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Private provider incentives in health care: the case of birth interventions

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Declaration of interest

The authors declare that they have no competing interests.

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Abstract

Private physicians and hospitals may face incentives to intervene in the process of childbirth because they are employed, paid and insured differently from their public counterparts. While private obstetric care has been associated with higher intervention rates, it is unclear to what extent this is attributable to selection effects. Using administrative birth data on over 280,000 births in Australia, we implemented an instrumental variables framework to account for the endogeneity of choice of care. We also exploit Australia's institutional framework to examine the differences in doctor-level and hospital-level incentives. We find that private obstetric care results in significantly higher probabilities of intervention (up to 25 percentage points higher). After accounting for patient preference and clinical need, we find that supply-side factors drive substantial variation remaining in intervention rates.

1 Introduction

Birth intervention practices variously act to "initiate, accelerate, terminate, regulate or monitor the physiological process of labour" (World Health Organization, 2018:1). The decision to intervene in childbirth is shared between the woman and her care providers and should be based on the best evidence that intervention is required to provide a better outcome than no intervention. Yet there has been much recent international attention to the twin challenges of "too little too late" and "too much too soon" prevalent in maternity care (Miller et al. 2016; Saini et al. 2017; Lee et al. 2013). In particular, receiving maternity care from a private provider has been associated with higher birth intervention rates in care in Europe (Lutomski et al. 2014; Mossialos, Allin, et al. 2005), the US (Huesch 2011; Misra 2008; Hoxha et al. 2017), South America (Barros et al. 2011; Murray 2000), and Australia (Roberts, Tracy, and Peat 2000; Dahlen et al. 2014).

Provider choices are responsive to financial incentives. These incentives can act on health providers to intervene in the physiological process of childbirth amongst low-risk women where no medical indications exist. Studies (mostly in North America) in maternity care have shown that at an individual level, doctors are incentivised to perform caesarean sections where higher fee-for-service payments exist (Gruber, Kim, and Mayzlin 1999; Lo 2008; Allin et al. 2015), to lower the risk of malpractice litigation (Localio et al. 1993; Baldwin et al. 1995; Dubay, Kaestner, and Waidmann 1999), and to schedule births at convenient (standard business hours) times (Brown 1996; Lefèvre 2014; Mossialos, Allin, et al. 2005). At the hospital level, the international literature has shown that private hospitals respond to financial and other (e.g. risk) incentives (Sloan 2000), and many studies have documented high variation in birth intervention rates between hospitals (Lee et al. 2013; Heres et al. 1995; Xu et al.). In Australia, Roberts et al. (2000) reports that women receiving private care in private hospitals have significantly higher rates than women receiving private care in public hospitals.

In this study, we hypothesise that doctor and hospital level incentives in private maternity care are a source of unwarranted variation in birth care. For private doctors, incentives exist to save time, increase fee revenue and convenience, and reduce the risk of malpractice litigation. Additionally, hospitals may encourage intervention by having staff and resources aligned with certain operating hours and maintaining a lower risk profile. Unlike previous studies, we examine the overall impact of these arrangements (rather than a single incentive), and we focus on a range of birth interventions (rather than just caesarean sections). The overall effects can be regarded as unwarranted practice variation, and we show that this unwarranted variation is large and significant. In addition, we exploit Australia's institutional framework to separate the doctor-level effects of receiving care from a private obstetrician to hospital-level effects attributable to giving birth in a private hospital (compared to receiving public care). Prior studies have not discerned between the two because in most countries, these are analogous circumstances.

From a health system perspective, the increasing use of birth interventions has significant economic implications. Although the literature on the cost-effectiveness of these interventions is small, a number of studies have suggested that birth interventions increase the cost of childbirth by between 10 and 67 percent (Bernitz, Aas, and Øian 2012; Allen et al. 2005; Schroeder et al. 2011). These proportionate costs are not trivial – in Australia, spontaneous birth and caesarean section of single infant are the two most common reason for an overnight public hospital admission, with labour and childbirth care comprising 19.5 percent of total public hospital expenditures (AIHW, 2017a; Tables 4.16 and 8.8).

The Australian policy context

Australia has a mixed public-private system of healthcare. All women are eligible for universal maternity care provided in public hospitals, however they may choose to take out private health insurance to pay for private maternity care. Women may choose private maternity care to access benefits such as choice of physician, continuity of care, and additional privacy and amenity if giving birth in a private hospital. Low-risk women wanting a planned caesarean section are also likely to choose private care, because this option is generally unavailable in public hospitals. Access to insurance benefits is subject to waiting periods of up to one year, such that women must purchase their insurance policy prior to falling pregnant. For women receiving private care, the birth of the baby may take place at either a private or public hospital. For women receiving public care, birth care takes place in public hospitals, and care is provided by appointed midwifery and obstetric staff. In this study, two-thirds of women giving birth in a hospital chose public care, 7 percent chose private care in a public hospital, while 27 percent gave birth in a private hospital.

The institutional framework in Australia produces distinctive incentives for providers. For specialist obstetricians (and others including anaesthetists), private practice – in either a public or private hospital – means they receive fee-for-service payment from the patient and are able to charge largely unregulated fees. Publicly appointed obstetricians by comparison are remunerated by the public hospital on a salary basis for agreed hours. For obstetric specialists then, there is a strong incentive to practice privately (and indeed a third of obstetricians in Australia only practice privately - Australian Medical Workforce Advisory Committee (2004)). For private hospitals, reimbursement typically takes place with the third-party health insurer at contracted per-diem prices, although these arrangements are commercial-in-confidence. This payment system might incentivise private hospitals to promote longer lengths of stay to extract greater payment, and indeed Einarsdottir et al. (2014) report longer lengths of stays in private hospitals.

On the patient side, private health insurance plays a large role. There is evidence that the Australian Federal Government's introduction of the private health insurance incentives between 1997 and 2000 led to significant substitution away from public patient care towards private care (Doiron and Kettlewell 2018; Eldridge, Onur, and Velamuri 2017). Private obstetric care, provided predominantly in privately-owned hospitals, rose significantly following the reforms, from 16.7 percent of births in 1997 to 25.7 percent by the end of 2001 (Shorten and Shorten 2004). The data suggest that women took up private health insurance for the purpose of receiving private obstetric care. Commensurately, the rate of birth interventions also rose after the private health insurance reforms (Shorten and Shorten 2004; Einarsdóttir et al. 2012).

By international standards, Australia has high rates of obstetric intervention, with evidence of high levels of unwarranted variation (Roberts, Tracy, and Peat 2000; Roberts et al. 2002; Australian Commission on Safety and Quality in Health Care and Australian Institute of Health and Welfare 2017). Many studies have consistently found that women in private hospitals have significantly higher rates of intervention in childbirth (Robson, Laws, and Sullivan 2009; Roberts, Tracy, and Peat 2000; Dahlen et al. 2014; Einarsdóttir et al. 2013; Shorten and Shorten 2004; Australian Institute of Health and Welfare 2011). Notably, rates of intervention for women receiving private care in public hospitals lie between that of women receiving public care and those receiving private care in private hospitals (Roberts, Tracy, and Peat 2000).

2 Materials and methods

Data

De-identified maternal and infant data were sourced from the New South Wales (NSW) Perinatal Data Collection (PDC). This population-based system collects data on all births greater than 400 grams birth weight, or 20 weeks gestation, and covers over a third of all births in Australia. A limitation of our study is that the data period spans only from 2007 to 2012. Since that time, intervention rates have continued to rise in Australia, such that our results may understate the current levels of intervention in all birth settings.

The PDC dataset provides rich information on the birth experience, including the following intrapartum interventions of interest to this study:

- the induction of labour: the artificial initiation of labour, typically with the administration of pharmacological agents.
- the administration of epidural or spinal analgesia: a local anaesthetic applied in the back, numbing pain impulses from the birth canal.
- Instrumental delivery: the use of a vacuum cup or forceps to assist with a vaginal birth.
- In-labour caesarean section: a surgical procedure whereby the baby is born through an incision made in the mother's abdominal wall and uterus.

Data on all hospital admissions relating to the mother were sourced from the NSW Admitted Patient Data Collection (APDC). The APDC dataset provides data on the birth facility, flagging whether the birth took place in a public or private facility. In addition, the APDC provides data on the patient's private health insurance status, as well as whether she received care from a private doctor.

The PDC and APDC datasets were linked using a maternal identifier provided by the Centre for Health Record Linkage. This study received approval from the NSW Population & Health Services Research Ethics Committee, approval number HREC/14/CIPHS/15.

We focus on a sample of low-risk women to minimise the impact of unobserved pregnancy complications on intervention outcomes. The low-risk sample of women is defined as follows:

- singleton birth;
- no pregnancy-related complications[1];
- cephalic presentation (baby in the head down position);
- gestational age at least 37 weeks

We also exclude 49,436 women having a planned caesarean section (43.8 percent were performed by public doctors). This is largely to mitigate the impact of unobserved health factors, as planned caesareans in the public system are only available to women with medical indications. In addition, their exclusion removes the impact of low-risk women choosing private care for the express purpose of accessing planned caesarean. Their exclusion also removes distortion in the results, as by definition, they cannot have a labour induction or instrumental delivery, but will automatically receive analgesia.

The PDC dataset also provides a limited set of sociodemographic factors, including maternal age, smoking status during pregnancy, maternal country of birth, geographical area of residence, and the number of previous pregnancies. In addition, data on geographical area of residence was mapped to an index of geographical remoteness, and of socioeconomic disadvantage.

[1] Pre-existing or pregnancy-related complications were identified from both the PDC and APDC datasets. Women were identified as having hypertension or diabetes (both pre-existing and pregnancy-related) on the PDC or via their diagnosis codes on antenatal or birth admissions on the APDC. In addition, complications resulting in a hospital admission relating to proteinuria, prolonged rupture of membranes, antepartum haemorrhage, disproportion, and placenta praevia, were also identified.

Table 1 illustrates the sociodemographic characteristics of low-risk mothers by patient category – public (non-paying) patients, private patients in public hospitals, and private patients in private hospitals. The data show that women choosing private care – in a public or private hospital – were much more likely to have their labour induced, receive an epidural, or have an instrumental birth or caesarean section. For example, 36.5 percent of women were induced in private hospitals, compared to 25.1 percent amongst public patients. Three-quarters of births amongst public patients were normal vaginal births, compared to around 63 percent under private care. Intervention rates for private patients in public hospitals sat between that of public patients, and private hospital patients.

Table 1 also shows that women receiving private care were on average older (mean age around 33 years), and were more likely to be married or in a defacto relationship, be a non-smoker, live in a relatively wealthy area and metropolitan area, and almost certainly hold private health insurance. Women from North American or North/West Europe cultural heritages were less likely to choose public care. There was little difference between primiparous and multiparous women- around two-thirds were public patients.

TABLE 1—DESCRIPTIVE DATA

	Panel A	Panel B	Panel C	Total
n	193,516	20,730	78,151	292,397
Induction (%)	25.1	33.7	36.5	28.7
Received Epidural analgesic (%)	29.4	46.1	58.6	38.4
Mode of birth (% by place)				
Normal vaginal	75.4	63.9	63.2	71.3
Forceps/instrument	12.4	19.7	20.4	15.0
Caesarean section	12.3	16.4	16.4	13.7
Total	100.0	100.0	100.0	100.0
Low birth weight (<2500g)	1.6	1.0	0.9	0.9
Maternal age	29.2	32.6	32.8	30.4
Married/defacto relationship (%)	80.2	94.2	97.4	85.8
Smoker (%)	14.7	3.7	1.2	10.3
Holds private health insurance (%)	8.4	88.1	97.2	39.2
Region of birth (%)				
Australia/Oceania	62.8	7.6	29.6	100.0
North/West Europe	59.1	9.9	31.0	100.0
South/East Europe	69.7	9.0	21.3	100.0
North Africa/Middle East	88.4	2.7	8.8	100.0
South East Asia	73.2	6.9	19.9	100.0
North East Asia	69.8	6.2	23.9	100.0
South/Central Asia	83.8	3.2	13.0	100.0
North America	51.1	8.9	40.0	100.0
South/Central America	69.1	6.4	24.5	100.0
Sub Saharan Africa	63.7	8.0	28.3	100.0
SEIFA Index of Socio-economic disadvantage				
Most disadvantaged quintile	85.8	4.1	10.1	100.0
2	86.2	6.0	7.8	100.0
3	74.9	6.2	18.9	100.0
4	64.9	10.0	25.1	100.0
Least disadvantaged quintile	47.4	7.3	45.3	100.0
Metropolitan resident	63.9	71.7	72.3	66.7
Number of previous pregnancies				
0	66.0	7.7	26.3	100.0
1 or more	66.4	6.4	27.2	100.0

Notes: Panel A = women receiving public care; Panel B = women receiving care from private doctor in a public hospital; Panel C = women receiving care in a private hospital
Source: NSW Perinatal Data Collection

Descriptive evidence for the effect of incentives and provider preferences is presented in Figure 4, which shows the percentage of births taking place each day of the week. The onset of labour is presumed to be uniformly distributed across the week, yet for all patient categories, births were less likely to occur on Saturdays and Sundays. This is commensurate with international studies, showing that caesarean sections, labour induction, and births are all less likely to fall on a weekend (Mossialos, Costa-Font, et al. 2005; Brown 1996; Järvelin Marjo, Hartikainen-Sorri, and Rantakallio 1993; Lerchl 2005; Lerchl and Reinhard 2007). Figure 4 shows that in addition, births under the care of a private obstetrician, and/or in a private hospital, are even less likely to fall on a weekend. The incidence of birth interventions by day-of-week shows similar patterns – Figure 5 illustrates the pattern of labour induction[2]. The data shows much lower rates of labour induction on weekends, and even lower still for women in private care.

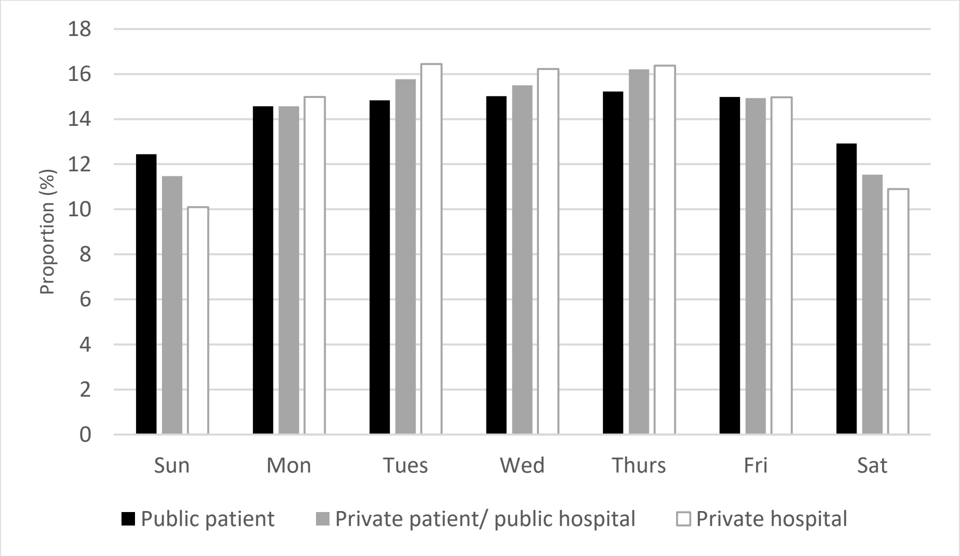

FIGURE 1. BIRTHS BY DAY OF THE WEEK
Source: NSW Perinatal Data Collection

[2] Based on date of giving birth. Although we do not have the dates of intervention, the vast majority of induced women likely gave birth on the same day of induction.

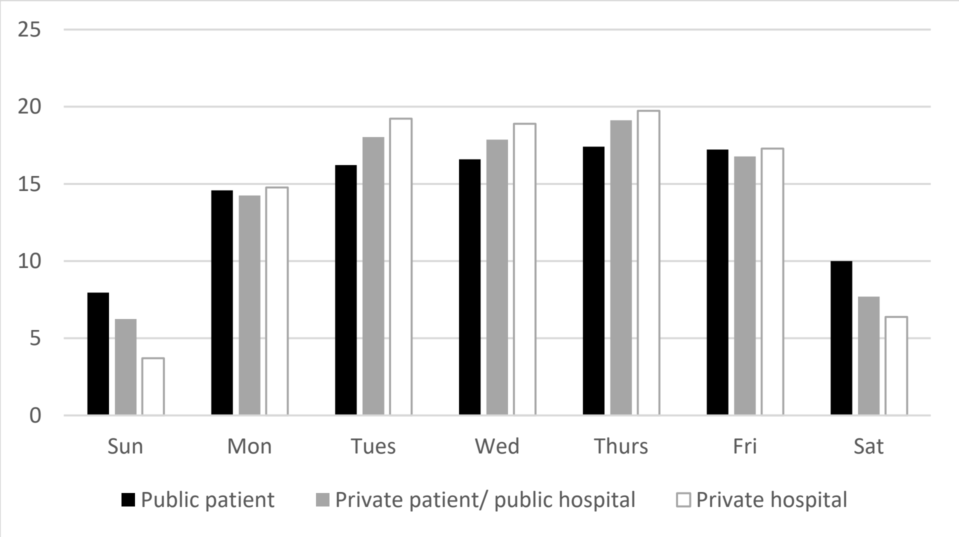

FIGURE 2. LABOUR INDUCTIONS BY DAY OF THE WEEK
Source: NSW Perinatal Data Collection

Empirical Strategy

The main empirical challenge is to purge the endogeneity of choice of care due to individual selection effects. Studies have shown that not only is the complexity of the pregnancy a factor, but the woman's previous experience, knowledge of available services, her attitudes towards childbirth and risk, the opinions of her peers, as well as service culture and provider factors contribute to her decision (Hollowell 2011). These factors contribute to observed and unobserved differences between the women giving birth under private and public care.

In Australia, it is also well established that higher-income and better educated individuals are more likely to be privately insured (Barrett Garry and Conlon 2003; Hopkins and Kidd 1996) and therefore are more likely to receive their maternity care from private obstetricians, and give birth in private hospitals (Shorten and Shorten 2004).

Existing studies have been limited in their ability to account for factors confounding the choice of birth setting, typically defining a low-risk sample of women to mitigate selection effects, and controlling for a very small number of observed maternal characteristics (e.g. age and smoker status). Our method of addressing the endogeneity of choice of birth setting is threefold. First, we controlled for differences in these observed maternal characteristics. Second, we focused on a sample of low-risk women and their births to mitigate any impact from unobserved pregnancy complications. Finally, we implemented an instrumental variables approach using distance to nearby birth facilities as an instrument for the endogenous choice variables. We used distance-to-nearby-hospitals to instrument for choice of birth setting. This approach has been adopted previously to address the endogeneity of hospital choice (McClellan and Newhouse 1997; Geweke, Gowrisankaran, and Town Robert 2003; Cutler 2007; Gowrisankaran and Town 1999; Doyle et al. 2015).

In addition to accounting for selection effects, we exploited features of the Australian institutional context to separate the doctor-level and hospital-level effects of incentives in private maternity care. We first set out our motivation for using geographical distance as a plausible and relevant instrument, and then provide details on our model specification.

Choice of instrument

The choice of instrument is motivated by considerations of the need to be placed close to a birth facility for antenatal care, for admission for labour and birth, and for returning home postpartum. In addition, the default option for when women first confirm their pregnancy is to be referred by their general practitioner (GP) to their local public hospital. Like other studies utilising distance-to-hospital, we argue that distance is plausibly uncorrelated with other factors affecting a woman's choice of birth setting.

New South Wales is Australia's most populous state, with a population of around 7.9 million people and a geographically vast area of over 800,000 square kilometres (over 310,000 square miles). Figure 3 shows a 'heatmap' of the geographical density of all births between 2007 and 2012, plotting the residential postcode of each woman who gave birth. Residents are clustered in the coastal areas of the state, and particularly so in the city of Sydney (which itself has a population of over 5 million people).

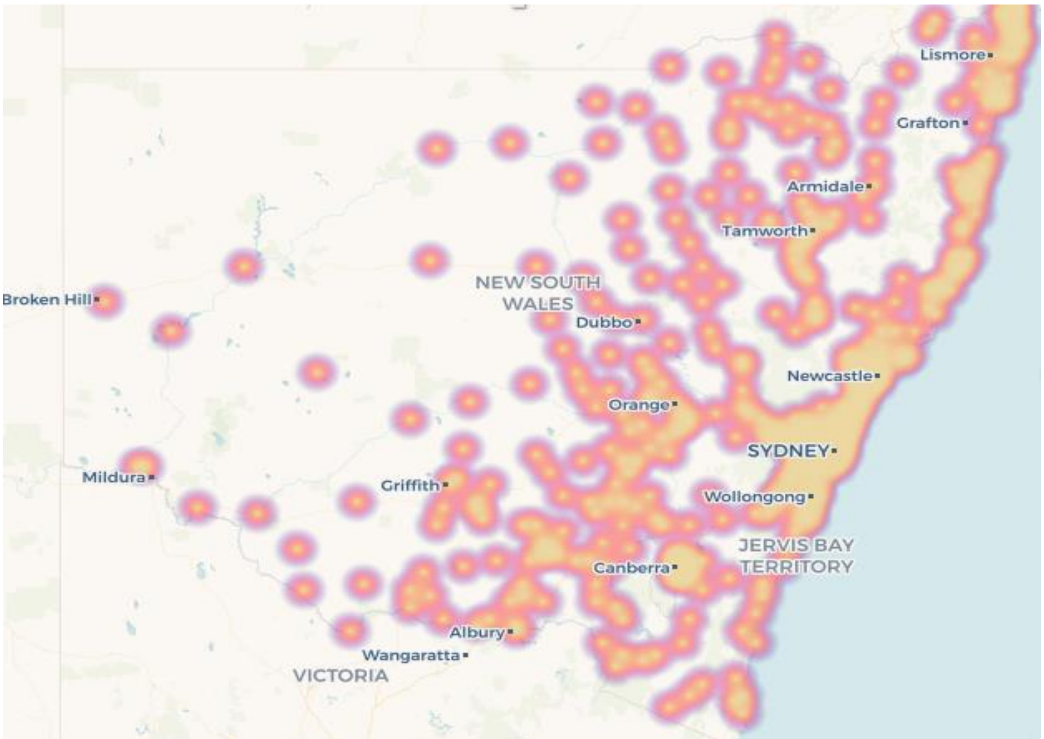

FIGURE 3. DENSITY MAP OF MOTHERS' RESIDENCE, 2007 - 2012
Source: NSW Perinatal Data Collection

Figure 4 shows the public (black dots) and private (white dots) hospitals catering to this population. There are 67 public facilities scattered throughout the state, while 18 private facilities are almost exclusively found in inner regional and metropolitan areas. Figure 5 illustrates the breakdown of public (black) and private (red) facilities for the Sydney area only, and shows that there are seven pairs of co-located public and private facilities.

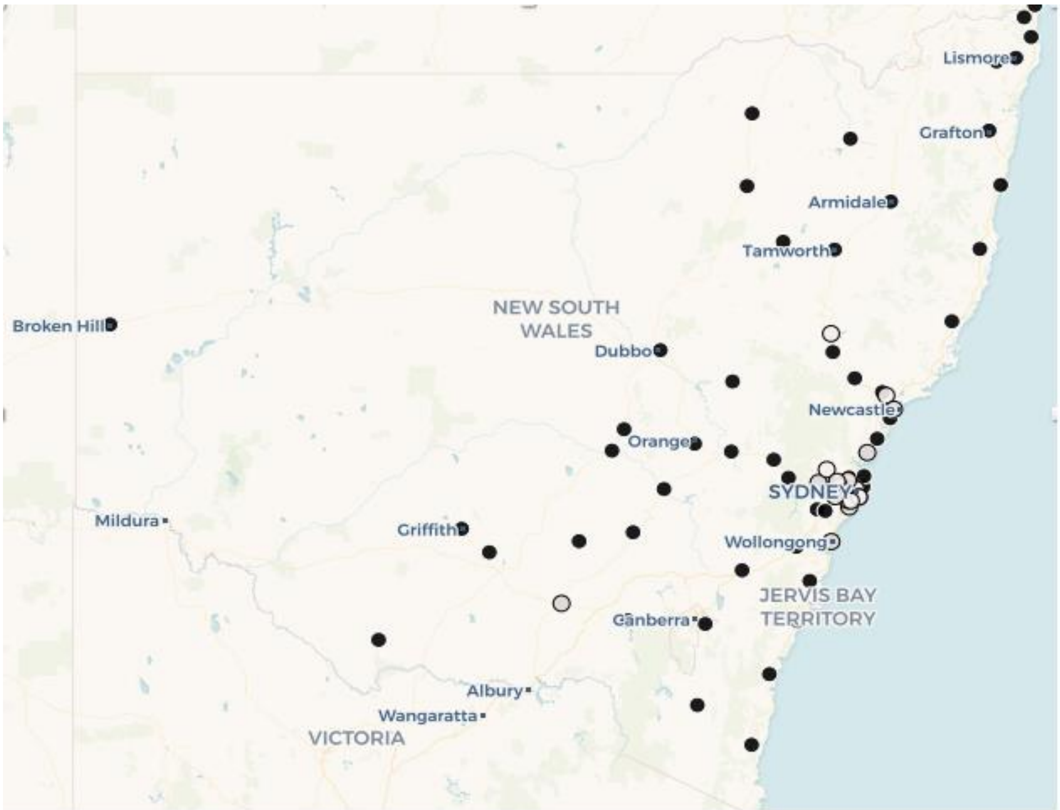

FIGURE 4. PUBLIC AND PRIVATE BIRTH FACILITIES IN NEW SOUTH WALES, AUSTRALIA
Notes: Public facilities denoted in black; private facilities in white.
Source: NSW Admitted Patient Data Collection.

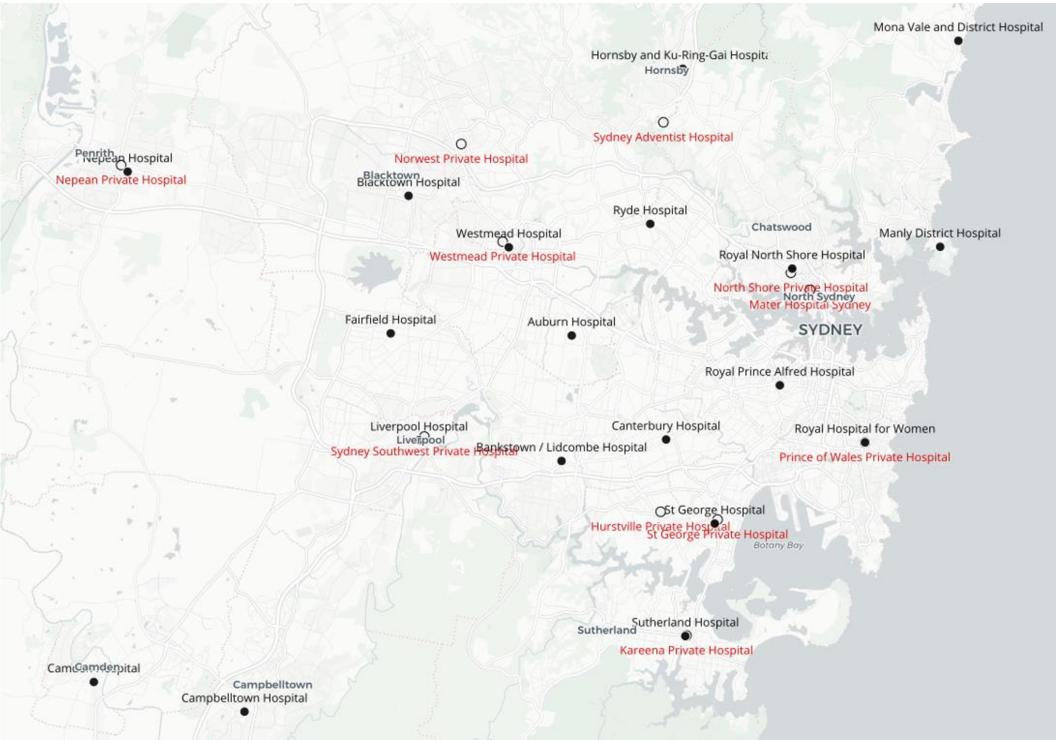

FIGURE 5. PUBLIC AND PRIVATE BIRTH FACILITIES IN GREATER SYDNEY
Notes: Public facilities denoted in black text; private facilities in red text.
Source: NSW Admitted Patient Data Collection.

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There is a strong correlation between distance and choice of maternity care (Table 2). For low-risk women in major cities and inner regional areas only (where all private facilities are found), we tabulated the distance-rank of their chosen birth facility according to their choice of care. The data showed that over 71 percent of women receiving public care attended their closest facility. The 'default' option for most pregnant women, is that unless otherwise requested, they will be referred to the public hospital which services their residential catchment area, and some services only accept local women. A further 16.5 percent of women receiving public care went to their next-closest hospital. For women giving birth in a private hospital, two-thirds chose one of their two closest facilities. Slightly lower proportions of women receiving private care in a public hospital chose their closest (64.9%) or next closest (14.4%) public hospital. Women giving birth in private hospitals were more likely to choose a hospital slightly further away, most likely one of the hospitals where their chosen obstetrician has visiting rights. Over two-thirds however chose their closest or next-closest private hospital. On average women in private facilities travelled slightly further (11.6km), compared to women in public hospitals (around 7.6km).

Table 2—Geographical distance and choice of care

	Patient type		
Distance rank of chosen hospital	Public patient	Private/ public hospital	Private hospital
1	71.8	64.9	37.6
2	16.5	14.4	28.3
3	4.7	6.8	12.1
4	3.4	4.8	11.6
5	1.3	2.7	4.4
Other	2.3	6.4	6.0
Number of births	193,516	20,730	78,042
Mean distance (km)	7.6	7.8	11.6

Model specification

Our model uses a standard random utility framework as follows:

$$C_{ij}^{*} = \boldsymbol{\beta_{1j} X_i} + \beta_{2j} Z_{1i} + \beta_{3j} Z_{2i} + u_{ij} \quad (1)$$

$$Y_i^{*} = \boldsymbol{\beta_4 X_i} + \beta_5 C_{i2} + \beta_6 C_{i3} + \varepsilon_i \quad (2)$$

where in equation (1), C_{ij}^{*} represents a latent preference for type of care for woman i. The observed variable C_i is a categorical variable denoting care type (*j=1,2,3)* defined as:

$$C_i = \begin{cases} 1 \; if \; j = 1, & public \; care \\ 2 \; if \; j = 2, & private \; care \; in \; public \; hospital \\ 3 \; if \; j = 3, & private \; care \; in \; private \; hospital \end{cases}$$

The distinctions between the categories of care type are central to the analysis. Women receiving public care ($C_i = 1$) are non-paying individuals receiving care in a public hospital, and are our reference group. Women receiving private care in public hospitals ($C_i = 2$) are paying individuals receiving care from a private obstetrician in a public hospital; this group identifies our private doctor-level effects. Finally, $C_i = 3$ denotes women paying for private care in private hospitals; this group identifies a private hospital effect that in part reflects a private doctor effect.

In Equation (2) Y_i^{*} represents an unobserved propensity for intervention. The observed outcome Y_i is the binary outcome for woman *i* (equal to 1 if an intervention took place, and zero otherwise). In equation (2), the C_{i2} and C_{i3} dummy variables (representing private patients in public and private hospitals, respectively) are assumed endogenous. We separately model four intervention outcomes, namely whether labour induction, administration of an epidural/spinal analgesia, instrumental delivery by forceps or vacuum, or an in-labour caesarean section, took place.

We assume that both C_{ij}^* and Y_i^* depend on a vector of observed maternal factors $\boldsymbol{X_i}$ including age, maternal birthplace, smoker status, metropolitan residence status, primiparous status, and marital status. The dataset does not include income or education data; we include instead a geographic area-level index of socioeconomic disadvantage. The model includes birth weight as a control for the health condition of the infant. Time effects using year of birth are also included.

We do not model the decision to buy private health insurance, because in many cases, the decision of choice of care is analogous to that of buying private health insurance; that is, many women purchase private health insurance for the express purpose of accessing private maternity care (Shorten and Shorten 2004). Moreover, Australian evidence exists showing that the results of modelling the choice between public and private hospitals vary only slightly according to whether insurance status is treated exogenously; Doiron and Kettlewell (2018) conclude that insurance status may be treated as exogenous if demographic and health controls are in place[3]. Despite this argument, we have taken a conservative approach to the specification of equation (1) by excluding the private health insurance status variable. We also exclude private health insurance from equation (2) because although private health insurance status has a large role in determining choice of care, we argue that conditional on care type, the intervention outcome in equation (2) itself does not depend on insurance status – that is, there is no reason that insurance status ipso facto would influence the decision to intervene, and that the relevant channel is care type.

[3] The inclusion of private health insurance status as an exogenous variable in equation (1) yielded very similar results to those reported here. These are available upon request.

Subsequently, we argue that a woman's differential distance to hospital plausibly has no direct effect on birth interventions. It is possible that for some women, distance to amenities (including hospitals) is correlated with endogenous characteristics, such as wealth and insurance status. However, we have included a geographically-based index of socioeconomic status to mitigate this effect; in addition, our sample of low-risk women reduces the possible impact of unobserved health status that could also be correlated with distance from hospital. Our sample of women is focused on populous areas of New South Wales, where the actual distances to a hospital facility are not large, and we are simply exploiting the variation in differential distance (at the 95th percentile in our sample, the distance to the closest public hospital is only 14km).

What remains to be considered is the potential endogeneity of choice of care type represented by C_{i2} and C_{i3}. Rather than relying on functional form for identification we proceeded in an instrumental variables framework using two sources of variation in our instruments, described as follows. In our results we show that they are strong instruments.

Our instrument must be uncorrelated with likely unobserved confounding factors (i.e. valid), and correlated with choice of birth setting (i.e. relevant). Other studies that have adopted distance-to-hospital as an instrument for hospital choice have used differential distance measures. Typically, that could be defined as distance to closest private hospital minus the distance to the closest public hospital. In our study, this approach is problematic, because 7 (out of 18) private hospitals are co-located with their public counterparts; this results in a differential distance of zero in many cases.

Consequently, our first instrument redefines differential distance, using the distance to the two nearest public, and two nearest private, hospitals as our first instrument:

$$Z_{1i} = dPub1_i + dPub2_i - dPriv1_i - dPriv2_i$$

where *dPub1* is the mother's distance to the closest public hospital, *dPub2* is her distance to the second public hospital, and *dPriv1* and *dPriv2* are her distances to her two closest private hospitals. The rationale for this approach exploits the variation in distances to each type of birth setting. For example, if a woman lives closer to 2 private hospitals than her 2 closest public hospitals, we expect that she is more likely to attend the private hospital for her birth.

Our second instrument Z_{2i} is a binary indicator denoting whether the woman's closest facility is a public-private co-located hospital. The rationale here is that proximity will again mean this hospital is a likely choice. In addition, because the co-located facilities are typically the largest teaching hospitals, which may signal higher quality, women may be more likely to choose the public facility.

Our main sample comprises all low-risk mothers who did not have a planned caesarean section. We also excluded homebirths and births in birth centres. Due to the lack of private facilities in more rural areas, we limited our sample to women based in major cities and inner regional areas. This resulted in a sample of 289,288 births.

We estimated equations (1) and (2) jointly using maximum likelihood, where equation (1) is modelled as a multinomial probit, and equation (2) as a binary probit. The model assumes a multivariate normal distribution for error terms u_{ij} and ε_i. Because all variables in (1) are individual specific, all parameters are specified to vary over j with those for $j = 1$ set to zero to ensure identification. We reported the predicted and marginal probabilities of each intervention for births taking place in a private hospital. Our test for weak instruments involves testing for the joint significance of the instruments in equation (1) (Bound, Jaeger, and Baker 1995).

3 Results

Table 3 presents our main results for four intervention outcomes – labour induction, epidural analgesia, instrumental delivery and caesarean section. We report the marginal effects from 3 models – Model 1 is a probit equation with no covariates other than $C_{i2}$and C_{i3}. Model 2 adds observed covariates, estimating equation (2) directly without accounting for potential endogeneity. Model 3 implements the full IV framework, jointly estimating equations (1) and (2). The marginal effect on C_{i2} represents the private doctor-level effect, that is, the impact of receiving care from a private obstetrician (in a public hospital), relative to women receiving care from public physicians and midwives. The marginal effect on C_{i3} represents the private hospital-level effect.

The results show that both effects are reduced between Models 1 and 2 as covariates are added, and lower again for doctor-level effects when accounting for selection effects in Model 3. Moving from Model 2 to Model 3, the private hospital effects increase by modest amounts, and stay below the effects found for Model 1. This illustrates the importance of accounting for both observed and unobserved differences in the women choosing each care type, and the results showed that these differences were statistically significant. Our test for the exogeneity of the choice of care rejects the hypothesis of exogeneity for three out of the four outcomes, and supported the use of our IV strategy.

The Model 3 estimates show that women receiving care from private obstetricians had higher intervention rates compared to those receiving public care. Giving birth in a private hospital raised the probability of intervention further. The results indicate that the doctor-level effects are large relative to additional hospital-level effects. In particular, Model 3 results show that while the probability of receiving an epidural is 9.5 percentage points higher for a woman seeing a private obstetrician in a public hospital, and 23.9 percentage points higher for a woman giving birth in a private hospital (relative to a woman receiving public care). For labour induction, the marginal probabilities are 4.9 and 10.5 percentage points, for care under a private obstetrician and in a private hospital, respectively. For instrumental delivery, the probabilities were 4.7 and 6.6 percentage points higher, respectively. For caesarean sections undertaken in labour, the probabilities are 1.9 and 3.1 percentage points higher, respectively. All results were statistically significant.

TABLE 3—MAIN SPECIFICATION RESULTS

n = 289,288	Model 1		Model 2		Model 3	
	Est.	Std. Err	Est.	Std. Err	Est.	Std. Err
Labour Induction						
Private doctor effect	0.084***	(0.0032)	0.070***	(0.0033)	0.049***	(0.0082)
Private hospital effect	0.110***	(0.0018)	0.097***	(0.0021)	0.105***	(0.0062)
Test of weak instruments					1133.05	0.000
Test of exogeneity					10.89	0.004
Epidural						
Private doctor effect	0.160***	(0.0033)	0.112***	(0.0033)	0.095***	(0.0086)
Private hospital effect	0.274***	(0.0017)	0.219***	(0.0020)	0.239***	(0.0065)
Test of weak instruments					1122.89	0.000
Test of exogeneity					11.26	0.004
Instrumental delivery						
Private doctor effect	0.070***	(0.0024)	0.052***	(0.0024)	0.047***	(0.0066)
Private hospital effect	0.076***	(0.0014)	0.063***	(0.0016)	0.066***	(0.0049)
Test of weak instruments					1116.07	0.000
Test of exogeneity					0.97	0.617
Caesarean delivery						
Private doctor effect	0.040***	(0.0024)	0.018***	(0.0024)	0.019***	(0.0061)
Private hospital effect	0.040***	(0.0014)	0.026***	(0.0016)	0.031***	(0.0048)
Test of weak instruments					1125.23	0.000
Test of exogeneity					1.19	0.552

Notes: The table reports marginal effects for models 1 to 3. Model 1 estimates equation (2) with no covariates other than H_{i2} and H_{i3}; Model 2 estimates equation (2) with additional observed covariates; Model 3 implements the full instrumental variables specification. This table also reports: the F-statistic (and its p-value) from a test of the joint significance of the two instruments from equation (1); and, the correlation between the error terms in equations (1) and (2) (and its p-value).
Source: NSW Perinatal Data Collection

Our test for weak instruments involves testing for the joint significance of the instruments in equation (1). The large test statistics and correspondingly small p-values strongly support the strength of our distance-based instruments.

Table 4 compares our estimates to those reported in previous Australian studies. We only report the marginal effects of giving birth in a private hospital as only one previous analysis considered births in private care at a public hospital. While these studies are not directly comparable due to sample differences, broadly we find that our estimates are towards the lower end of available estimates, suggesting that selection effects have a material effect on estimated intervention rates. For example, we find that there is an increased probability of an instrumental delivery of 6.6 percentage points, compared to previous estimates ranging from 5.9 to 16.6 percentage points.

TABLE 4—COMPARISON TO PRIOR STUDIES

	IV estimates	Dahlen et al. (2014)	Roberts et al. (2000)	Einarsdottir et al. (2013)
Induction of labour	10.5	12.10	10.00	9.60
Epidural analgesia	23.9	35.40	25.70	25.80
Instrumental delivery	6.6	10.80	16.60	5.90
Caesarean section	3.1	3.30	3.80	0.70
Sample period	2007-2012	2000-2008	1996 - 1997	1998-2008
Sample	NSW low risk mothers	NSW primiparous low risk mothers	NSW primiparous low risk mothers	All Western Australian mothers

Notes: The table reports estimated marginal effects of giving birth in a private hospital, compared to giving birth in a public hospital.

Robustness checks

Our first sensitivity test limits the model to births at co-located facilities. Examining co-located facilities removes the possible impact of endogenous private hospital location. That is, private hospitals may choose their location to be in close proximity to wealthier women with a propensity for birth interventions, affecting the validity of our instrument. In the case of co-located public-private facilities, private hospitals are placed no closer to any such residents than public hospitals. It comes at the expense of concentrating on a very distinctive type of hospitals (i.e. private hospitals next to large teaching hospitals). The results in Table 5 show similar hospital effects to those reported in Table 3, but larger doctor-level effects; the doctor and hospital effects are of a similar magnitude. Probabilities of intervention under private care remain high relative to public care, and are attributable more strongly to doctor-level incentives for these co-located facilities.

Finally, we report results from a linear probability model of intervention outcomes with hospital fixed effects. Here the impact of private care in a private hospital can no longer be identified but the impact of private care being offered by doctors in public hospitals can be estimated. We expect to see doctor-effects similar to the main results in Table 3, after accounting for any possible unobserved hospital-level variation. The coefficients reported in Table 5 show that the doctor-effects are broadly similar to those in Table 3; the impact on labour induction was an exception, being 8.4 percentage points compared to 4.9 percentage points in our main results. From these estimations, hospital fixed effects can be estimated which show that hospital-specific effects varied greatly across public and private facilities; in Table 5 we report the inter-quartile range of these estimated hospital-specific effects, which ranged from 8 to 25 percentage points. This is considerable variability compared to the raw intervention rates reported in Table 5.

TABLE 5—ROBUSTNESS CHECKS

n=110,378	Co-located facilities		Hospital fixed effects		
	Est.	Std. Err	Est.	Std. Err	IQR
Labour Induction					
Private doctor effect	0.143***	(0.0140)	0.084***	(0.0036)	0.18
Private hospital effect	0.130***	(0.0088)	-	-	-
Epidural					
Private doctor effect	0.167***	(0.0137)	0.095***	(0.0035)	0.25
Private hospital effect	0.195***	(0.0090)	-	-	-
Instrumental delivery					
Private doctor effect	0.071***	(0.0117)	0.046***	(0.0028)	0.08
Private hospital effect	0.060***	(0.0072)	-	-	-
Caesarean delivery					
Private doctor effect	0.020**	(0.0098)	0.021***	(0.0027)	0.09
Private hospital effect	0.033***	(0.0068)	-	-	-

Source: NSW Perinatal Data Collection

4 Discussion

This paper exploits rich administrative data on women and their pregnancy and childbirth experience to implement an instrumental variables framework for examining the impact of private doctor-level, and private hospital-level incentives on birth interventions. Our results show that after purging the impact of differences in patient preferences and clinical need, there remains significant variation in birth intervention rates driven solely by supply-side factors. In particular, private maternity care raises intervention rates at both the doctor and hospital level. This variation can be deemed unwarranted as it is likely attributable to incentives faced by both private doctors and private hospitals, which relate to differences in how private providers are employed, insured, and paid. It is possible that the results reflect both overtreatment in the private setting, as well as undertreatment in the public setting. The latter effect may arise due to greater resource constraints and time-pressures which may prevail in a public maternity setting.

Our results have strong implications for women making choices about maternity care. From the woman's perspective, knowledge of circumstances where she is more likely to experience a birth intervention is powerful, as many studies show that women desire an active role in childbirth decision-making (Brown and Lumley 1994; Hollins Martin and Fleming 2011). This is particularly important in circumstances where she may be less well-informed and more reliant on her care providers.

Our results also have significant policy implications for the Australian health system. Concern has also long been expressed about 'inverse care', whereby many of the most healthy women receive specialist obstetric care at levels higher than women who may be in greater need, meaning that scarce health care resources may be directed to women at lower risk of complications. Our results indicate that, after accounting for the clinical need and individual preferences of women, the occurrence, and associated costs, of birth interventions is often much higher in private care. In a mixed publicly and privately funded system such as Australia's, where public funds are directed towards private care, the burden of these unnecessary interventions falls on the already-overstretched health system, taxpayers whose tax dollars are directed towards a more affluent segment of the population, and on the women who receive these interventions without express clinical need or desire.

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