsistent. To overcome this, we follow Hausman and Wise (1978) and apply a MNP model to examine the association between mode of birth and type of antenatal care. According to Alvarez and Nagler (1998), the MNP produces more accurate estimates than those of the MNL as it relaxes the IIA assumption. In addition to this, the MNP allows for a much more flexible pattern of error correlation, as the error terms are assumed to be independent and identical standard normal (Cameron and Trivedi, 2010).

In the model, the mode of birth for mother i (MOB_i) is modelled as a function of the mode of antenatal care received (X_i^A), a vector of socio-economic characteristics ($\boldsymbol{X}_i^S$), a vector of maternal characteristics ($\boldsymbol{X}_i^M$) and a vector of clinical characteristics ($\boldsymbol{X}_i^C$). The model is represented as:

$$\mathrm{MOB}_i = f(X_i^A, \boldsymbol{X}_i^S, \boldsymbol{X}_i^M, \boldsymbol{X}_i^C, \varepsilon_i) \tag{1}$$

where the dependent variable MOB_i comprises four alternatives (*NB*, *ANB*, *ELCS* and *EMCS)*, while ε_{ij} is a stochastic error term (discussed below). The socio-economic characteristics in $\boldsymbol{X}_i^S$ include education, employment status, social class, household income, region, as well as indicator variables for PHI and Medical Card. The maternal characteristics in $\boldsymbol{X}_i^M$ include the age category and ethnicity of the mother, along with her BMI, and an indicator variable capturing whether or not she smokes. Finally, $\boldsymbol{X}_i^C$ includes clinical characteristics on whether it is the mother's

first child or a nulliparous pregnancy, whether it is a multiple birth pregnancy, as well as a range of dummy variables capturing the presence of antenatal complications. Table 1 presents a more detailed description of the variables used to estimate Equation 1, along with sample descriptive statistics.

The MNP model can be usefully considered using a latent variable framework. In particular, we define the underlying latent variable for individual $i = 1,..., N$ of alternative $j = 1,\ldots, J$ as

$$\eta_{ij} = \boldsymbol{X}_i \alpha_j + \varepsilon_{ij} \tag{2}$$

where the vector $\boldsymbol{X}_i$ contains the observed independent variables for the ith individual. Associated with $\boldsymbol{X}_i$ are the J vectors of regression coefficients α_j. The key feature of the MNP model is that $\varepsilon_{i1},..., \varepsilon_{iJ}$ are assumed to be normally distributed errors. Thus, in this setting, the mother chooses alternative k such that $\eta_{ik} \geq \eta_{im}$ for $m \neq k$. Once estimated, the usual approach to calculating partial effects can be followed in order to predict, for example, the impact of a change in one explanatory variable on the probability of an outcome (Jones, 2007). Our primary interest is the partial effect of mode of antenatal care on the probability of mode of birth and we therefore present a series of results for each of the four modes of birth. In all cases, the results presented consist of average partial effects.

In reporting our findings, we first present a set of results for a single variable model which is estimated including mode of antenatal care received (X_i^A) only. We then present results from the full multivariable specification [1]. In addition, in an appendix, we present results from a series of sensitivity analyses which explore the robustness of our findings for alternative samples, independent variable subsets, and independent and dependent variable specifications. In particular, results are presented for the nulliparous sample only, given the potential implications of the first delivery on subsequent deliveries. Furthermore, results are presented for an alternative six category mode of birth variable and a five category mode of antenatal care variable. In some cases, where necessary, the sensitivity analysis was conducted using MNL regression. Finally, for descriptive purposes, we present the results from a MNP analysis of mode of antenatal care, estimated controlling for a vector of socio-economic and maternal characteristics. This descriptive analysis is conducted to provide context for the interpretation of the main results.

IV RESULTS

This section examines the association between mode of antenatal care and mode of birth. The estimation results for the MNP model are reported in Table 2 and Table 3. In particular, we present estimated average partial effects on the probability of a *NB*, *ANB*, *ELCS* and *EMCS.* While a range of explanatory variables are included as controls in the analysis (Table 3), we focus our discussion on the relationship

Table 1: Variable Descriptions and Descriptive Statistics of Study Sample and Subsamples by Mode of Antenatal Care

Variable Name	*Variable Description*	*Study Sample*			
		Total	*Standard care*	*Private consultant-led care*	*Midwifery-led care*
Mode of Antenatal Care		9,083 (100%)	7,749 (85.31%)	1,146 (12.58%)	188 (2.07%)
Mode of Birth		%	%	%	%
Normal birth	NB	58.67	59.96	47.64	72.87
Assisted normal birth	ANB	15.02	14.75	16.93	14.36
Elective caesarean section	ELCS	12.85	11.78	21.64	3.19
Emergency caesarean section	EMCS	13.46	13.51	13.79	9.57
Socio-economic Characteristics					
Private health insurance	PHI	57.75	52.32	96.77	44.15
Education level	primary education	11.41	12.76	2.09	12.23
	secondary education	51.63	53.66	38.22	50.00
	higher education	36.96	33.58	59.69	37.77
Employment	currently employed	58.70	56.77	72.95	51.60
Social class	household head is professional/managerial/ technical	50.40	46.01	79.84	52.13
	household head is other non-manual/skilled manual	30.05	32.15	16.40	26.60
	household head is semi-skilled or unskilled	8.75	9.65	2.88	7.45
	unclassified	10.80	12.20	0.87	13.83

Table 1: Variable Descriptions and Descriptive Statistics of Study Sample and Subsamples by Mode of Antenatal Care (Contd.)

Variable Name	*Variable Description*	*Study Sample*			
		Total	*Standard care*	*Private consultant-led care*	*Midwifery-led care*
Household income	1st or lowest income quintile	20.74	23.16	4.45	20.21
	2nd income quintile	18.39	20.03	7.50	17.02
	3rd income quintile	19.02	19.90	12.65	21.81
	4th income quintile	22.13	21.10	28.18	27.66
	5th or highest income quintile	19.72	15.81	47.21	13.30
Region	urban	44.14	42.69	52.88	50.53
Medical card	no Medical Card	71.58	68.10	95.46	69.68
	full Medical Card	25.54	28.71	3.84	27.13
	GP Visit Card	2.87	3.19	0.70	3.19
Maternal Characteristics					
Age category	age < 25	10.54	11.95	1.22	9.04
	age 25-30	20.98	22.75	8.73	22.87
	age 30-35	35.33	35.06	36.56	38.83
	age 35-40	26.91	24.74	42.06	23.94
	age >40	6.24	5.50	11.43	5.32
Ethnicity	Irish White background	80.62	78.62	93.63	84.04
	any other White background	13.12	14.31	5.24	12.23
	African or any other Black background	3.01	3.43	0.26	2.13
	Chinese or any other Asian background	2.81	3.16	0.61	1.60

Table 1: Variable Descriptions and Descriptive Statistics of Study Sample and Subsamples by Mode of Antenatal Care (Contd.)

Variable Name	*Variable Description*	*Study Sample*			
		Total	*Standard care*	*Private consultant-led care*	*Midwifery-led care*
Ethnicity (contd.)	Other - including mixed background	0.44	0.48	0.26	0.00
Body mass index (BMI) status	BMI 18.5-25 (*healthy weight*)	52.91	51.97	59.34	52.66
	BMI 25-30 (*overweight*)	30.38	30.46	29.76	30.85
	BMI >30 (*obese*)	16.71	17.58	10.91	16.49
Smoking status	smoker	23.48	24.56	15.45	28.19
Nulliparous	first child	38.49	38.95	35.86	35.64
Multiple pregnancy	non-singleton pregnancy	3.38	3.14	5.41	1.06
Antenatal Complications	raised blood pressure	10.81	11.10	9.16	9.04
	preeclampsia	7.11	7.33	5.76	6.38
	urinary or kidney infection	14.58	15.36	9.34	14.36
	persistent vomiting or nausea	17.36	17.83	14.92	12.77
	gestational diabetes	2.80	2.97	1.92	1.06
	bleeding	5.85	6.07	4.62	4.26
	vaginal infection	3.61	3.73	2.79	3.72
	intrauterine growth restriction	2.09	2.08	2.27	1.60
	rhesus incompatibility	4.06	4.03	4.45	3.19
	influenza	3.58	3.54	3.93	3.19
	placenta praevia	2.79	2.84	2.71	1.06
	miscarriage in multiple pregnancy	0.50	0.45	0.87	0.00

Table 1: Variable Descriptions and Descriptive Statistics of Study Sample and Subsamples by Mode of Antenatal Care (Contd.)

Variable Name	*Variable Description*	*Study Sample*			
		Total	*Standard care*	*Private consultant-led care*	*Midwifery-led care*
	previous pregnancy condition	0.58	0.65	0.26	0.00
	high risk pregnancy complications	2.19	2.03	3.49	1.06
	maternal pregnancy condition	0.94	0.89	1.22	1.06
	non-pregnancy condition	1.35	1.38	1.13	1.60
	pain	2.46	2.19	4.10	3.19
	excessive fluid	0.71	0.74	0.44	1.60
	other placental disorders	0.21	0.19	0.35	0.00
	other labour and birth complications	0.45	0.40	0.79	0.53

Source: Analysis of GUI Infant Cohort Wave 1 data.

Table 2: MNP Model Partial Effects Estimates – No Controls

Variable Name	*Variable Description*	*Probability of NB*		*Probability of ANB*		*Probability of ELCS*		*Probability of EMCS*	
Mode of Antenatal Care									
Mode of Antenatal Care	= Standard care	Ref	xxx	Ref	xxx	Ref	xxx	Ref	xxx
	= Private consultant-led care	0.123***	–0.252***	0.022	0.026	0.099***	0.185***	0.003	0.042
	= Midwifery-led care	0.129***	Ref	–0.004	Ref	–0.086***	Ref	–0.039*	Ref
Log likelihood	–10213.22								
AIC	20444.45								
BIC	20508.48								
Observations	9,083								

Source: Analysis of GUI Infant Cohort Wave 1 data.
Note: The table presents results from a multinomial probit model of mode of birth, estimated controlling for antenatal care. Results are presented in the form of average partial effects on the probability of a mode of birth. *** denotes statistically significant at 1 per cent, ** denotes statistically significant at 5 per cent, and * denotes statistically significant at 10 per cent.

between mode of antenatal care and mode of birth. We chose these final models on the basis of a range of statistical and goodness-of-fit tests and measures. The robustness of our final model estimates was also tested by undertaking sensitivity analyses, and in general we found that the main results, findings and conclusions were not sensitive to these alternative model specifications (see Appendix Tables A.1-A.10).

The main results from the MNP model (Table 3) indicate that, after controlling for a range of factors, mode of antenatal care is associated with a statistically significant difference in the probability of a *NB* and an *ELCS*. Notably, we find no significant differences in the probabilities of *ANB* or *EMCS* across the different modes of antenatal care. More specifically, we find that, all else equal, the probability of *NB* is 11.0 percentage points higher for those who had midwifery-led care relative to those who had standard care, controlling for a range of variables including clinical need. On the other hand, we find that the probability of *NB* is 8.0 percentage points lower for mothers who had private consultant-led care relative to those who had standard care. Further, we find that the probability of *NB* is 19.0 percentage points lower for those who had private consultant-led care relative to those who had midwifery-led care. In terms of *ELCS* delivery, we find the probability is 8.1 percentage points lower for those with midwifery-led care relative to those with standard care. Conversely, the probability of *ELCS* is 6.4 percentage points higher for those who had private consultant-led care relative to standard care. Moreover, the probability of *ELCS* is 14.5 percentage points higher for those with private consultant-led care relative to those with midwifery-led care, again after controlling for a range of factors.

Although not considered in detail here, we also find that a range of socio-economic, maternal and clinical characteristics were significantly correlated with mode of birth. In particular, our findings indicate that the probability of a *NB* was significantly lower for those at older ages, overweight and obese, for nulliparous and multiple birth pregnancies, and for a range of antenatal complications. Alternatively, the probability of a *NB* was significantly higher for those of non-Irish White ethnicity. The probability of an *ANB* was significantly lower for those with GP Visit Cards, for those of non-Irish White ethnicity, and for those who were obese. On the other hand, the probability of an *ANB* was significantly higher for nulliparous and multiple birth pregnancies, and for a range of antenatal complications. The probability of an *ELCS* was significantly lower for those in urban areas, for those of Irish White ethnicity, and for nulliparous pregnancies. Alternatively, the probability of an *ELCS* was significantly higher for those with PHI, for older ages, for overweight and obese, for multiple birth pregnancies, and for a range of antenatal complications. Finally, the probability of an *EMCS* was significantly lower for those in urban areas and for a range of antenatal complications, while the probability of an *EMCS* was significantly higher for older ages, for overweight and obese, for nulliparous and multiple birth pregnancies and for a range of antenatal complications.

Table 3: MNP Model Partial Effects Estimates – With Controls

Variable Name	*Variable Description*	*Probability of NB*		*Probability of ANB*		*Probability of ELCS*		*Probability of EMCS*	
Mode of Antenatal Care									
Mode of Antenatal Care	= Standard care	Ref	xxx	Ref	xxx	Ref	xxx	Ref	xxx
	= Private consultant-led care	–0.080***	–0.190***	0.014	0.019	0.064***	0.145**	0.002	0.025
	= Midwifery-led care	0.110***	Ref	–0.005	Ref	–0.081***	*Ref	–0.024	Ref
Socio-economic Characteristics									
Private health insurance	= PHI	–0.015		–0.006		0.024**		–0.002	
Education level	= primary education	Ref		Ref		Ref		Ref	
	= secondary education	–0.003		0.008		0.009		–0.013	
	= higher education	0.014		0.013		–0.016		–0.011	
Employment	= currently employed	–0.007		0.006		0.009		–0.008	
Social class	= household head is professional/ managerial/technical	Ref		Ref		Ref		Ref	
	= household head is other non-manual/skilled manual	0.014		–0.012		–0.001		–0.001	
	= household head is semi-skilled or unskilled	0.032		–0.021		0.005		–0.016	
	= unclassified	0.027		–0.017		–0.017		0.007	
Household income	= 1st or lowest income quintile	Ref		Ref		Ref		Ref	
	= 2nd income quintile	0.021		–0.014		0.002		–0.009	
	= 3rd income quintile	–0.024		0.019		0.025		–0.019	
	= 4th income quintile	–0.038*		0.015		0.010		0.013	
	= 5th or highest income quintile	–0.010		0.011		–0.006		0.006	
Region	= urban	0.016		0.012		–0.016**		–0.012*	

Table 3: MNP Model Partial Effects Estimates – With Controls (Contd.)

Variable Name	*Variable Description*	*Probability of NB*	*Probability of ANB*	*Probability of ELCS*	*Probability of EMCS*
Medical Card	= no Medical Card	Ref	Ref	Ref	Ref
	= full Medical Card	–0.004	–0.001	0.001	0.005
	= GP Visit Card	0.029	–0.042**	–0.024	0.037
Maternal Characteristics					
Age category	= age < 25	Ref	Ref	Ref	Ref
	= age 25-30	–0.018	–0.021	0.024**	0.014
	= age 30-35	–0.062***	–0.006	0.042***	0.026**
	= age 35-40	–0.103***	–0.014	0.090***	0.027**
	= age >40	–0.130***	–0.023	0.115***	0.038**
Ethnicity	= Irish White background	Ref	Ref	Ref	Ref
	= any other White background	0.068***	–0.022**	0.035***	–0.012
	= African or any other Black background	0.029	–0.042*	–0.023	0.036
	= Chinese or any other Asian background	0.018	–0.026	0.001	0.007
	= other – including mixed background	0.002	0.031	0.001	–0.034
BMI status	= BMI 18.5-25 (healthy weight)	Ref	Ref	Ref	Ref
	= BMI 25-30 (overweight)	–0.046***	–0.013	0.031***	0.031***
	= BMI > 30 (obese)	–0.121***	–0.026**	0.067***	0.067***
Smoking status	= smoker	0.018	–0.002	–0.011	–0.011
Nulliparous	= first child	–0.245***	0.179***	–0.049***	0.115***
Multiple pregnancy	= non-singleton pregnancy	–0.337***	0.061***	0.127***	0.149***

Table 3: MNP Model Partial Effects Estimates – With Controls (Contd.)

Variable Name	*Variable Description*	*Probability of NB*	*Probability of ANB*	*Probability of ELCS*	*Probability of EMCS*
Antenatal Complications					
Antenatal complications	= raised blood pressure	–0.027	–0.007	0.019*	0.015
	= preeclampsia	–0.083***	0.031**	–0.004	0.055***
	= urinary or kidney infection	0.002	0.021*	–0.006	–0.017*
	= persistent vomiting or nausea	0.016	0.012	–0.004	–0.024**
	= gestational diabetes	–0.059**	–0.012	0.035*	0.037*
	= bleeding	–0.008	–0.020	–0.021	0.049***
	= vaginal Infection	0.031	0.025	–0.024	–0.033
	= intrauterine growth restriction	–0.101***	–0.017	0.010	0.108***
	= rhesus incompatibility	–0.031	0.032*	0.006	–0.007
	= influenza	0.002	0.008	0.002	–0.012
	= placenta praevia	–0.188***	–0.020	0.086***	0.121***
	= miscarriage in multiple pregnancy	–0.059	–0.095	0.081**	0.073*
	= previous pregnancy condition	–0.125*	–0.047	0.061	0.110***
	= high risk pregnancy complications	–0.038	0.009	–0.026	0.056**
	= maternal pregnancy condition	0.043	–0.036	0.008	–0.014
	= non-pregnancy condition	0.078*	–0.028	–0.065*	0.015
	= pain	0.006	–0.016	0.011	–0.001
	= excessive fluid	–0.108*	0.072**	0.086	–0.049
	= other placental disorders	0.810	–1.674	0.249	0.616
	= other labour and birth complications	–0.355***	0.026	0.224***	0.106**
Log likelihood	–9158.235				
AIC	18616.47				
BIC	19683.59				
Observations	9,083				

Source: Analysis of GUI Infant Cohort Wave 1 data.
Note: The table presents results from a multinomial probit model of mode of birth, estimated controlling for antenatal care, socio-economic, maternal, and clinical characteristics. Results are presented in the form of average partial effects on the probability of a mode of birth. *** denotes statistically significant at 1 per cent, ** denotes statistically significant at 5 per cent, and * denotes statistically significant at 10 per cent.

V DISCUSSION

This study examines the role of antenatal care on mode of birth in Ireland, which is characterised by a complex mix of public and private maternity care provision. Our results suggest that mode of antenatal care impacts upon *NB* and *ELCS* delivery, but has no impact upon *ANB* or *EMCS* delivery. We find that midwifery-led antenatal care is associated with significantly higher levels of *NB* and significantly lower levels of *ELCS* relative to consultant-led care in both the public and private sectors. While these results are cross-sectional in nature and should be interpreted as independent associations, our findings should be of interest to both health policy makers and healthcare providers seeking to reduce rates of unnecessary caesarean section delivery due to their associated adverse health outcomes and excess costs.

While the midwifery-led antenatal care model is underdeveloped in Ireland by international standards, our results suggest that it could increase the likelihood of *NB* and reduce the likelihood of *ELCS* relative to alternative public and private models of antenatal care. The philosophical underpinnings of the midwifery-led model focuses on the natural ability of women to experience birth with minimum or no routine intervention (Sandall *et al*., 2016). This philosophy appears to be aligned with a midwifery provider preference for normal birth, whenever possible. Furthermore, in the Irish specific case, differing financial incentives do not exist for midwives across the different modes of birth. That said, the choice of mode of birth is likely to be influenced by the pregnant woman and her attending health professional caregivers. Importantly, we are unable to identify the extent to which patients and providers may have influenced mode of birth. Indeed, there is potential endogeneity in our results, as the positive association between midwifery-led care and *NB* may reflect the selection of women with a preference for *NB* into midwife-led care rather than measuring the effect of midwife-led care status on the process leading to *NB*. In other words, a woman who wishes to have a *NB* may be more likely to choose midwife-led antenatal care to directly influence this outcome. Notably, women who chose midwifery-led care were significantly less likely to have PHI, to be currently employed, to be of non-White Irish ethnicity, or to have a multiple birth pregnancy (see Appendix Table A.1). Alternatively, those in certain higher income categories and from urban backgrounds were more likely to choose midwifery-led care. Given the limited nature of our analysis, we cannot be certain on the true nature of this mechanism, however it is apparent that a clear pathway to *NB* exists with the midwife-led care model.

On the other hand, the private consultant-led antenatal care model appears to increase the likelihood of *ELCS* and reduce the likelihood of *NB*. As regards the choice of *ELCS*, this again is likely to be influenced by the pregnant woman and her attending health professional caregivers. While we are unable to identify the extent to which each influences this decision, the results suggest that the existence of a financial transaction between a patient and provider may directly influence

mode of birth. Furthermore, non-financial incentives, such as time and legal factors may influence the private consultant and the delivery care team in their prescription of an *ELCS* delivery. This thesis is consistent with the supplier induced demand theory with respect to *ELCS* delivery. Indeed, there is increasing evidence that financial incentives and private sector pressures appear to be playing an important role in this context internationally (Hoxha *et al*., 2017). There is also a patient preference argument, which suggests that if a woman has a preference for an *ELCS* delivery, and she has the financial or other non-financial means, such as direct access to the decision-maker, to do so, she may select private antenatal care in an attempt to influence the mode of birth prescribed. Notably, women who chose private consultant-led care were significantly more likely to have PHI, to have higher levels of education, income and age, to be from an urban area and to have a multiple birth pregnancy (see Appendix Table A.1). Alternatively, those currently employed, in lower social classes, those of non-White Irish ethnicity, and those nulliparous pregnancies were significantly less likely to choose private consultant-led care. Indeed, the purchase of PHI and the choice of private antenatal care may be consistent with the view of healthcare as a 'private' good where the patient is a 'consumer'. This view may in turn encourage women to state their preferences for specific care pathways to their healthcare providers. Indeed, there exists potential endogeneity in our analysis in that the positive association between private antenatal care and *ELCS* may reflect the selection of women with clinically complex pregnancies into private care rather than measuring the effect of private status on the process leading to *ELCS* (Brick *et al*., 2016). While again we cannot be certain on the true nature of this mechanism, it is clear from our analysis that a pathway to *ELCS* exists within the private-consultant-led care model.

Taken together, our findings may have implications for antenatal care policy and practice. Firstly, further investment in, and development of, midwifery-led antenatal care services as an alternative to existing public and private antenatal care models may be warranted. Indeed, this supports the recent Irish policy move to expand this element of the maternity care system in Ireland (Department of Health and Children, 2016). In our data, the standard antenatal care model was the dominant form, with 85.31 per cent of women reporting that they used this option, while only 2.07 per cent used midwifery-led antenatal care. Thus, there is substantial scope for the expansion of midwifery-led care in the Irish maternity care system and, given our findings, this has potential for increasing *NB* rates and reducing *ELCS* rates. This notwithstanding, there remain a number of important outstanding questions in relation to the clinical and cost effectiveness of midwifery-led care relative to standard care, as well as its acceptability to pregnant women. To this end, and mirroring the growing international evidence base (Homer *et al*., 2012), Begley *et al*. (2011) found that care provided in the midwife-led units is as safe as that in the consultant-led units and resulted in less intervention. From a health economics perspective, Kenny *et al*. (2015) found that care provided by

midwife-led units costs less than care provided by the consultant-led units, while a further study by Fawsitt *et al*. (2017a) found that both models of care are cost-beneficial and should be pursued. Nonetheless, women may need to be convinced of the benefits of midwifery-led care. Fawsitt *et al*. (2017b) found that women only revealed a preference for midwifery-led care when co-located with an acute obstetric unit due to its close proximity to medical services. Thus, further evidence may be required to inform future policy and practice in the maternity care sector.

Our findings in respect of private consultant-led antenatal care are consistent with the existing evidence base for Ireland, although we have employed a different dataset. In particular, the results suggest that, as discussed elsewhere, stricter regulation of the actors, both providers and patients, engaged in the private antenatal care pathway may be warranted to curb the growing rates of unnecessary elective caesarean section delivery. Indeed, some have suggested that there may be a need for the introduction of clinical guidelines related to caesarean section (Brick *et al*., 2016). That said, it is worth noting that as only 12.58 per cent of women in our sample used the private antenatal care option, the impact of any such policy may be marginal in terms of overall *ELCS* rates. Furthermore, it is important to note that the proportion of private practice in maternity care more generally in Ireland has fallen since the period during which the data for our estimation sample were collected. For example, 34.2 per cent of all discharges from maternity hospitals were private in 2008 (Economic and Social Research Institute, 2010), while the equivalent figure was 18.3 per cent for 2017 (Healthcare Pricing Office, 2018). This notwithstanding, rates of caesarean section have continued to rise during this period and as we have examined in this paper, private practice appears to play a significant role in determining *ELCS* as a mode of birth.

Our study has a number of limitations. All data utilised in our analysis were self-reported by study participants and therefore may be subject to bias. In addition to this, we exclude birth mothers from the GUI sample who did not have data on the full set of variables used in the analysis. However, our estimation sample was broadly representative of the full sample (see Appendix Table A.2) and the results from the single variable model for the full sample were consistent (see Appendix Table A.3). In the construction of our dependent variable and main independent variable of interest, we made a number of assumptions to simplify the variables which may limit our analysis. That is, the GUI recorded additional modes of birth and additional modes of antenatal care, which were collapsed into smaller categories for the purposes of analysis on the basis of advice from clinical expertise and given our focus on the role of private consultant-led and midwifery-led care. However, results from sensitivity analyses using alternative definitions of the main original variables were consistent with our findings presented here (see Appendix Tables A.4 and A.5).

We are unable to identify the specific hospital for each mother in our sample, which may be important if birth practices differ across hospital settings, although

we did include an urban/rural indicator variable which will likely pick up some of these effects. That said, there may be additional variation with respect to practices in Dublin versus other areas that are not captured in our analysis. While we focus on antenatal care, we were unable to identify from our sample those women who chose semi-private care; that is, women who selected to receive postnatal care in a semi-private room, even though they had public antenatal care. In the analysis presented, such women are most likely to be included under the public pathway. This choice may influence mode of birth if different financial incentives exist for providers in respect of *NB* versus *ELCS*. However, the fact that we control for PHI, which was significant for *ELCS*, goes some way to account for this effect, if it exists. There may also be issues of concern relating to the generalisability of our analysis which we were unable to address. For our estimation sample, 12.58 per cent of women reported choosing private consultant-led antenatal care and formed the 'private' cohort for our analysis. For the corresponding period, 34.2 per cent of all maternity discharges from public hospitals were coded as private (Economic and Social Research Institute, 2010). We suggest that this divergence is most likely explained by those women who do not choose private antenatal care but have a private or semi-private delivery.

Additionally, our dataset does not include a number of variables that we would have ideally liked to include in our analysis, such as previous caesarean section. This variable is a strong predictor of subsequent *ELCS* (Brick *et al*., 2016) and its absence is a limitation of our work. Nonetheless, we do include a wide range of other controls, such as previous pregnancy conditions, in our models which may go some way to proxy for previous emergency caesarean section. Furthermore, we conducted a sensitivity analysis on the sub-sample of 3,496 nulliparous women, of whom 86.33 per cent had standard care, 11.76 per cent had private consultant-led care and 1.92 per cent (or 67) had midwifery-led care. While the results for midwifery-led care relative to standard care were no longer statistically significant, the estimates for private consultant-led care (i.e. *NB*: -0.074***; *ELCS*: 0.075***) relative to standard care were consistent (see Appendix Table A.6). In the case of some variables, such as the PHI status of the mother, we rely on information nine months post-birth. While we believe it to be unlikely that there would be large switches in PHI status for these mothers over this short period of time, it could be argued that women could have given up their PHI given the timing of the survey in the context of the economic crisis in Ireland.

Notably, our empirical strategy may be open to question if the IIA condition does not hold. While the MNP is superior to the MNL in such cases, it does not overcome the problem completely. Therefore, we also estimated a binary probit model on a reduced sample to explore the results for *NB* versus *ECS*, and they are consistent. Finally, while we include a wide range of control variables in our MNP regression models, omitted variable bias and unobserved heterogeneity may continue to be an issue, and as a result we interpret our results as associations rather

than causal effects. That said, we undertook a series of sensitivity analyses (see Appendix Tables A.7-A.10) and our findings, as presented, appear to be robust.

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APPENDIX – SUPPLEMENTARY MATERIALS

Table A.1: MNP Model Partial Effects Estimates for Mode of Antenatal Care

Variable Name	*Variable Description*	*Mode of Antenatal Care*		
		Probability of Standard care	*Probability of Private consultant-led care*	*Probability of Midwifery-led care*
Socio-economic Characteristics				
Private health insurance	PHI	–0.154***	0.175***	-0.021***
Education level	primary education	Ref	Ref	Ref
	secondary education	–0.027*	0.025	0.002
	higher education	–0.051***	0.044**	0.007
Employment	currently employed	0.025***	–0.017**	–0.008**
Social class	household head is professional/managerial/ technical	Ref	Ref	Ref
	household head is other non-manual/ skilled manual	0.022**	0.015*	–0.008*
	household head is semi-skilled or unskilled	0.024	0.015	–0.009
	unclassified	0.053**	0.050**	–0.002
Household income	1st or lowest income quintile	Ref	Ref	Ref
	2nd income quintile	0.010	–0.012	0.001
	3rd income quintile	0.005	–0.013	0.008
	4th income quintile	–0.041**	0.027*	0.014**
	5th or highest income quintile	–0.090***	0.086***	0.003
Region	urban	–0.047***	0.040***	0.007**
Medical Card	no Medical Card	Ref	Ref	Ref
	full Medical Card	0.018	–0.016	–0.002
	GP Visit Card	0.044*	–0.047**	0.003

Table A.1: MNP Model Partial Effects Estimates for Mode of Antenatal Care (Contd.)

Variable Name	*Variable Description*	*Mode of Antenatal Care*		
		Probability of Standard care	*Probability of Private consultant-led care*	*Probability of Midwifery-led care*
Maternal Characteristics				
Age category	age < 25	Ref	Ref	Ref
	age 25-30	–0.015	0.009	0.006
	age 30-35	–0.028	0.020	0.008
	age 35-40	–0.055**	0.050**	0.005
	age >40	–0.089***	0.085***	0.004
Ethnicity	Irish White background	Ref	Ref	Ref
	any other White background	0.050***	–0.043***	–0.008*
	African or any other Black background	0.091***	–0.078***	–0.013**
	Chinese or any other Asian background	0.108***	–0.092***	–0.015***
	if other – including mixed background	0.058	–0.034	–0.023***
Body mass index (BMI) status	BMI 18.5-25 (*healthy weight*)	Ref	Ref	Ref
	BMI 25-30 (*overweight*)	0.002	–0.003	0.001
	BMI >30 (*obese*)	0.012	-0.011	–0.001
Smoker status	smoker	0.004	–0.009	0.004
Nulliparous	first child	0.030***	–0.027**	–0.003
Multiple birth pregnancy	non-singleton pregnancy	–0.029	0.053***	–0.025*

Source: Analysis of GUI Infant Cohort Wave 1 data.
Note: The table presents results from a multinomial probit model of mode of antenatal care. Results are presented in the form of average partial effects on the probability of a mode of antenatal care. *** denotes statistically significant at 1 per cent, ** denotes statistically significant at 5 per cent, and * denotes statistically significant at 10 per cent.

Table A.2: Comparison of Characteristics of Full Sample versus Estimation Sample

Variable Name	*Variable Description*	*Full Sample*		*Study Sample*	
Mode of Delivery					
Normal birth (NB)	= 1 if normal birth; = 0 if otherwise	59.02	10,900	58.67	9,083
Assisted Normal Delivery (ANB)	= 1 if assisted normal birth; = 0 if otherwise	14.85		15.02	
Elective caesarean section (ECS)	= 1 if elective caesarean section; = 0 if otherwise	12.74		12.85	
Emergency caesarean section (EMCS)	= 1 if emergency caesarean section; = 0 if otherwise	13.39		13.46	
Mode of Antenatal Care					
Standard care	= 1 if standard care; = 0 if otherwise	85.46	10,694	85.31	9,083
Private consultant-led care	= 1 if private consultant led care; = 0 if otherwise	12.47		12.58	
Midwife-led care	= 1 if midwife led care; = 0 if otherwise	2.07		2.07	
Socio-economic Characteristics					
Private health insurance (PHI)	= 1 if private health insurance	56.33	10,892	57.75	9,083
Education level	= 1 if primary education	11.82	10,894	11.41	9,083
	= 2 if secondary education	52.17		51.63	
	= 3 if higher education	36.01		36.96	
Employment	= 1 if currently employed	57.26	10,895	58.70	9,083
Social class	= 1 if household head is professional/managerial/technical	48.64	10,903	50.40	
	= 2 if household head is other non-manual/skilled manual	30.36		30.05	
	= 3 if household head is semi-skilled or unskilled	9.15		8.75	
	= 4 if unclassified	11.85		10.80	
Household income	= 1 if 1st or lowest income quintile	21.66	10,063	20.74	9,083
	= 2 if 2nd income quintile	18.68		18.39	
	= 3 if 3rd income quintile	19.03		19.02	
	= 4 if 4th income quintile	21.52		22.13	
	= 5 if 5th or highest income quintile	19.10		19.72	

Table A.2: Comparison of Characteristics of Full Sample versus Estimation Sample (Contd.)

Variable Name	*Variable Description*	*Full Sample*		*Study Sample*	
Region	= 1 if urban; = 0 if rural	44.54	10,857	44.14	9,083
Medical Card	= 0 if no Medical Card	70.49	10,896	71.58	9,083
	= 1 if full Medical Card	26.59		25.54	
	= 2 if GP Visit Card	2.92		2.87	
Maternal Characteristics					
Age category	= 1 if age < 25	11.52	10,903	10.54	9,083
	= 2 if age 25-30	21.19		20.98	
	= 3 if age 30-35	34.54		35.33	
	= 4 if age 35-40	26.31		26.91	
	= 5 if age >40	6.44		6.24	
Ethnicity	= 1 if Irish White background	79.57	10,859	80.62	9,083
	= 2 if any other White background	13.76		13.12	
	= 3 if African or any other Black background	3.33		3.01	
	= 4 if Chinese or any other Asian background	2.85		2.81	
	= 5 if other - including mixed background	0.50		0.44	
Body mass index (BMI) status	= 1 if BMI 18.5-25 (*healthy weight*)	53.07	10,065	52.91	9,083
	= 2 if BMI 25-30 (*overweight*)	30.28		30.38	
	= 3 if BMI >30 (*obese*)	16.65		16.71	
Smoking status	= 1 if yes	23.13	10,716	23.48	9,083
Nulliparous	= 1 if first child	38.62	10,903	38.49	9,083
Multiple pregnancy	= 1 if non-singleton pregnancy	3.60	10,903	3.38	9,083
Antenatal Complications	= 1 if raised blood pressure	10.59	10,902	10.81	9,083
	= 1 if preeclampsia	7.02	10,902	7.11	9,083
	= 1 if urinary or kidney infection	14.25	10,902	14.58	9,083

Table A.2: Comparison of Characteristics of Full Sample versus Estimation Sample (Contd.)

Variable Name	*Variable Description*	*Full Sample*		*Study Sample*	
	= 1 if persistent vomiting or nausea	17.58	10,902	17.36	9,083
	= 1 if gestational diabetes	2.85	10,903	2.80	9,083
	= 1 if bleeding	5.85	10,903	5.85	9,083
	= 1 if vaginal infection	3.57	10,903	3.61	9,083
	= 1 if intrauterine growth restriction	2.18	10,902	2.09	9,083
	= 1 if rhesus incompatibility	3.92	10,902	4.06	9,083
	= 1 if influenza; 0 if otherwise	3.71	10,902	3.58	9,083
	= 1 if placenta praevia	2.67	10,902	2.79	9,083
	= 1 if miscarriage in multiple pregnancy	0.42	10,902	0.50	9,083
	= 1 if previous pregnancy condition	0.61	10,903	0.58	9,083
	= 1 if high risk pregnancy complications	2.15	10,903	2.19	9,083
	= 1 if maternal pregnancy condition	1.00	10,903	0.94	9,083
	= 1 if non-pregnancy condition	1.40	10,903	1.35	9,083
	= 1 if pain	2.46	10,903	2.46	9,083
	= 1 if excessive fluid	0.66	10,903	0.71	9,083
	= 1 if other placental disorders	0.22	10,903	0.21	9,083
	= 1 if other labour / birth complications	0.45	10,903	0.45	9,083

Source: Analysis of GUI Infant Cohort Wave 1 data.

Table A.3: MNP Model Partial Effects Estimates for Full Sample – No Controls

Variable Name	*Variable Description*		*Probability of NB*	*Probability of ANB*	*Probability of ELCS*	*Probability of EMCS*
Mode of Antenatal Care		N (%)				
Mode of Antenatal Care	= Standard care	9,139 (85.46)	Ref	Ref	Ref	Ref
	= Private consultant-led care	1,334 (12.47)	–0.130***	0.014	0.107***	0.009
	= Midwifery-led care	221 (2.07)	0.120***	–0.006	–0.080***	–0.034*
Log likelihood	–11969.27					
AIC	23956.54					
BIC	24022.04					
Observations	10,692					

Source: Analysis of GUI Infant Cohort Wave 1 data.

Note: The table presents results from a multinomial logit model of mode of birth, estimated controlling for antenatal care. Results are presented in the form of average partial effects on the probability of a mode of birth. *** denotes statistically significant at 1 per cent, ** denotes statistically significant at 5 per cent, and * denotes statistically significant at 10 per cent.

Table A.4: MNP Model Partial Effects Estimates for Alternative Mode of Birth Variable

Variable Name	*Variable Description*	*Probability of NB*	*Probability of Suction Assisted Birth*	*Probability of Forceps Assisted Birth*	*Probability of Vaginal Breech Delivery*	*Probability of ELCS*	*Probability of EMCS*
N(%)		5,329 (58.67)	901(9.92)	430 (4.73)	33 (0.36)	1,167 (12.85)	1,223 (13.46)
Mode of Antenatal Care							
Mode of	= Standard care	Ref	Ref	Ref	Ref	Ref	Ref
Antenatal Care	= Private consultant-led care	–0.078***	0.000	0.014*	–0.001	0.062***	0.002
	= Midwifery-led care	0.115***	–0.015	0.013	–0.004	–0.085***	–0.024
Log likelihood	–10010.38						
AIC	20520.75						
BIC	22299.29						
Observations	9,083						

Source: Analysis of GUI Infant Cohort Wave 1 data.
Note: The table presents results from a multinomial logit model of mode of birth, estimated controlling for antenatal care, socio-economic, maternal, and clinical characteristics. Results are presented in the form of average partial effects on the probability of a mode of birth. *** denotes statistically significant at 1 per cent, ** denotes statistically significant at 5 per cent, and * denotes statistically significant.

Table A.5: MNP Model Partial Effects Estimates for Alternative Antenatal Care Pathways Variable

Variable Name	*Variable Description*		*Probability of NB*	*Probability of ANB*	*Probability of ELCS*	*Probability of EMCS*
Mode of Antenatal Care		N (%)				
Mode of Antenatal Care	= Shared Care	7,170 (78.94)	Ref	Ref	Ref	Ref
	= Private consultant-led care	1,146 (12.62)	–0.080***	0.013	0.066***	0.001
	= Hospital clinic alone	579 (6.37)	0.005	–0.018	0.026*	–0.013
	= Midwifes clinic alone	172 (1.89)	0.125***	–0.010	–0.083***	–0.033
	= Independent midwife clinic	16 (0.18)	–0.064	0.034	–0.031	0.061
Log likelihood	–9154.243					
AIC	18620.49					
BIC	19730.29					
Observations	9,083					

Source: Analysis of GUI Infant Cohort Wave 1 data.

Note: The table presents results from a multinomial probit model of mode of birth, estimated controlling for antenatal care, socio-economic, maternal, and clinical characteristics. Results are presented in the form of average partial effects on the probability of a mode of birth. *** denotes statistically significant at 1 per cent, ** denotes statistically significant at 5 per cent, and * denotes statistically significant.

Table A.6: MNP Model Partial Effects Estimates for Nulliparous Sample

Variable Name	*Variable Description*		*Probability of NB*	*Probability of ANB*	*Probability of ELCS*	*Probability of EMCS*
Mode of Antenatal Care		N (%)				
Mode of Antenatal Care	= Standard care	3,018 (86.33)	Ref	Ref	Ref	Ref
	= Private consultant-led care	411 (11.76)	–0.074***	0.013	0.075***	–0.013
	= Midwifery-led care	67 (1.92)	0.082	0.005	–0.020	–0.067
Log likelihood	–4041.813					
AIC	8371.625					
BIC	9258.575					
Observations	3,496					

Source: Analysis of GUI Infant Cohort Wave 1 data.
Note: The table presents results from a multinomial logit model of mode of birth, estimated controlling for antenatal care, socio-economic, maternal, and clinical characteristics. Results are presented in the form of average partial effects on the probability of a mode of birth. *** denotes statistically significant at 1 per cent, ** denotes statistically significant at 5 per cent, and * denotes statistically significant at 10 per cent.

Table A.7: MNP Model Partial Effects Estimates for Alternative: *Socio-economic Variables Subset*

Variable Name	*Variable Description*	*Probability of NB*	*Probability of ANB*	*Probability of ELCS*	*Probability of EMCS*
Mode of Antenatal Care					
Mode of Antenatal Care	= Standard care	Ref	Ref	Ref	Ref
	= Private consultant-led care	–0.075***	0.009	0.089***	–0.006
	= Midwifery-led care	0.132***	0.009	–0.084***	–0.039*
Log likelihood	–10068.33				
AIC	20238.65				
BIC	20601.48				
Observations	9,083				

Source: Analysis of GUI Infant Cohort Wave 1 data.

Note: The table presents results from a multinomial probit model of mode of birth, estimated controlling for antenatal care and socio-economic characteristics. Results are presented in the form of average partial effects on the probability of a mode of birth. *** denotes statistically significant at 1 per cent, ** denotes statistically significant at 5 per cent, and * denotes statistically significant.

Table A.8: MNP Model Partial Effects Estimates for Alternative: *Maternal Variables Subset*

Variable Name	*Variable Description*	*Probability of NB*	*Probability of ANB*	*Probability of ELCS*	*Probability of EMCS*
Mode of Antenatal Care					
Mode of Antenatal Care	= Standard care	Ref	Ref	Ref	Ref
	= Private consultant-led care	–0.086***	0.020*	0.064***	0.002
	= Midwifery-led care	0.113***	–0.000	–0.081***	–0.032
Log likelihood	–9355.959				
AIC	18807.92				
BIC	19149.4				
Observations	9,083				

Source: Analysis of GUI Infant Cohort Wave 1 data.
Note: The table presents results from a multinomial probit model of mode of birth, estimated controlling for antenatal care and maternal characteristics. Results are presented in the form of average partial effects on the probability of a mode of birth. *** denotes statistically significant at 1 per cent, ** denotes statistically significant at 5 per cent, and * denotes statistically significant.

Table A.9: MNP Model Partial Effects Estimates for Alternative: *Clinical Antenatal Variables Subset*

Variable Name	*Variable Description*	*Probability of NB*	*Probability of ANB*	*Probability of ELCS*	*Probability of EMCS*
Mode of Antenatal Care					
Mode of Antenatal Care	= Standard care	Ref	Ref	Ref	Ref
	= Private consultant-led care	–0.124***	0.025**	0.097***	0.002
	= Midwifery-led care	0.121***	–0.005	–0.085***	–0.031
Log likelihood	–10029.78				
AIC	20197.56				
BIC	20688.44				
Observations	9,083				

Source: Analysis of GUI Infant Cohort Wave 1 data.

Note: The table presents results from a multinomial probit model of mode of birth, estimated controlling for antenatal care and clinical characteristics. Results are presented in the form of average partial effects on the probability of a mode of birth. *** denotes statistically significant at 1 per cent, ** denotes statistically significant at 5 per cent, and * denotes statistically significant.

Table A.10: MNP Model Partial Effects Estimates for Alternative: *Socio-economic and Maternal Variables Subset*

Variable Name	*Variable Description*	*Probability of NB*	*Probability of ANB*	*Probability of ELCS*	*Probability of EMCS*
Mode of Antenatal Care					
Mode of Antenatal Care	= Standard care	Ref	Ref	Ref	Ref
	= Private consultant-led care	–0.081***	0.012	0.065***	0.003
	= Midwifery-led care	0.115***	–0.004	–0.080***	–0.032
Log likelihood	–9308.536				
AIC	18797.07				
BIC	19437.35				
Observations	9,083				

Source: Analysis of GUI Infant Cohort Wave 1 data.
Note: The table presents results from a multinomial probit model of mode of birth, estimated controlling for antenatal care, socio-economic and maternal characteristics. Results are presented in the form of average partial effects on the probability of a mode of birth. *** denotes statistically significant at 1 per cent, ** denotes statistically significant at 5 per cent, and * denotes statistically significant.