Public–private differentials in health care delivery: the case of cesarean deliveries in Algeria

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Abstract
Akin to other developing countries, Algeria has witnessed an increasing role of the private health sector in the past two decades. Our study sheds light on the public–private overlap and the phenomenon of physician dual practice in the provision of health care services using the particular case of cesarean deliveries in Algeria. Existing studies have reported that, compared to the public sector, delivering in a private health facility increases the risk of enduring a cesarean section. While confirming this result for the case of Algeria, our study also reveals the existence of public–private differentials in the effect of medical vari-ables on the probability of cesarean delivery. After controlling for selection in both sectors, we show that cesarean deliveries in the private sector tend to be less medically justified compared with those taking place in the public sector, thus, potentially leading to maternal and neonatal health problems. As elsewhere, the contribution of the private health sector to the unmet need for health care in Algeria hinges on an appropriate legal framework that better coordinates the activities of the two sectors and reinforces their complementarity.

Keywords Public–private differentials · Physician dual practice · Algeria · Cesarean delivery

JEL Classification I11 · I18 · K32

Introduction

Ensuring universal access to reproductive health while reducing under-five child mortality rate by two-thirds and maternal mortality rate by three-quarters have been amongst the United Nations 2015 Millennium Development Goals (MDG 4 and MDG 5). The recently adopted Sustainable Development Goals (SDGs 2015–2030) have urged all countries to intensifying their efforts to further reduce the global maternal mortality ratio to less than

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70 per 100,000 live births, to end preventable deaths of newborns and children under 5 years of age and to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5-mortality to at least as low as 25 per 1000 live births by 2030 (United Nations, 2015). Akin to other developing countries, Algeria—an upper-middle-income country undergoing a rapid demographic and epidemiological transition—has made a remarkable progress in this domain, with significant reductions in both infant mortality rate (from 39.7‰ in 1990 to 21.9‰ in 2015) and maternal mortality rate (from 216 per 100,000 live births in 1990 to 140 in 2015) (World Health Organization, UNICEF, UNFPA, World Bank Group, and United Nations Population Division, 2015).

Over the past 2 decades, Algeria has witnessed an increasing role of the private health sector and physician dual practice in health care delivery. Although encouraged by the government in order to reduce spatial inequalities in health, this increasing complementarity between public and private health sectors may lead to adverse medical and economic effects. This article contributes to the literature on the public–private differential and physician dual practice in health care delivery using the case of cesarean deliveries in Algeria. We investigate the factors influencing the cesarean section deliveries using data from the latest Multiple Indicator Cluster Survey (MICS) conducted in 2012–2013. This study examines whether the determinants of cesarean delivery differ according to the place of delivery (whether public or private).

The case of cesarean delivery is interesting in its own right. The cesarean section rate has grown considerably over the last decade, especially in developing countries (Flamm, 2000; Porreco & Thorp, 1996). Stanton and Holtz (2006) estimate cesarean rates in the developing world at 12% with variable regional rates from 3 to 26%. Arab countries are no exception to this "epidemic of cesarean sections" (Betrán et al., 2016; Khawaja et al., 2009; Mikki et al., 2009). This issue is particularly important form both medical and economic perspectives. The strong increase in cesarean sections raises a question about the determinants of this practice. On the medico-clinical level, professional recommendations to assist health care professionals in decision-making on cesarean section have been developed (Di Renzo & Malvasi, 2016). However, such recommendations are rather indicative, leaving greater discretion to health care professionals to decide whether or not to practice a cesarean section. Furthermore, there is no consensus on an "optimal rate" of cesarean sections, even if the World Health Organization (1985, 2015) and others (Betrán et al., 2015; Ye et al., 2014) consider a rate of 10–15% above which cesarean sections may be deemed medically unjustified and may not necessarily be associated with a reduction in maternal and neonatal mortality. A variety of non-medical factors pertaining to the demand for medical care (e.g., socio-economic and socio-demographic characteristics of women) and the supply of medical care (e.g., characteristics of the health care system) are shown to play an important role in the decision to rescue to cesarean sections (Baubeau & Buisson, 2003).[1] Cesarean indications are often medically unjustified. Although cesarean section is a common procedure, it is not uncommon to observe a complication that darkens the fetal and maternal prognosis. However, the argument generally put forward by the doctor is the fetal and/or maternal rescue. In reality, is this the case? Health professionals do not communicate enough with mothers about the risks incurred after the cesarean section. It is naive to

[1] Demand-side factors include the role of social network (Leone, Padmadas, & Matthews, 2008) or the fear of vaginal delivery (Fritel, 2015), while supply-side factors are mainly related to financial motives (Cavalieri, Guccio, Lisi, & Pignataro, 2014; Gruber, Kim, & Mayzlin, 1999; Gruber & Owings, 1996; Johnson & Rehavi, 2016; McGuire & Pauly, 1991; Milcent & Rochut, 2009; Triunfo & Rossi, 2009).

think that all information disseminated by doctors is unbiased and expresses an opinion based on their experience (Penna & Arulkumaran, 2003). The costs of the negatives effects of cesarean section may be significant in comparison with normal delivery (Filippi et al., 2015). Research between 2000 and 2005 shows evidence of very small numbers of women requesting a cesarean section (McCourt et al., 2007). In economic terms, the significant remuneration differences between cesarean delivery and vaginal delivery may explain the high incidence of cesarean section.

The remainder of the paper is organized as follows. The following Section features the Algerian health care system. Section 3 presents the methodology and the dataset used in the econometric analysis. The results are presented in Sect. 4 and discussed in Sect. 5 along with some recommendations.

The Algerian context

The Algerian health care system is a dual public–private sector. The Ministry of Health, Population and Hospital Reform (MHPHR) runs the public sector and regulates the rapidly evolving private-for-profit sector (MSPRH, 2001). Health care expenditures are mainly funded through general tax revenues, social security funds and out-of-pocket payments. Available data indicate that total health expenditure (THE) represented 7.2% of GDP in 2014. Although the share of THE in GDP has significantly increased over the last 2 decades (from 3.7% in 1995 to 7.2% in 2014), the share of public health expenditure in THE has fallen from 77.4% in 2001 to 72.7% in 2014 (World Health Organization, 2017). This reflects a gradual shift of health financing towards private sources. As a result the share of health care expenditure borne by households was as high as 26.5% in 2014 (Lamri, 2014; Tlilane, 2004). The relatively high share of household direct expenditures on health care can also be explained by the small share of medical costs covered by the social security, especially for private sector health services. Although in the case of Algeria no empirical evidence has been made available to date on the effect of health care expenditure on household welfare, reported evidence from neighboring countries with similar socio-economic characteristics alert on the relatively high financial burden and the risk of catastrophic and impoverishing health expenditures associated with ill-health (Abu-Zaineh et al., 2013; Makhloufi et al., 2015). From a macroeconomic perspective, Bousmah et al. (2016) show that the increasing share of private health spending in total health spending in the Middle-East and North-Africa region is negatively associated with health outcomes when institutional quality is weak.

In Algeria, de facto complementarity between the public and the private providers with a phenomenon of dual practice have informally developed from an attempt to raise practitioners' remunerations. De jure complementarity between the two sectors have been endorsed by the "décret exécutif n° 99–236 du 19 octobre 1999". These dual practices have further been reinforced by a new legislation ("circulaire n° 001 MSPRH/MIN du 31 mars 2010"). Accordingly, public-sector's practitioners are allowed to combine public-sector work with a fee-for-service in the private sector—the so-called "profitable activities". These reforms are meant to tackle the spatial inequalities in the distribution of health care services across the different regions. Consequently, the MHPHR has started to contract private sector practitioners to cover areas that have deficits of doctors in certain specialties. The private health care sector encompasses private physicians and private clinics with or without hospital beds. The role and number of private physicians has grown rapidly during

the last 2 decades particularly in some specialties such as gynecology, ophthalmology or otorhinolaryngology. In 2012, private–public ratios for these three specialties were estimated at 75:25%, 70:30% and 65:35%, respectively (Zehnati, 2014). The deficit of specialist physicians in the public sector is more pronounced for gynecology.

Free access to different types of health care services is guaranteed to all citizens by the Algerian Constitution (Article 66). In practice, however, patients' health care pathways vary depending on financing and reimbursement modalities and on the physician's referral strategies (Zehnati, 2014). The decree of 1999 allowing practitioners to work in both sectors has offered physicians more liberty to refer patients and decide on their therapeutic itineraries. Zehnati (2014) reports that referral practices tend to be driven by practitioners' financial incentives, who seek to maximize their gains through modifying patients' therapeutic pathways. For instance, in the particular case of birth delivery, the study shows that about 72% of cesarean section surgeries in two districts of Algeria, Algiers and Béjaia, took place at the private sector clinics, representing about 50% of their revenue. Given the large public–private differentials in terms of remuneration, public sector hospitals may be regarded as a source of generating a fee-for-service private clientele (Zehnati & Peyron, 2013). Anecdotal evidence on heterogeneous referral practices (preferential and quicker referrals) are often reported. Patients generally face two entry barriers: a relational barrier to get appropriate access to the needed services in the public sector and a financial barrier to access the private sector (Zehnati, 2014). The rapid growth of private health providers and the public–private dual practice may have increased the financial burden of health care.

Material and methods

Data

This paper uses the latest available data from the MICS conducted in Algeria in 2012–2013 (UNICEF, 2015). The MICS is a national representative survey that provides detailed data on maternal and infant health, in addition to a set of socio-demographic and socio-economic characteristics of households. A sample of 28,000 Algerian households, distributed according to seven regions, has been selected using a two-stage stratified cluster-random sampling procedure.

This study uses individual-level data pertaining to adult women of reproductive age (15–49). The target population comprises a sub-sample of 5278 adult women who delivered in a public or a private health facility in the 2 years prior to the survey. The variable of interest is a binary variable taking on a value of 1 if a woman had a cesarean delivery and zero otherwise. A set of explanatory variables, which are shown to be potentially important associates with cesarean delivery, are identified and included in the analysis (Stivanello et al., 2014). We would expect cesarean section to be positively associated with private-sector delivery, complications during pregnancy, maternal age and socio-economic level. The number of prenatal visits is predicted to be positively associated with the probability of cesarean delivery. Of note, a high number of prenatal visits is likely to act as a proxy for complications during pregnancy uncaptured by the medical factors included in the model. Finally, we would expect very small and very large infants to be more likely to be delivered by cesarean (U-shaped relationship between infant size and cesarean delivery).

Table 1 provides a detailed description of the main variables used in our study. On all deliveries, about 15.3% were cesarean, and 7.4% took place in a private health facility,

Table 1 Variables description

Variable	Type	Definition	Percentage of sample
Cesarean delivery (dependent variable)	Binary	Vaginal delivery (=base category); cesarean delivery	84.69; 15.31
Place of delivery	Binary	Public health facility (=base category); private health facility	92.63; 7.37
Birth order	Discrete	Order of the index delivery: 1 (=base category); 2; 3; 4; 5 or more	29.39; 25.01; 19.67; 12.58; 13.36
Number of prenatal visits	Discrete	≤4 (=base category); ≥5 and ≤9; ≥10	59.28; 37.32; 3.39
Infant size at birth	Discrete	Very small (=base category); smaller than average; average; larger than average; very large	4.36; 10.78; 66.71; 13.45; 4.70
Complications during the pregnancy			
Vaginal bleeding	Binary	No (=base category); yes	91.44; 8.56
High blood pressure	Binary	No (=base category); yes	92.88; 7.12
Facial or body edema	Binary	No (=base category); yes	90.17; 9.83
Vaginal infection	Binary	No (=base category); yes	87.70; 12.30
Burning urination	Binary	No (=base category); yes	89.09; 10.91
Gestational diabetes	Binary	No (=base category); yes	98.18; 1.82
Mother's characteristics			
Region	Discrete	North Center (=base category); Northeast; Northwest; Highlands Center; Highlands East; Highlands West; South	13.26; 10.78; 12.28; 16.31; 14.99; 15.61; 16.77
Area	Binary	Rural (=base category); urban	34.14; 65.86
Maternal age	Continuous	In years	
Mother ever had a child who died	Binary	No (=base category); Yes	93.26; 6.74
Wealth quintile	Discrete	1st (poorest) quintile (=base category); 2nd; 3rd; 4th; 5th (richest)	
Formal education	Discrete	Elementary school or less (=base category); middle school; high school; higher	34.98; 30.28; 23.57; 11.18

as shown in Table 1. As far as public–private differential is concerned, data shows that while only 7% of women who delivered in a public health facility had a cesarean section, about 53% of deliveries taking place in a private health facility were cesarean.

Methodology

The methodology employed involves three steps. First, a baseline probit model of cesarean delivery is estimated. Secondly, we estimate a bivariate probit model to investigate whether the decisions about the mode of delivery and the place of delivery are correlated. Note that the descriptive analysis indicates that these two outcomes are strongly positively correlated ($\rho = 0.29$, $p < 0.001$), thus, a joint-specification of the two binary variables is called for. A bivariate probit model jointly estimates two binary probit models while allowing for correlation between the error terms of both equations (Cameron & Trivedi, 2009). A test for error term correlation (Wald test of $\rho = 0$) is then performed. Such joint estimation with a bivariate probit model is needed in the case where the hypothesis that $\rho = 0$ is rejected.

Thirdly, we examine whether the factors associated with cesarean delivery differ according to the place of delivery. To do so, we need to estimate the determinants of the mode of delivery separately for the two sectors (deliveries in a public versus private health facility). The aforementioned correlation between the mode and the place of delivery alerts on the potential presence of self-selection: women are unlikely to be randomly distributed across places of delivery (public versus private). We suspect that giving birth in a private health facility is positively correlated with cesarean delivery. Scrutinizing the factors associated with cesarean delivery according to the place of delivery requires, therefore, controlling for potential selection. The latter is addressed here using the propensity score matching (PSM) technique (Garrido et al., 2014). The PSM allows to adjust for pre-treatment observable differences between the treatment group (women who delivered in a private facility) and the control group (women who delivered in a public facility). Using a probit model, we estimate in a first step the propensity scores of the treatment group on the set of explanatory variables except the mode of delivery. Then, a kernel matching procedure is implemented, with cesarean delivery specified as outcome variable, using the Epanechnikov kernel function with a bandwidth of 0.06 and the conditional treatment probability (the propensity scores) estimated in the first step. As a result, women who delivered in the public or private sector are matched based on their propensity scores. Finally, two probit models are estimated separately on the two sub-samples of women with the same set of explanatory variables, and using the matching weights from the propensity scores. It is thus possible to compare the results of the two models. It is worth noting that direct comparisons of coefficients from different nonlinear regression models are not straightforward (Mood, 2010). Although our methodology allows correcting for selection bias due to observable differences between the treatment and comparison groups, potential omitted cluster-level confounders might threaten the direct comparisons of coefficients from both models (Arpino & Cannas, 2016). As we are in the presence of very small-sized clusters, existing methods to reduce such potential bias are not applicable here. We thus acknowledge the potential presence of omitted cluster-level confounders. Note that the results of this final step are discussed mainly in terms of sign and significance. Lastly, it is worth mentioning that in all regressions, standard errors are clustered at the primary sampling unit (PSU) level to account for the possible autocorrelation in the residuals.

Results

Results of the analysis of the factors associated with the risk of having a cesarean delivery are presented in Table 2. As shown, the probability of cesarean section is significantly positively associated with the place of delivery. The average marginal effect (AME) of the place of delivery indicates that giving birth in the private sector increases the probability of cesarean section by 33.9 percentage points ($p < 0.001$). The probability of cesarean delivery also increases with the number of prenatal visits, with an AME of 0.052 for ten or more prenatal visits ($p < 0.10$). By contrast, the probability of cesarean section tend to decrease with the birth order of the newborn, being the lowest for a birth order of 5 or more (AME = −0.179, $p < 0.001$). Expectedly, the probability of cesarean delivery appears to be lower for the average size of a newborn compared with very small, larger than average and very large. Among the other medical factors, women who had, during the pregnancy, a high blood pressure, a facial or body edema, or gestational diabetes appear to be more exposed to have a cesarean section. Nonetheless, no significant association is found for women who had, during the pregnancy, vaginal bleeding, vaginal infection or burning urination. Place of living appears to be a contributor to the probability of having cesarean delivery with women living in urban areas and in the Northwest regions being at higher risk of having a cesarean delivery than their rural and north-center region counterparts.[2] The probability of cesarean section tend also to increase with maternal age and for mothers who had ever experienced the death of a child. Compared with women in the poorest wealth quintile, those in the 3rd and the 4th quintiles have a 2.9% ($p < 0.10$) and 4.6% ($p < 0.01$) lower probability of enduring a cesarean section, respectively, while no difference is observed for those in the 2nd and the highest quintiles. Finally, more formally educated women have a markedly higher probability of enduring a cesarean section, pointing to the existence of a socio-economic gradient.

Table 3 shows the results for the bivariate probit model of enduring a cesarean section and delivering in a private health facility estimated using the same set of explanatory variables as before. AMEs, computed for the joint probability of success (Pr(cesarean delivery = 1, delivery in a private health facility = 1)), are also reported. Overall, the coefficient estimates for the cesarean section equation are broadly similar to those obtained using the binary probit model. More importantly, result of the Wald test, which allows to estimate and test for the potential correlation between the error terms of the two equations, strongly rejects the hypothesis that $\rho = 0$. The estimate for the correlation coefficient is $\rho = 0.556$ and the chi-squared test of 196.20, showing that this estimate is significantly different from zero. This indicates that the decisions about the mode of delivery and the place of delivery are jointly influenced by unobservable factors, which are positively related to the mode and the place of delivery. Also note that, compared with the previous model (Table 2), the socio-economic gradient is now observed for both wealth and education: the richer and the more formally educated, the higher the joint probability of both enduring a cesarean section and giving birth in the private sector.

The previous findings motivate the use of the PSM technique in order to account for potential selection bias before estimating separately the determinants of cesarean delivery

[2] This may be explained by the fact that the majority of clinics are located in the main urban centers. In 2015, 34.5% of medical and surgical clinics were concentrated in the cities of Algiers and Oran (MSPRH, 2017). Also, public health facilities, when located in the highlands or in southern regions, often lack obstetrician-gynecologists (Zehnati, 2014).

Table 2 Results of the probit model of the factors associated with the risk of enduring a cesarean delivery

Probit model (dependent variable = cesarean delivery)	Coefficient estimates	AMEs
Place of delivery (ref. = public health facility)		
Private health facility	1.159***	0.339***
	(0.079)	(0.028)
Birth order (ref. = 1)		
2	− 0.274***	− 0.068***
	(0.059)	(0.015)
3	− 0.625***	− 0.135***
	(0.077)	(0.016)
4	− 0.684***	− 0.144***
	(0.095)	(0.018)
5 or more	− 0.959***	− 0.179***
	(0.112)	(0.018)
Number of prenatal visits (ref. = ≤ 4)		
≥ 5 and ≤ 9	0.128*	0.026*
	(0.050)	(0.010)
≥ 10	0.247*	0.052^{+}
	(0.118)	(0.027)
Infant size at birth (ref. = very small)		
Smaller than average	0.032	0.007
	(0.127)	(0.028)
Average	− 0.222*	− 0.043^{+}
	(0.113)	(0.024)
Larger than average	0.290*	0.071*
	(0.123)	(0.028)
Very large	0.286^{+}	0.070^{+}
	(0.153)	(0.037)
Complications during the pregnancy		
Vaginal bleeding	− 0.107	− 0.020
	(0.084)	(0.015)
High blood pressure	0.458***	0.108***
	(0.079)	(0.021)
Facial or body edema	0.193*	0.041*
	(0.079)	(0.018)
Vaginal infection	− 0.095	− 0.018
	(0.084)	(0.015)
Burning urination	0.008	0.002
	(0.088)	(0.017)
Gestational diabetes	0.466**	0.112**
	(0.155)	(0.043)
Region (ref. = north center)		
Northeast	0.157	0.032
	(0.097)	(0.020)
Northwest	0.238*	0.050*
	(0.094)	(0.020)

Table 2 (continued)

Probit model (dependent variable = cesarean delivery)	Coefficient estimates	AMEs
Highlands center	−0.018	−0.003
	(0.090)	(0.017)
Highlands east	−0.078	−0.014
	(0.092)	(0.017)
Highlands west	0.058	0.011
	(0.088)	(0.017)
South	0.017	0.003
	(0.092)	(0.018)
Urban area (ref. = rural)	0.106^{+}	0.021^{+}
	(0.062)	(0.012)
Maternal age	0.040***	0.008***
	(0.005)	(0.001)
Mother ever had a child who died	0.238*	0.052*
	(0.098)	(0.023)
Mother's wealth quintile (ref. = 1st (poorest) quintile)		
2nd quintile	−0.007	−0.001
	(0.072)	(0.015)
3rd quintile	−0.143^{+}	−0.029^{+}
	(0.081)	(0.017)
4th quintile	−0.238**	−0.046**
	(0.086)	(0.017)
5th (richest) quintile	−0.119	−0.025
	(0.096)	(0.020)
Mother's formal education (ref. = elementary school or less)		
Middle school	0.093	0.017
	(0.061)	(0.011)
High school	0.226***	0.045***
	(0.064)	(0.013)
Higher	0.265**	0.054**
	(0.085)	(0.018)
Constant	−2.212***	
	(0.205)	
Log pseudolikelihood	−1902.713	
Wald test p value	0.0000	
Pseudo R^2	0.158	
N	5278	

$^{+}p < 0.10$; $*p < 0.05$; $**p < 0.01$; $***p < 0.001$. Clustered standard errors computed at the primary sampling unit (PSU) level in parenthesis. dy/dx for factor levels is the discrete change from the base level

Table 3 Results of the bivariate probit model

Bivariate probit model	Coefficient estimates		AMEs
	Dep. var. = cesarean delivery	Dep. var. = delivery in a private health facility	Pr(cesarean delivery = 1, delivery in a private health facility = 1)
Birth order (ref. = 1)			
2	−0.276***	−0.135^{+}	−0.018**
	(0.058)	(0.074)	(0.006)
3	−0.617***	−0.168*	−0.030***
	(0.075)	(0.086)	(0.006)
4	−0.681***	−0.252*	−0.035***
	(0.091)	(0.116)	(0.007)
5 or more	−0.948***	−0.303*	−0.042***
	(0.109)	(0.134)	(0.007)
Number of prenatal visits (ref. = ≤4)			
≥5 and ≤9	0.180***	0.267***	0.019***
	(0.049)	(0.063)	(0.004)
≥10	0.312**	0.326*	0.028*
	(0.111)	(0.139)	(0.011)
Infant size at birth (ref. = very small)			
Smaller than average	0.010	−0.119	−0.007
	(0.122)	(0.145)	(0.011)
Average	−0.248*	−0.205^{+}	−0.019*
	(0.107)	(0.123)	(0.009)
Larger than average	0.266*	−0.011	0.009
	(0.117)	(0.133)	(0.011)
Very large	0.295*	0.136	0.023
	(0.145)	(0.160)	(0.014)

Table 3 (continued)

Bivariate probit model	Coefficient estimates		AMEs
	Dep. var. = cesarean delivery	Dep. var. = delivery in a private health facility	Pr(cesarean delivery = 1, delivery in a private health facility = 1)
Complications during the pregnancy			
Vaginal bleeding	−0.078	0.082	0.001
	(0.081)	(0.090)	(0.006)
High blood pressure	0.410***	−0.120	0.005
	(0.080)	(0.107)	(0.008)
Facial or body edema	0.179*	0.039	0.008
	(0.078)	(0.094)	(0.007)
Vaginal infection	−0.086	−0.009	−0.003
	(0.081)	(0.093)	(0.006)
Burning urination	0.014	0.044	0.003
	(0.087)	(0.109)	(0.007)
Gestational diabetes	0.435**	−0.008	0.012
	(0.153)	(0.190)	(0.016)
Region (ref. = north center)			
Northeast	0.129	−0.085	−0.000
	(0.094)	(0.109)	(0.008)
Northwest	0.179^{+}	−0.187^{+}	−0.005
	(0.093)	(0.109)	(0.008)
Highlands center	−0.079	−0.262*	−0.016*
	(0.088)	(0.109)	(0.007)
Highlands east	−0.008	0.218*	0.013
	(0.089)	(0.103)	(0.009)

Table 3 (continued)

Bivariate probit model	Coefficient estimates		AMEs
	Dep. var. = cesarean delivery	Dep. var. = delivery in a private health facility	Pr(cesarean delivery = 1, delivery in a private health facility = 1)
Highlands WEst	−0.056	−0.582***	−0.028***
	(0.087)	(0.128)	(0.007)
South	−0.081	−0.483***	−0.025***
	(0.090)	(0.123)	(0.007)
Urban area (ref. = rural)	0.105^{+}	0.004	0.003
	(0.060)	(0.074)	(0.004)
Maternal age	0.039***	0.011^{+}	0.002***
	(0.005)	(0.007)	(0.000)
Mother ever had a child who died	0.247**	0.147	0.017^{+}
	(0.093)	(0.119)	(0.009)
Mother's wealth quintile (ref. = 1st (poorest) quintile)			
2nd quintile	−0.008	0.032	0.001
	(0.071)	(0.103)	(0.005)
3rd quintile	−0.096	0.268*	0.010^{+}
	(0.079)	(0.107)	(0.006)
4th quintile	−0.176*	0.320**	0.010^{+}
	(0.084)	(0.106)	(0.006)
5th (richest) quintile	0.019	0.613***	0.035***
	(0.091)	(0.108)	(0.007)
Mother's formal education (ref. = elementary school or less)			
Middle school	0.109^{+}	0.141*	0.009*
	(0.059)	(0.071)	(0.004)

Table 3 (continued)

Bivariate probit model	Coefficient estimates		AMEs
	Dep. var. = cesarean delivery	Dep. var. = delivery in a private health facility	Pr(cesarean delivery = 1, delivery in a private health facility = 1)
High school	0.221***	0.082	0.009*
	(0.063)	(0.085)	(0.004)
Higher	0.354***	0.432***	0.037***
	(0.083)	(0.093)	(0.008)
Constant	− 2.087***	− 1.934***	
	(0.199)	(0.248)	
ρ (robust standard error)	0.556 (0.031)		
Wald test of ρ = 0	chi2(1) = 196.207 Prob > chi2 = 0.0000		
Log pseudo-likelihood	− 3129.527		
Wald test *p* value	0.0000		
N	5278		

$^{+}p < 0.10$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$. Clustered standard errors computed at the primary sampling unit (PSU) level in parenthesis. Marginal effect for factor levels is the discrete change from the base level

in the two sectors. In a probit model, we, first, estimate the propensity scores of the treated group (women giving birth in a private health facility) on the same set of explanatory variables, except the mode of delivery. Results show that the balancing property is satisfied.[3] The resulting propensity scores are then used to perform the matching. A test assessing the comparability between the two matched samples is performed. Results show that most of the pre-matching bias is considerably reduced after matching.[4] Then, the matching weights from the propensity scores are used to estimate separately a model explaining the factors associated with the risk of having a cesarean section as per the public and private sectors. Results, which are presented in Table 4 are broadly similar for both sub-samples with regard to the birth order, the number of prenatal visits, the maternal age as well as the wealth quintile. These results are also in line with those of the baseline model (Table 2).

Quite interestingly, the results reveal a substantial public–private differential concerning a number of medical factors. In particular, compared to smaller or larger newborns' size, the average size of newborns is significantly negatively associated with the probability of enduring a cesarean delivery at a public sector facility, while no significant association is found for the case of the private sector. Also of note, the probability of enduring a cesarean delivery appears to be higher in the public sector for women who had, during their pregnancy, gestational diabetes or a facial or body edema. However, none of these variables emerge to be significant for cesarean section delivery taking place in the private sector. The only complication during the pregnancy which increases the probability of a cesarean section in both public and private sectors is high blood pressure.

Discussion

This study sheds light on the public–private overlap and the phenomenon of dual practice in the provision of health care services using the particular case of cesarean deliveries in Algeria. Unless appropriately regulated, the public–private overlap coupled with physician dual practice may hinder the efficient provision of health care services and impose additional financial and non-financial barriers on households. This may also have adverse consequences on population health. In this study, we show that cesarean deliveries in the private sector are not determined only by medical factors, which goes against the WHO guidelines (World Health Organization, 1985, 2015).

Our study has several limitations. First, the absence of data on other medical-related factors (e.g., fetal presentation at delivery, previous cesarean or previous negative birth experience) is a practical limitation. Their inclusion would have allowed us to better capture the medical factors influencing the probability of cesarean section. Second, we acknowledge the presence of a potential recall bias that is usually associated with self-reported data, for instance regarding infant size at birth or complications during pregnancy. However, we can reasonably assume that the mother's recall bias would be lower in surveys relying on a shorter recall period. For instance, Ngandu et al. (2016) showed that the negative association between coverage estimates for maternal and child health indicators and the proportion of missing data was higher in the Demographic and Health

[3] The results, which are not shown here for reasons of space, are available from the authors upon request.

[4] Before and after the matching, and for each variable, we perform a t-test of mean equality between the two groups. The results, which are not shown here for reasons of space, are available from the authors upon request.

Table 4 Factors associated with the risk of enduring a cesarean section according to the place of delivery

Probit models (dependent variable = cesarean delivery)	Public health facility		Private health facility	
	Coefficient estimates	AMEs	Coefficient estimates	AMEs
Birth order (ref. = 1)				
2	−0.201*	−0.051*	−0.040	−0.013
	(0.079)	(0.020)	(0.188)	(0.063)
3	−0.594***	−0.128***	−0.739**	−0.254***
	(0.102)	(0.021)	(0.230)	(0.074)
4	−0.571***	−0.124***	−0.709*	−0.244**
	(0.122)	(0.024)	(0.287)	(0.094)
5 or more	−0.891***	−0.167***	−0.901**	−0.306**
	(0.135)	(0.021)	(0.342)	(0.107)
Number of prenatal visits (ref. = ≤ 4)				
≥ 5 and ≤ 9	0.094	0.020	0.256^{+}	0.089^{+}
	(0.061)	(0.013)	(0.150)	(0.052)
≥ 10	0.283*	0.065^{+}	0.631^{+}	0.214*
	(0.143)	(0.036)	(0.342)	(0.109)
Infant size at birth (ref. = very small)				
Smaller than average	−0.043	−0.010	0.372	0.128
	(0.156)	(0.037)	(0.382)	(0.130)
Average	−0.273*	−0.058^{+}	0.261	0.090
	(0.136)	(0.033)	(0.331)	(0.113)
Larger than average	0.249^{+}	0.066^{+}	0.420	0.144
	(0.148)	(0.037)	(0.361)	(0.123)
Very large	0.277	0.075	0.203	0.070
	(0.186)	(0.050)	(0.431)	(0.148)
Complications during the pregnancy				
Vaginal bleeding	−0.146	−0.030	0.014	0.005
	(0.112)	(0.021)	(0.229)	(0.078)
High blood pressure	0.474***	0.121***	0.590*	0.196*
	(0.107)	(0.031)	(0.287)	(0.089)
Facial or body edema	0.296**	0.070**	0.018	0.006
	(0.098)	(0.026)	(0.232)	(0.080)
Vaginal infection	0.047	0.010	−0.137	−0.047
	(0.115)	(0.025)	(0.230)	(0.079)
Burning urination	0.013	0.003	0.264	0.090
	(0.121)	(0.026)	(0.242)	(0.081)
Gestational diabetes	0.396*	0.099^{+}	0.805	0.253^{+}
	(0.196)	(0.056)	(0.533)	(0.140)
Region (ref. = north center)				
Northeast	0.124	0.028	0.736**	0.256**
	(0.121)	(0.027)	(0.262)	(0.088)
Northwest	0.130	0.029	0.718*	0.250**
	(0.113)	(0.025)	(0.292)	(0.097)
Highlands center	−0.033	−0.007	0.142	0.050
	(0.116)	(0.024)	(0.281)	(0.098)

Table 4 (continued)

Probit models (dependent variable = cesarean delivery)	Public health facility		Private health facility	
	Coefficient estimates	AMEs	Coefficient estimates	AMEs
Highlands east	−0.223+	−0.042+	0.367+	0.129+
	(0.125)	(0.024)	(0.217)	(0.075)
Highlands west	0.067	0.015	0.164	0.057
	(0.114)	(0.025)	(0.325)	(0.114)
South	−0.065	−0.013	0.214	0.075
	(0.112)	(0.023)	(0.317)	(0.111)
Urban area (ref. = rural)	0.084	0.018	0.078	0.027
	(0.082)	(0.017)	(0.213)	(0.073)
Maternal age	0.043***	0.009***	0.039*	0.013*
	(0.007)	(0.001)	(0.016)	(0.005)
Mother ever had a child who died	0.306*	0.073*	−0.207	−0.071
	(0.122)	(0.032)	(0.310)	(0.106)
Mother's wealth quintile (ref. = 1st (poorest) quintile)				
2nd quintile	−0.016	−0.004	−0.078	−0.025
	(0.083)	(0.019)	(0.285)	(0.091)
3rd quintile	−0.120	−0.027	−0.387	−0.129
	(0.097)	(0.022)	(0.302)	(0.098)
4th quintile	−0.220*	−0.047*	−0.721*	−0.245*
	(0.104)	(0.023)	(0.304)	(0.099)
5th (richest) quintile	−0.089	−0.020	−0.545+	−0.184+
	(0.111)	(0.025)	(0.313)	(0.102)
Mother's formal education (ref. = elementary school or less)				
Middle school	0.097	0.018	0.050	0.017
	(0.073)	(0.013)	(0.207)	(0.072)
High school	0.335***	0.070***	−0.140	−0.048
	(0.077)	(0.016)	(0.222)	(0.077)
Higher	0.318**	0.066**	0.250	0.086
	(0.107)	(0.023)	(0.237)	(0.081)
Constant	−2.324***		−1.366*	
	(0.269)		(0.645)	
Log pseudo-likelihood	−149.926		−234.408	
Pseudo R^2	0.107		0.129	
Wald test p value	0.0000		0.0003	
N	4889		389	

+$p < 0.10$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. Clustered standard errors computed at the primary sampling unit (PSU) level in parenthesis. dy/dx for factor levels is the discrete change from the base level. Regressions are weighted by the propensity scores computed previously to account for sample selection bias

Surveys, which rely on a 5-year recall period, than in the MICS, based on a 2-year recall period. Finally, our data do not allow us to quantify the potential inability to perform a cesarean section due to a lack of resources in the public sector. However, previous studies of the Algerian health system did not highlight shortages of health professionals or

equipment for maternal health in the public sector (Zehnati, 2014). Therefore, we do not expect this phenomenon, if any, to influence the results.

The hypertrophy of the private medical sector is an essential characteristic of the Algerian health system. The private sector is very much present in large urban areas as well as in the underserved regions. However, its role remains limited in the economically less developed regions such as the western highlands and the south, where the public sector dominates. Our results support the hypothesis that cesarean sections taking place at the private facilities are rather driven by non-medical factors. The absence of appropriate regulations, the overloaded public facilities and the dual practice of public sector physicians all contribute to such medically-unjustified practices. Clearly, existing guidelines for cesarean sections, though necessary, remains insufficient to limit such practices, particularly in the context of the rapidly growing private medical sector, the inadequate supply in the public sector and the high fertility rates. Appropriate legislations that reinforce the public–private complementarity and the surveillance of private medical practices are required in order to improve maternal and neonatal care delivery in Algeria.

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