PhD Dissertation

Empirical Studies in Health Economics

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Abstract

Notwithstanding the relevant role played by the healthcare sector and the significant amount of resources absorbed, there is an intense discussion over the optimal way of financing and managing it. In my dissertation I examine three possible factors that may interfere with the proper functioning of the health system, reducing its efficiency. The aim is to provide empirical results and policy-oriented recommendations, which may foster the understanding of the mechanisms behind such a strategic sector. In the first two chapters, I study possible drivers other than medical conditions that may affect the physician's decision between alternative treatments. First, I evaluate the role of financial incentives given to physicians, estimating the effect of a fee equalization policy which operates on the DRG reimbursement assigned to delivery events. Second, I discuss whether the demand side (*i.e.,* patients' side) enter the decision process when alternative treatments are considered. More precisely, I investigate potential mechanisms of information transmission among patients in explaining territorial variations in the use of cesarean sections. The third chapter is devoted to the analysis of the local supply of healthcare workers, since the availability of qualified personnel is a key element in the provision of quality health services. All in all, in accordance with the literature, I found that financial incentives are a source of inefficiency, even if they do not play the lion share in explaining the use of unnecessary treatments. The demand side, largely unexplored, seems to have a high potential of entering and affecting the decision process, amplifying inefficiencies. Lastly, the geographic distribution of professionals is proved to be sensible to policies changing recruitment and financing rules, with more disadvantaged locations in terms of availability of professionals reporting lower public health outcomes.

1 Introduction

Notwithstanding the relevant role played by the healthcare sector and the significant amount of resources absorbed, there is an intense discussion over the optimal way of financing and managing it. The data reported by Eurostat in 2020 show that the EU spends on average the 10% of national GDP in the healthcare sector, with wide differences between Member States (*e.g.,* from 11.3% of Germany and France, to 5.2% of Romania. Italy is placed a bit lower than the EU average, spending approximately 8.8%). Moreover, the current pandemic has highlighted the strategic role played by the sector, with different responses having a huge impact on everyday life. One of the central issues is perfectly described by Rosenbaum (2017) and consists in defining what is the *appropriate* level of care we want and how to reach it. On the one hand, those who sustain the "Less-is-More" campaign affirm that most of healthcare expenditure goes into unnecessary care, which is wasteful for the community and potentially harmful for the patients. They strongly ask for a reduction in healthcare spending to cut unnecessary care, implicitly considering financial incentives as the exclusive driver of inefficiencies. On the other hand, scholars claim that looking only at economic resources we are oversimplifying the problem, not considering many other drivers (*e.g.,* professional expertise, availability of technology and infrastructure, demand side preferences).

In my dissertation I examine three possible factors that may interfere with the proper functioning of the health system, reducing its efficiency. The aim is to provide empirical results and policy-oriented recommendations, which may foster the understanding of the mechanisms behind such a strategic sector.

In the first two chapters, I study possible drivers other than medical conditions that may affect the physician' decision between alternative treatments. In both papers, the empirical analysis focuses on the specific case of deliveries, using hospital discharge data collected by the Italian Ministry of Health. Deliveries are indeed a particularly suitable setting. They are among the most common hospital events occurring worldwide, there is a clear alternative between two treatments (*i.e.,* vaginal delivery or cesarean section), and they are both effective even if specific guidelines specify which is the appropriate option according to the medical conditions of the mother and the child (WHO (2015)). In the first place, I evaluate the physicians' response to a variation in financial incentives, while for the second case I estimate the role of demand side information sharing in affecting the decision.

The first chapter considers the case study of a policy introduced in Lombardy in 2005, which operates on the DRG reimbursements given to alternative delivery methods. The policy operates on the financial incentives given to professionals by equalizing the level of reimbursement between the two treatments. Applying a difference-in-differences estimation over the control region of Veneto, we estimate a 2.6% reduction in cesarean sections due to policy implementation. We verify the effectiveness of fee equalization policies in reducing unnecessary treatments, since we observe more low-risk mothers delivering naturally and no significant changes in the incidence of complications for vaginal deliveries. Still, the magnitude of the effect highlights the marginal role of financial incentives in driving c-section overuse. The heterogeneity analysis enriches the discussion of the results, observing, among others, larger reductions in cesarean sections in lower quality and more capacity-constrained hospitals.

The second chapter discusses the role played by the demand side (*i.e.,* patients' side) in the decision between alternative treatments. More precisely, we investigate potential mechanisms of information transmission among patients when explaining territorial variations in the use of cesarean sections. The analysis grounds on the assumption that patients are affected by information sharing at the local level and that they can enter to some extent the medical decision process. Using proxies of information sharing at the municipality level (*e.g.,* incidence of cesarean sections in the 12 months before the delivery date in the future mother's municipality of residence), we estimate a significant effect on the probability that the individual mother undergoes a c-section. The results are verified when Italian and foreign mothers are studied separately, considering information sharing more probable within own-group. Both groups adjust for the transmission of complementary information, as the incidence of complications due to cesarean sections.

The third chapter is devoted to the analysis of the local supply of healthcare workers, since the availability of qualified personnel is a key element in the provision of quality health services. I evaluate whether restriction imposed on the recruitment and financing of the healthcare sector by a specific policy (*i.e.,* Italian Budget Law 2010) affect the local supply of professionals, estimating its secondary effects on public health and access to care. Additionally, I propose a descriptive discussion over the changes in individual characteristics of physicians who decide to migrate, comparing before and after policy movements to Switzerland. I do find that a higher policy intensity translates into a lower local supply of healthcare workers. The decrease is particularly strong in the public sector and among the professional category of physicians. Geographical areas which experienced stronger reductions in the number of public-sector physicians show significantly worst public health outcomes (*e.g.,* increase in the overall death rate, particularly among females). After policy, I observe a change in the characteristics of professionals who decide to migrate: they appear to be younger and more talented, probably looking for better career perspectives abroad.

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Fee Equalization and Appropriate Health Care*

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Abstract

Fee equalization in health care brings under a unique tariff several medical treatments, coded under different Diagnosis Related Groups (DRGs). The aim is to improve healthcare quality and efficiency by discouraging unnecessary, but better-paid, treatments. We evaluate its effectiveness on childbirth procedures to reduce overuse of c-sections by equalizing the DRGs for vaginal and cesarean deliveries. Using data from Italy and a difference-in-differences approach, we show that setting an equal fee decreased c-sections by 2.6%. This improved the appropriateness of medical decisions, with more low-risk mothers delivering naturally and no significant changes in the incidence of complications for vaginal deliveries. Our analysis supports the effectiveness of fee equalization in avoiding c-sections, but highlights the marginal role of financial incentives in driving c-section overuse. The observed drop was only temporary and in about a year the use of c-sections went back to the initial level. We found a greater reduction in lower quality, more capacity-constrained hospitals. Moreover, the effect is driven by districts where the availability of Ob-Gyn specialists is higher and where women are predominant in the gender composition of Ob-Gyn specialists.

JEL Classification: K13; K32; I13
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1 Introduction

The economic driver is considered one of the main causes of distortions in the provision of appropriate health care: over-prescription of medical treatments would be due to financial incentives represented by differences in reimbursement levels between equally effective alternatives. Given the agency role played by physicians in a patient-physician relation, the underlying assumption is that, at the margin, when weighting costs and benefits of a medical treatment on a (hypothetically) purely medical basis, the better paid treatment (or drug) is chosen. It seems obvious that once the economic driver is removed, we should witness a decrease in such treatments: the greater the gap between payments before equalization, the higher the expected benefits in terms of appropriateness. This intuition is the rationale for proposing fee equalization across treatments that target the same disease or condition (OECD, 2016). Yet, though theoretical expectations are clear, empirical evaluations of these policies are rarely available.

We analyze the introduction of a fee equalization policy between vaginal deliveries and cesarean sections. The high c-section rates observed in many countries are often mentioned as a clear example of treatment overuse: while the World Health Organization defines a 15% incidence as acceptable (WHO, 2015), the actual rates have surpassed both this figure and what is generally suggested by obstetric indications. Different c-section rates across health care systems have often been attributed to economic incentives given to health care practitioners.[1] Generally, c-sections are paid better than vaginal deliveries and the difference in prices has often been used to explain the magnitude of the incidence of c-sections. The seminal work by Gruber and Owings (1996) shows that worse financial outcomes for US obstetricians caused by a decline in fertility in the 1970s led to a 16% higher c-section rate during the 1970-1982 period. Gruber et al. (1999) study the effects of price differentials between vaginal and cesarean reimbursements on the Medicaid population, concluding that each $100 increase in the absolute differential produces a 4% increase in c-section rates. Similarly, Johnson and Rehavi (2016) exploit the price differential between c-sections performed in insurance-owned hospitals and non-insurance-owned hospitals to show that women delivering in insurance-owned hospitals are 5 percentage points less likely to undergo a c-section. Foo et al. (2017) also provide evidence of the effect that price differentials have on treatment decisions, regardless

[1] The economic incentive argument also works in association with other explanations. First, doctors who are inexperience and who may have inadequate skills produce a mismatch between patient needs and the chosen delivery method. Hence, women who need a c-section may not receive it, while women whose medical conditions call for a c-section may deliver naturally (Currie and MacLeod, 2017). Second, the fear of litigation can induce doctors to perform unnecessary c-sections. As a reaction to the pressure of being involved in a malpractice lawsuit (even if unsuccessful), doctors may perform a c-section to protect themselves rather than patients (Currie and MacLeod, 2008; Shurtz, 2014; Bertoli and Grembi, 2018).

of the identity of the receiver of the payment. They indeed find that a one standard deviation higher physician price differential ($420) causes a 12% increase in the odds ratio for c-sections, while the same increase ($5,805) in the hospital price differential leads to a 31% higher odds ratio.

We focus on the fee equalization implemented in 2005 in Lombardy, a northern Italian region with a population of approximately 10 million inhabitants. This case study has three main strengths that reinforce the external validity of our results. First, we do not focus on a specific type of patient (*i.e.*, Medicaid patients or patients insured under a specific company) but address standard prices (DRGs) applied to all patients who undergo in a treatment (*i.e.*, pregnant women). Second, our reference policy consists of an increase in the price for vaginal deliveries (*i.e.*, 70 euros equal to +4.2% price increase), rather than a decrease in the price for c-sections. Third, the reference policy targets hospitals operating in a public health care system with salaried physicians, rather than directly affecting the fees paid to individual physicians as in previous studies on fee equalization. This allows us to address the role of hospitals in directing physicians' choices.

Using patient level data for 2002-2008 and the neighboring region of Veneto as a control group, we apply a difference-in-differences approach and show that in the absence of a price difference between vaginal deliveries and cesarean sections, the latter decrease by 2.6% at the mean of c-section. This effect is totally driven by a reduction in c-sections without complications (-2.6%) and is a short run effect, as shown by an event study approach. We take a further step to investigate the distribution of the reduction. While an average decrease in c-sections, in the context of c-section overuse, is welcome, a more insightful approach should consider whether the reduction is achieved on low-risk rather than high-risk mothers: when needed, a c-section can improve the health of both the mother and the newborn (Card et al., 2019; Jensen and Wüst, 2015). Defining classes of medical risk based on observable clinical conditions, we estimate a reduction of 2.5% on low-risk mothers, which does not translate into an increase in complications during vaginal deliveries. These results appear to be consistent with the findings produced by Kozhimannil et al. (2018) for the 2009 Minnesota's Medicaid Program (-3.24% c-sections), by OECD (2016) for the the case of maternity care in England in 2013 (less than a -2%), and by Keeler and Fok (1996) for the Calfornia Blues Cross reform in the 1990s (-0.7%). However, in these three cases, the fee equalization was obtained by simultaneously lowering the price for c-sections and increasing the price for vaginal deliveries, which makes it more difficult to disentangle the role of the financial incentives through the usual channels of income and substitution effects. Lo (2008) is the only work studying the effect of raising the fee for a vaginal delivery up to the level of a c-section. It analyzes a policy introduced in Taiwan in 2005 but without finding any significant effect on c-section rate during the months following the equalization.

We show that our results could not be explained by possible unintended effects of the policy as the selection of patients according to the severity of their condition (*i.e.*, cream skimming), mismatch between actual and reported health status (*i.e.*, upcoding), a shift of Lombardy mothers seeking a c-section to neighboring regions (*i.e.*, patient sorting), or a change in the underlying quality of vaginal deliveries (*i.e.*, use of epidurals). Finally, we exploit the characteristics of hospitals and physicians to provide an analysis of the factors channeling the reaction to the reform, improving the understanding of which characteristics make hospitals more or less responsive to price differentials. We estimate that the reduction in c-sections is stronger in hospitals facing greater capacity constraints (*e.g.*, limits to longer hospitalizations). Moreover, c-sections decrease more in low-quality hospitals; that is, in hospitals where medical decisions are more likely to be affected by factors other than patient medical needs. Patient socio-economic status does not matter, but physician characteristics are relevant. We observe stronger effects in districts with a greater availability of Ob-Gyn specialists which are consistent with the general expectation that knowledge spillovers and larger reputation concers are more likely in more concentrated contexts Molitor (2018). The reduction is also driven by districts where there is a higher incidence of female Ob-Gyn specialists. The gender of the physician may indeed determine a different response to incentives or perception of patients' needs. As a placebo, we replicate the analysis with these two dimensions over several other specialty-groups (*e.g.*, Psychiatry), showing no significant estimates.

To appreciate the full implications of fee equalization for delivery methods, note that, because the average pre-policy incidence of c-sections was 28% in Lombardy, this response can explain only a small fraction of c-section overuse. This means that the economic driver does not play the lion share of inappropriate health care, at least as far as c-sections are concerned and with respect to the Italian case. Although the estimated effects are difficult to monetize, we perform some back-of-the-envelop calculations to understand the approximate cost of this intervention. Considering that each of the 278,472 natural deliveries without complications occurring in the post-policy period received an extra 70 euros in payment and that the 126,025 c-sections without complications would have been 2.6% higher in number in the absence of the policy, Lombardy paid an extra cost of 19,493,040 euros to avert 3,364 c-sections. This means that each c-section avoided cost an extra 5,795 euros. To have the complete picture, one must also quantify the costs and benefits associated with the health outcomes of the patients. Since we cannot observe the medium and long-run effects of avoiding a c-section (*e.g.*, improved immune system and lower respiratory morbidity for infants and lower risks of hysterectomy or abnormal placentation for women), we cannot perform a proper cost-benefit analysis of the policy. Nevertheless, these figures provide some initial evidence to reason about the opportunity of this type of intervention.

Our work also contributes to the general literature on the role of financial incentives on the supply of health care, which usually identifies the economic motivation as the main driver in treatment selection, especially in the substitution between more and less intensive treatments. For example, exploiting the price shocks caused by the 1997 geographical consolidation of Medicare payment regions, Clemens and Gottlieb (2014) show that a 2% increase in payments is associated with a 3% increase in the supply of care, and that this reaction is much stronger among relatively elective, but intensive, treatments. In the context of obstetric practices, Ho and Pakes (2014) find that insurers allocate patients across hospitals in their network based on the prices paid to the hospitals and this effect is stronger when insurers are more highly captitated.

The remainder of the paper is organized as follows. Section 2 provides an overview of the institutional setting and the existing evidence of economic incentives in the Italian health care system. Section 3 explain the equalizing policy of Lombardy and its expected effect. Section 4 describes the control area and the data and defines the outcomes of interest. Section 5 presents both our identification strategy and the results, while Section 6 describes the validity and robustness checks. Analysis of the elements affecting the degree of responsiveness of hospitals to the monetary driver is presented in Section 7 and Section 8 concludes.

2 Institutional Setting

Italian health care services are managed at the local level, with regions (*i.e.*, 21 independent authorities) in charge of the provision of medical care to their resident population. Although bounded to national standards set by the central government, regions enjoy wide discretion to regulate and organize health care delivery within their borders (Ferré et al., 2014). This has resulted in the creation of public hospital networks based on different combinations of hospitals managed by local health authorities (LHAs), independent hospitals (*e.g.*, teaching hospitals) and private accredited institutions (Anessi-Pessina et al., 2004).

Each region is organized into LHAs, which administer the health plan to the residents in their catchment area. Patients are assigned to a hospital based on their municipality of residence (*i.e.*, their home hospital) but they can freely choose the hospital where to be treated, leading to both intra- and inter-regional mobility. However, out-of-region flows are quite limited with respect to childbirth, as Italian mothers, on average, travel approximately 10.6 miles (*i.e.*, 17 km) to deliver their babies and often prefer their home hospital (Amaral Garcia et al., 2015).

Since 1995, the financing of all hospitals operating within the Italian NHS has worked through a DRG-based system, which is enforced for every patient (Cavalieri et al., 2013).[2] The national government releases and updates a list of tariffs that serves as a benchmark and regions are free to decide their own rates (Bertoli and Grembi, 2017a).

2.1 Existing Evidence on the Role of Financial Incentives in the Italian Case

The role of financial incentives in shaping hospital behavior in a quite diversified public health care system as the Italian one has attracted the attention of several scholars. A strand of the empirical work looks at impact of institutional elements at the regional level on the use of inappropriate care proxied by unnecessary c-sections. Francese et al. (2014), for example, focus on the role of supply factors and pricing policies (*e.g.*, the existence of regional DRG tariffs as oppose to national tariffs), and on the role of political economy variables (*e.g.*, the years of experience of the regional governor and the alignment between regional and central governments), while accounting for the riskiness of birth through maternal demographic characteristics and education. Based on a regional fixed effects model, the authors show that the implementation of regional DRG tariffs negatively affects inappropriate c-sections which decrease also when regional governments can rely more on their own resources as this makes them more accountable to their voters. On a similar path, De Luca et al. (2019) investigate the impact of institutional quality, as proxied by the Institutional Quality Index, on the performance of c-sections on first-time mothers. Their IV strategy shows that one standard deviation increase in institutional quality makes c-section rates drop by 10 percentage points.

Another strand of the literature has investigated the role of DRG prices and DRG price differentials between vaginal and caesarean deliveries in driving the excessive use of c-sections by hospital type. Cavalieri et al. (2014) provide evidence on the greater responsiveness of private hospitals that regardless of the fact of being profit or non-profit report a stronger reaction to price differentials compared to public hospitals. However, the authors do not observe any statistically different behavior among public hospitals. Hence, hospitals enjoying different degrees of financial and administrative autonomy are not differently affected by changes in price differentials. The same conclusion is also suggested by Verzulli et al. (2016) with respect to changes in the actual level of DRG

[2] DRGs are a common mechanism used to group procedures by similar medical conditions and resource utilization to express hospital activity in standardized units comparable across providers. Based on cost data usually related to a set of chosen hospitals, a fixed (average) rate is assigned to each DRG. The rate should cover the average expenses incurred in treating patients within each DRG. Therefore, DRG tariffs are not connected to the actual costs sustained for a given case by a specific hospital.

tariffs. Using hospital panel data from the region of Emilia-Romagna, the authors show that public hospitals react only to variations in the DRG tariffs for surgical procedures, but the magnitude of this response does not vary by hospital type, that is, between public independent hospitals and LHA-run hospitals. By contrast, Di Giacomo et al. (2017) do not observe any effect of an increase in DRG prices on the c-section rates of public hospitals in Piedmont, while they do detect more frequent upcoding practices. However, the lack of an effect on c-sections could be explained by the fact that the price differential did not change as tariffs for both vaginal and cesarean deliveries were increased by the same proportion.

The relationship between hospital ownership and responsiveness to DRG tariffs is also the focus of Berta et al. (2020), which is the study most closely related to ours. The authors compare how profit and non-profit private hospitals and public independent hospitals (*i.e.*, hospital trusts) behave with respect to the equalized fees for vaginal and cesarean deliveries in Lombardy. The results suggest that private and public hospitals do not display a different behavior except when operating in low competitive environments. When hospitals enjoy market power, private for-profit hospitals tend to prefer the more remunerative vaginal deliveries over c-sections more frequently than private non-profit and public independent hospitals do. However, this work does not provide causal evidence for these findings and it is based on a period that follows the policy we assess. Moreover, the related data cover a more recent time span when the portion of deliveries occurring in private facilities is two-time larger than the one observed during our period of observation.[3]

3 The Fee Equalization Policy

3.1 The Policy Adopted in Lombardy

To address the overuse of c-sections, Lombardy implemented a payment reform in 2005 that equalized the DRG tariff for vaginal and cesarean deliveries for all its hospitals. The price equalization was obtained by increasing the DRG tariff for a vaginal delivery to match that of a c-section. This change in price implied an increase in payment for a vaginal delivery by 4.2% (*i.e.*, 70 euros).

The unusual choice of achieving equalization by increasing the tariff for vaginal deliveries is consistent with the will to make vaginal deliveries more economically attrac-

[3]Rather then on competitive dynamics, Guccio and Lisi (2016) look at the impact on c-section rates of peer effects among hospitals subject to the same regional audit system run at the LHA level. Based on a classical peer effect analysis and also a spatial econometric analysis, peer effects turn out to play a relevant role in driving the use of c-sections. For instance, a one-percentage-point increase in the c-section rates of peers would raise hospitals' c-section rates by about 0.7 percentage points.

tive without further penalizing c-sections reimbursement (Regione Lombardia, 2010). In 2004, Lombardy was already applying a 20% marked down on the c-section tariff compared to what suggested by the national DRG listing (*i.e.*, 1,924 euro against 2,397 euro). Since DRG tariffs are standard prices, a further reduction could have triggered the unintended consequence of preventing the use of c-sections even when patient medical conditions would call for it. The rationale of the equalizing policy was not to discourage c-sections per se, but rather to decrease inappropriate c-sections, that is, to ensure a better match between the medical conditions of patients and the delivery method. When not medically justified, c-sections entail a waste of resources and the exposure of patients to higher adverse health outcomes than natural deliveries (Shearer (1993)). Several studies support negative long-term effects of cesarean delivery for both mothers and newborns. For example, with respect to unnecessary c-sections, Costa-Ramón et al. (2018) show that they cause a significant worsening of neonatal health, decreasing the APGAR score by almost one point in very healthy babies, on average.[4] C-sections have been associated also with childhood asthma (Sevelsted et al., 2016; Hyde et al., 2012) and neurological problems (Oreopoulos et al., 2008). As for maternal health, these procedures may lead to post-partum maternal health problems, including urinary and gastrointestinal dysfunctions, dyspareunia, difficulties breastfeeding, psychological health challenges, intensified exhaustion, lack of sleep, and bowel problems (Thompson et al., 2002; Gilliam, 2006; Tonei, 2019).

3.2 Expected Effects

Fee equalization looks like an effective policy answer to the potential distortions in the use of c-sections caused by price differentials (MACPAC, 2019). According to the standard model of supply induced demand by McGuire and Pauly (1991), physicians gain utility from income and leisure, whereas performing unnecessary treatments causes them disutility due to ethical or reputational concerns. This rationale implies that when the marginal benefits of a treatment exceed its marginal costs, physicians take advantage of their agency relation with patients to increase the use of the treatment. The extensions of this model to childbirth (Keeler and Fok, 1996; Gruber and Owings, 1996; Gruber et al., 1999; Fabbri and Monfardini, 2001; Johnson and Rehavi, 2016) assume that the profit rate between cesarean and vaginal deliveries is always positive: c-sections are paid more without requiring greater physician input since they can be scheduled, they take less time, and the cost of their greater complexity does not overcome the benefit of their

[4]The Apgar score measures neonatal health as tested one and five minutes after birth. This index goes from 1 to 10, where 10 indicates perfect health. Five factors are evaluated to determine the Apgar score: skin color, pulse rate, reflex, activity and respiratory effort. A score of 7 and above is considered normal, 4 to 6 fairly low, and 3 or less is regarded as critically low.

shorter duration. As a result, a negative shock in the profit rate due to a decrease in the price of a c-section triggers two offsetting effects: physicians perform fewer c-sections as they became less profitable (*i.e.*, substitution effect), while the decreased income of physicians makes performing c-sections more desirable to make up the lost earnings (*i.e.*, income effect) Gruber et al. (1999).

To model hospital behavior, we follow the theoretical formulation of the physician intensity decision developed by Gruber et al. (1999) who built up on the physician's utility function modelled in McGuire and Pauly (1991).[5] In our institutional setting, hospitals/departments are the level of analysis comparable to that of the single physician in the US who consider the fees directly paid to her for her own work. In fact, in Italy, physicians are employed by a single hospital, are salaried, and work a fix amount of hours[6]. The entity receiving the delivery tariff coincides with the hospital who has proven to be well able to convey its priorities to its employees inlcuding doctors (Dafny, 2005; Fenn et al., 2007, 2013; Amaral Garcia et al., 2015). Then, hospital physicians have incentives to perform more generously paid procedures because hospital funds are dependent on DRGs and departments with inadequate funds may be downscaled and/or shutted down. The same holds for hospital managers who may also be interested in building financial surpluses to expand hospital capacity (Januleviciute et al., 2016) or may be downgraded or replaced in case of budget overruns.

Adopting the hospital perspective does not imply that physicians are no longer responsive to economic incentives, but rather questions the traditional assumption that the profit rate always breaks in favor of c-sections. Without knowing the actual costs of each procedure, the mere fact that the DRG price for c-sections exceeds the price for vaginal deliveries may no longer be sufficient to conclude that the profit rate between cesarean and vaginal deliveries is positive in the first place. The DRG price is not meant to cover only the work of the doctor, as in the models with physician fees. The price must also fund the fixed costs (*e.g.*, equipments for the operating room) and the costs for additional inputs required (*e.g.*, materials –medications–, personnel –nurses and anesthetists–). Although the c-section price remains higher than the vaginal delivery price after the change, the hospital's net earnings for a c-section may be lower than those for a natural delivery.

In our case, Lombardy's policy achieves fee equalization by increasing the reimbursement for natural deliveries without changing the reimbursement for c-sections. As a consequence, under the new payment scheme, the income and the substitution effects

[5] These models have been already used to model the dynamics in public health care system as in Salm and Wubker (2019); Guccio and Lisi (2016); Fabbri and Monfardini (2001); Gilman (2000).

[6] The standard physician's contract in a public hospital requires 38 hours of work per week, organized over shifts to meet the needs of the ward.

modelled by Gruber et al. (1999) work along together: natural deliveries become relatively more lucrative, thus, hospital physicians have the incentive to increase them (*i.e.*, income effect) preferring them to c-sections (*i.e.*, substitution effect). Hence, the reference policy provides a useful setting to study the role of economic incentives in driving medical decisions as both possible theoretical effects move in the same direction, that is, towards an increase in vaginal deliveries. However, the magnitude of any increase is an empirical question. In fact, although monetary incentives should no longer favor cesarean deliveries, these procedures still entail advantages in terms of shorter duration and scheduling possibilities. Understanding the relevance of these potential channels has important policy implications.

The second strong assumption of the models is that patients must be homogeneous, so that performing a c-section is orthogonal to the patient type. In other words, reducing c-sections is good on average, and increasing c-sections is bad on average. Yet, from a policy perspective, the main goal is to achieve a reduction in c-sections for low-risk mothers (*i.e.,* women whose clinical condition does not require a c-section). In fact, as suggested by Currie and MacLeod (2017), better decision making by physicians (*i.e.*, less subject to non-medical incentives) should result in a reallocation of procedures from low-risk to high-risk patients. To the best of our knowledge, Fabbri and Monfardini (2001) provides the only theoretical framework that builds upon the work of McGuire and Pauly (1991), Gruber et al. (1999) to account for the maternal risk profile in our same setting. The basic intuition is that, other things being equal, the disutility of a c-section increases the less risky a patient is: for instance, the ethical and reputational concerns become greater. As the monetary advantage of c-sections over vaginal deliveries decreases, the marginal benefits of a c-section are less likely to offset the marginal costs the less risky a patient is. Therefore, one would expect to observe a reduction in c-sections for low-risk mothers and no effect for high-risk mothers.

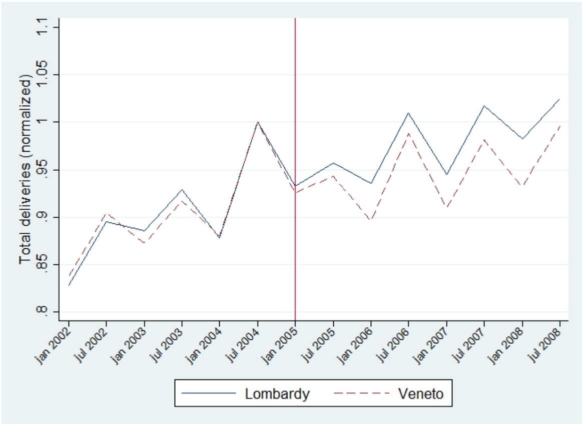
4 Comparison Group, Data, and Outcomes

4.1 Veneto as Control Region

To evaluate the impact of Lombardy's policy, we use Lombardy hospitals as the treated group and those of the neighboring region of Veneto as the control group. To defend this choice, in the light of a highly heterogenous and regionalized health care system, we first look to the comparability of mothers in the two regions. Then, we analyze as institutional differences in healthcare systems could affect the interpretation of our estimates.

As far as the average incidence of c-sections is concerned, Veneto and Lombardy are quite similar.[7] Their share of c-sections is consistently below the national average; for instance, in 2004, 36.4% of childbirths in Italy occurred through a c-section (Ministero della Salute, 2004), while the statistics for both Veneto and Lombardy were 27.2% and 26.5%. Indeed they are not only comparable for the average incidence of c-section. As apparent from Figure 1, they have also analogous trends in terms of deliveries during our observational period.

Figure 1: Delivery Trends by Region

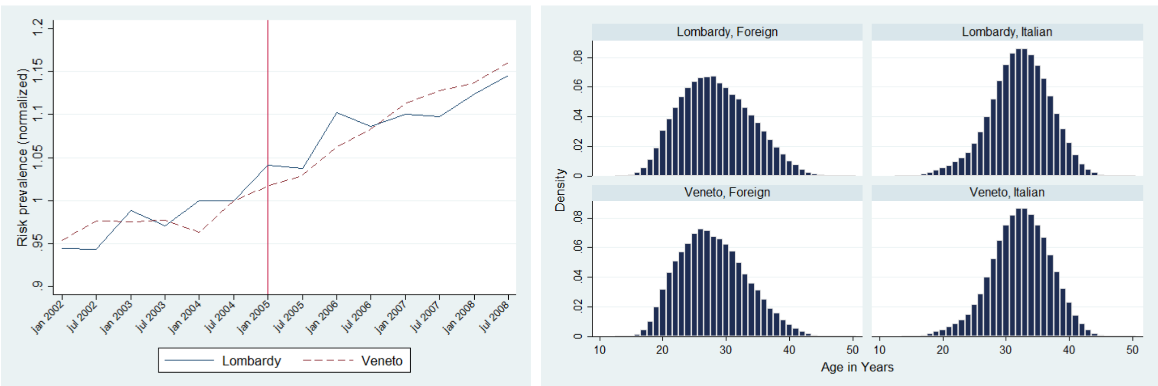


Notes: The figure shows the trends in deliveries for the two regions, Veneto and Lombardy, normalized with respect to the last semester before policy implementation (2nd semester 2004). The Figure describes the evolution in the total number of deliveries registered in a hospital of the relevant region.

Figure 2: Trends in Maternal Risk Prevalence and Age Distribution by Region

(a) Risk prevalence

(b) Age distribution



Notes: Figure (a) shows of the risk prevalence in the two regions; that is, the trend in the share of mothers suffering from at least one medical condition that would call for the performance of a c-section. Figure (b) shows mothers' age distribution at the time of delivery by region of residence and citizenship. The average age is 28 for foreign women and 32 for Italian mothers, both in Lombardy and Veneto.

The population of pregnant women in Lombardy is highly comparable to that in Veneto. As shown in Figure 2 (panel (a)), future mothers have a similar evolution in

[7]Veneto and Lombardy are quite similar also in terms of the performance of their regional health care systems being commonly ranked among the top 4 performers for health care (CREA sanitá, 2018).

the medical risk profiles, proxied by the risk prevalence.[8] Moreover, pregnant women also show an analogous socio-economic profile. Figure 2 (panel (b)) shows that the age distributions are homogeneous between the two regions, even distinguishing by citizenship. In addition, we formally test the balance in the relevant maternal and fetus conditions, and in the characteristics of the delivery and labor which may affect the performance of a c-section. Table 1 shows that there are basically no statistically significant differences between the two regions excepting only statistics on married mothers and those suffering from thyroid problems.

Table 1: Balance of the Observables

	Treated: Lombardy		Control: Veneto				
	Mean	Std. Dev.	Mean	Std. Dev.	Diff.	T-test	p-value
Women's basic characteristics							
Age	31.531	4.984	31.536	5.008	-0.007	-0.302	0.763
Italian	0.838	0.369	0.838	0.368	-0.001	-0.525	0.599
Married	0.573	0.494	0.763	0.424	-0.190	-88.570	0.000
Delivery/labor characteristics							
Previous c-section	0.103	0.303	0.103	0.304	-0.000	-0.223	0.824
Multiple delivery	0.016	0.124	0.015	0.121	0.001	1.257	0.209
Ante-partum hemorrhage	0.001	0.028	0.001	0.030	-0.000	-0.922	0.357
Labor problems	0.008	0.090	0.009	0.092	-0.000	-0.934	0.350
Women's medical conditions							
Obesity	0.000	0.015	0.000	0.016	-0.000	-0.299	0.765
Sexually transmitted diseases	0.000	0.013	0.000	0.015	-0.000	-1.114	0.265
Hypertension	0.000	0.013	0.000	0.011	0.000	0.728	0.467
Thyroid problem	0.001	0.033	0.002	0.050	-0.001	-6.526	0.000
Main complications	0.030	0.170	0.030	0.172	-0.000	-0.479	0.632
Reproductive system problems	0.236	0.425	0.237	0.425	-0.001	-0.257	0.797
Other problems	0.006	0.078	0.006	0.076	0.000	0.934	0.350
Fetus conditions							
Immaturity or pre-term	0.000	0.016	0.000	0.017	-0.000	-0.608	0.544
Fetus problems	0.005	0.069	0.005	0.070	-0.000	-0.647	0.517

Notes: *Fetus problems* include fetus abnormality and rhesus isoimmunization related to the fetus. *Labor problems* refer to precipitous labor or prolonged labor/pregnancy. *Main complications* controls for placenta previa, cordon problems and eclampsia. *Reproductive system problems* refers to cervix anomalies and pelvic abnormalities. *Other problems* include diabetes, renal failure, addiction to drugs and cardiovascular problems.

Although Lombardy and Veneto are two perfectly comparable settings when it comes to the future mothers' characteristics, institutional differences remains. Lombardy is the only example in Italy of a purchaser-provide split model with its LHAs buying health care services from public independent and private accredited hospitals (Brenna, 2011). Differently, in Veneto, LHAs are simultaneously providers of health care services through

[8] The risk prevalence is defined as the evolution of the number of mothers suffering from at least one risk factor that may justify a cesarean intervention. The risk factors considered are anemia, hypertension, cardiovascular diseases, diabetes, sexually transmitted diseases, obesity, thyroid disfunction, drug addiction, eclampsia, cervix anomalies, previous c-section, immaturity or pre-term, prolonged pregnancy, renal failure, pelvic abnormality, precipitous labor, breech presentation, multiple delivery, antepartum hemorragia, abnormality in fetus heart rate, fetus rhesus isoimmunization, amniotic cavity problems, placenta previa, and fetus abnormality.

their own-managed hospitals and purchasers of health care services from public independent and private accredited hospitals or hospitals run by other LHAs (Jommi et al., 2001). Private providers are traditionally expected to respond to economic incentives the most, followed in order by public independent hospitals and LHA-managed hospitals. Even if the different nature of providers could affect how they react to economic incentives in the two regions, the inclusion of hospitals fixed effects in our empirical model takes care of these time invariant differences. In other words, the different institutional settings do not threat our identification: they only make us aware that the effects we find are extensible to settings similar to Lombardy, while they might not necessarily work in the same way in public healthcare system where agents might be less sensitive to the economic incentives. In addition, the concerns related to the incomparability of hospitals in the two regions should be considered minor for at least two reasons. First, the private sector plays a marginal role with respect to childbirth in both Lombardy and Veneto. Second, the existing evidence does not support the existence of a different response to economic incentives depending on the type of public hospital Verzulli et al. (2016); Cavalieri et al. (2014). This is consistent with the application, in both Lombardy and Veneto, of strict planning and financial requirements on public hospitals which all end up to be accountable to regional governments and face comparable adverse consequences in case of budget overruns (for a detailed description of these features of the two regional health care systems, see Appendix B).

Finally, in both regions, the reimbursement of public and private accredited hospitals is DRG-based. In this way, even in the single producer and buyer (LHA-centered) model of Veneto, the reimbursement system is strongly committed to the application of DRG tariffs as in Lombardy and it did not change when Lombardy implemented fee equalization. Since we are adopting a difference-in-differences identification strategy, we are assuming that Veneto is absorbing the time trend in the incidence of c-sections, absent the policy. In the empirical part, we prove this point showing the results for an event study analysis, which confirms the appropriateness of Veneto as a comparison group.

4.2 Data

Our analysis relies on patient-level data taken from hospital discharge records (*SDO – Schede di dimmissione ospedaliera*) provided by the Italian Ministry of Health and referring to all childbirth events that occurred in public or private accredited hospitals in Veneto and Lombardy between 2002 and 2008.[9] Since our focus is on the effect of the

[9]We do not extend the observation period beyond 2008 to avoid the possible noise caused by the great recession that may have influenced the fertility choices of women, as well as the provision of

equalizing policy on the overuse of unnecessary c-sections, we restrict our sample as to exclude weekend deliveries. Since c-sections are generally scheduled during workdays, c-sections performed on weekends are likely to be emergency procedures (Amaral Garcia et al. (2015) and Bertoli and Grembi (2019)).[10]

As a result, the final sample includes 716,445 observations: 490,599 for Lombardy and 225,846 for Veneto. Compared to the administrative data released by the Italian Institute of Statistics (ISTAT), our sample accounts for 30% of all childbirth events reported in the country (*i.e.*, all Italian births) between 2002 and 2008. This sample includes also deliveries performed in private hospitals, although they constitute a very small portion of our dataset being the private sector in the two regions basically non-existent when childbirth is at stake. In 2004, almost all deliveries (i.e., 99.8%) in Veneto occurred in a public (LHA-managed or public independent) hospital. Similarly, in Lombardy, the deliveries occurred in a public independent hospital accounted for 93.4% and those in a private accredited hospital for 6%, whereas only 4% took place in a purely private facility (Ministero della Salute, 2005).[11]

4.3 Outcomes of Interest

The equalizing policy targets unnecessary c-sections, thus, the decision to perform a c-section is our main outcome of interest and is defined by a dummy *C-section*, which is equal to 1 if a woman delivered by c-section and 0 otherwise. As discussed in Section 3.2, we expect an overall decrease in the use of c-sections when the price differential between vaginal and cesarean deliveries is eliminated. However, from a policy perspective, the crucial aspect is to discourage the performance of c-sections on women whose medical conditions do not require this procedure. We test this aspect in two subsequent steps.

First, we look at the effect of the policy on both vaginal and cesarean deliveries, distinguishing between appropriate and inappropriate cesarean. Second, we estimate the effect of the policy on the use of c-sections by patient type: low-, medium-, and

hospital services since 2009 (Bertoli et al., 2019).

[10] We also run all analyses on the whole universe of deliveries. Results are confirmed and available upon request.

[11] In both regions, the remaining 0.2% of deliveries occurred outside an health care facility (e.g., home deliveries). We test the robustness of our results to the exclusion of private hospitals and, as shown in Table A.6, our results are confirmed. In addition, public hospitals of both regions accept privately paying patients. Still, this is a quite rare event for childbirths since related costs are entirely covered by universal coverage. As a result, pregnant women decide to pay out-of-pocket to have a private room (the so-called regime of *differenza alberghiera*) or to have the doctor of their choice following the delivery (the so-called regime of *libera professione*). Again, in both regions, these scenarios are quite unusual to the extent that, during our period of observation, only 6% and 1% of deliveries were fully or partially paid by patients in Lombardy and Veneto, respectively. Yet, we further test our baseline findings to the exclusion of deliveries that were fully or partially paid by mothers obtaining consistent results as reported in Table A.6.

high-risk patients. This allows us to provide more detailed insights into how the policy affects the matching between patient conditions and the chosen delivery method. To identify appropriate and inappropriate c-sections and the patient type, we compute the woman's predicted probability of a c-section (PPC) using fitted values of a logit model of the probability of undergoing a c-section on a set of maternal and infant observable risk factors.[12] As a result, *Inappropriate C-section* (*Appropriate C-section*) is a dummy taking a value of 1 if a c-section was performed on a woman with a predicted probability lower (equal to or higher) than 0.6 (Currie and MacLeod (2017) and Bertoli and Grembi (2019)). Similarly, *Inappropriate Vaginal* (*Appropriate Vaginal*) is equal to 1 if a woman with predicted probability equal to or higher (lower) than 0.6 delivers naturally. As for patient type, low-risk patients are those women with a predicted probability of undergoing a c-section equal to or less than 0.4. Women with a probability between 0.4 and 0.7 are considered medium-risk patients, while high-risk patients are those with a probability equal to or higher than 0.7.

To assess the impact of the policy on maternal and neonatal morbidity, we use two composite measures that are also estimated by delivery type. *Preventable* indicates whether the patients (*i.e.*, mother and newborn) suffered any preventable delivery or post-delivery complications[13], while *Non-preventable* indicates whether patients reported a non-preventable delivery complication (including any fetus malposition, fetus or mother disproportion, complications related to the umbilical cord, premature separation of placenta or rupture of the membranes, threatened premature labor, abnormal forces during labor). Finally, we check if the policy also impacted on the hospitalization of mothers with *Length of Stay* which corresponds to the number of days spent in the hospital since the day of admission for delivery.

Table A.1 reports the descriptive statistics of our sample. On average, 31% of women delivered by c-section and 14% of these procedures can be considered inappropriate because they were performed on women with a low-risk profile. Overall, the vast majority of mothers were Italian; they were slightly older than 31 and 66% were married. C-sections registered a preventable problem in 3% of cases and a non-preventable problem in 10% of cases. Mothers delivering naturally were more likely to experience a problem that could have been anticipated (4%) than an unpredictable problem (3%).

[12] This approach is consistent with Baicker et al. (2006); Frakes (2012); Amaral Garcia et al. (2015); Bertoli and Grembi (2019). The set of maternal and infant observable risk factors used in the estimation includes the three sets of covariates listed in Table A.2.

[13] Consistent with Dubay et al. (1999), Dubay et al. (2001), Currie and MacLeod (2008), Dranove and Watanabe (2009), Dranove et al. (2011), Shurtz (2013), Shurtz (2014) and Bertoli and Grembi (2019), *Preventable* includes maternal fever, perineal laceration and infection, perineal hematomas, uterus laceration, infections, meconium, complications related to anesthesia, hemorragia, cardiac complications, embolism and retained placenta.

5 Econometric Strategy

We apply a difference-in-differences (DD) estimation to identify the effect of the equalizing policy on $Outcome_{iht}$ for mother i giving birth in hospital h at time t, where t is the quarter-year. $Post_t$ is a dummy equal to 1 for t after the first quarter of 2005, and $Treated_h$ is a dummy identifying Lombard hospitals as the treated hospitals. Hence, δ is the DD estimator that captures the effect of the policy as shown in Equation 1:

$$Outcome_{iht} = \alpha + \delta(Treated_h * Post_t) + \beta_1 X1'_{iht} + \beta_2 X2'_{hit} + \beta_3 X3'_{hit} + \gamma_t + \omega_h + \epsilon \quad (1)$$

where γ_t are quarter-year fixed effects to control for common shocks and ω_h are hospital fixed effects to account for time-invariant unobservable characteristics across hospitals. We control for a wide range of factors that could affect the likelihood of undergoing a c-section as listed in Table A.2. $X1'_{iht}$ groups the basic attributes of the mother, including her age and marital status, $X2'_{iht}$ includes the health conditions that define her risk profile, and $X3'_{iht}$ considers the characteristics of the pregnancy that may affect the choice of delivery method and the incidence of complications.

5.1 Results

Table 2 shows the results for our primary outcomes. The adoption of an equalizing policy leads to a statistically significant reduction in the performance of c-sections. The magnitude of the average effect, as reported in Column (1), is a 0.8 percentage point decrease in c-sections, which corresponds to a 2.6% reduction at the mean of the variable.[14] According to columns 2 and 3, this overall decrease in c-sections is driven by a reduction in c-sections without complications (-2.6% at the mean of the variable), while we do not observe any change in the performance of c-sections with complications.

Although these findings confirm that hospitals respond to economic incentives, they also point out two additional aspects. First, economic incentives can only marginally explain actual unnecessary c-sections. Considering that the average c-section rate in Lombardy before the adoption of the policy was 28%, the economic motivation clearly explains only a very small portion of the gap with the traditional 10-15% target set by the WHO. Eliminating the monetary advantage of c-sections over vaginal deliveries, is not sufficient to make the two procedures equally attractive conditional on patient's medical profiles. Second, economic incentives seem to affect (even if marginally) the choice of the delivery method mainly in the less severe medical cases (*i.e.*, in the absence

[14] The reduction in c-sections is robust to a logistic regression (Table A.3 in Appendix A) and to the replacement of the three sets of controls in Equation 1 with the predicted probability of receiving a c-section based on medical conditions (Table A.4 in Appendix A).

of complications).

If the equalizing policy were successful in removing the economic incentives to opt for an unnecessary c-section, we should observe an improvement in the matching between patient conditions and delivery methods. Hence, we check whether the estimated decrease in c-sections produces any change in the matching of delivery types to patient conditions. As is apparent from Table 2, the policy leads to a reallocation of treatment decisions: the overall observed reduction in c-sections is driven by a drop in inappropriate c-sections, which experience an overall 5% decrease (column 4). The decrease is not surprisingly associated with an increase in natural deliveries (+1.2%; column 7). Inappropriate vaginals and appropriate c-sections (columns 5 and 6) are not affected.

Table 2: DD - Delivery Methods

	C-sections			**Inappropriate**		**Appropriate**	
	All	Without complications	With complications	C-section	Vaginal	C-section	Vaginal
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
δ	-0.008***	-0.008***	0.013	-0.007***	-0.000	-0.001	0.008***
	(0.002)	(0.010)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)
Obs.	716,445	30,706	685,739	716,445	716,445	716,445	716,445
Mean	0.314	0.305	0.513	0.137	0.014	0.177	0.672
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Controls include $X1$, $X2$ and $X3$ as listed in Table A.2. *Inappropriate* and *Appropriate* procedures are identified based on the probability of undergoing a c-section (PPC) estimated through a logistic regression as discussed in Section 4.3. Robust standard errors in parentheses. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

These findings are consistent with the effects registered by class of medical risk (Table 3). The improvement in the procedures' appropriateness is driven by a 2.5% reduction in c-sections on low-risk women, that is, patients the least in need of a cesarean delivery given their medical conditions. This is the risk class where one can reasonably expect to observe a strong response to removal of the economic incentives. In fact, these are cases clearly not medically suitable for a c-section and for which the shift to a vaginal delivery should entail a lower risk of adverse outcomes. As a consequence of directly affecting the use and the appropriateness of delivery methods, the reference policy may impact the morbidity of the patients involved (*i.e.*, women and newborns). According to Table 4, no statistically significant effect on either preventable and non-preventable complications is observed, regardless of the delivery method. By constrast, we observe an effect on the number of days of hospitalization. If the length of stay in case of a natural delivery does not change, women undergoing a c-section show a 2.7% longer hospitalization. After the policy, low-risk women are more likely to deliver naturally; hence, these mothers, who may potentially recover faster from the delivery given their general healthy status, are removed from the pool of performed c-sections and the individual riskier situation of those remaining is reflected by the longer hospitalization.

Table 3: DD - C-sections by Risk Class

	Low Risk	**Medium Risk**			**High risk**
	ppc<=0.4	0.4<ppc<=0.5	0.5<ppc<=0.6	0.6<ppc<=0.7	ppc>0.7
	(1)	(2)	(3)	(4)	(5)
δ	-0.004**	-0.007	-0.009	0.025	0.001
	(0.002)	(0.032)	(0.324)	(0.028)	(0.003)
Obs.	569,502	5,243	4,855	6,999	129,846
Mean	0.163	0.458	0.588	0.696	0.937
Controls	Yes	Yes	Yes	Yes	Yes
Quarter-year FE	Yes	Yes	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes	Yes	Yes

Notes: Controls include $X1$, $X2$ and $X3$ as listed in Table A.2. *Low-risk*, *Medium-risk* and *High-risk* patients are identified based on the probability of undergoing a c-section (PPC) estimated through a logistic regression as discussed in Section 4.3. Robust standard errors in parentheses. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 4: DD - Secondary Outcomes

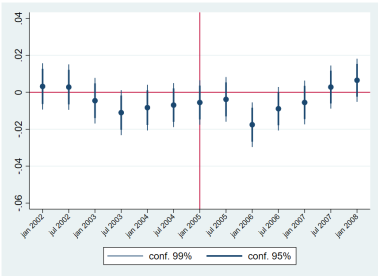
	Preventable Complications		**Non-Preventable Complications**		**Length of Stay**	
	C-section	Vaginal	C-section	Vaginal	C-section	Vaginal
	(1)	(2)	(3)	(4)	(5)	(6)
δ	0.000	0.001	-0.001	0.001	0.140***	0.002
	(0.001)	(0.001)	(0.002)	(0.001)	(0.014)	(0.005)
Obs.	716,445	716,445	716,445	716,445	214,852	429,161
Mean	0.039	0.043	0.102	0.028	5.112	3.247
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Controls include $X1$, $X2$ and $X3$ as listed in Table A.2. Robust standard errors in parentheses. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

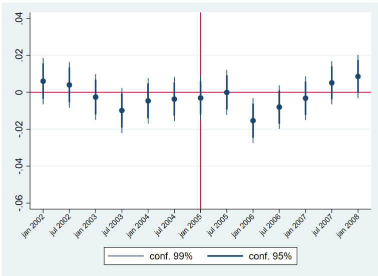
We provide a more rigorous inspection of these results within an event study framework in Figures 3 and 4. We modify Equation 1 by adding semester leads and lags and take the second half of 2008 as the reference period. The plotted estimates for c-sections show a lack of anticipatory effects and a statistically significant decrease in the second semester after the policy implementation. The same holds for inappropriate c-sections, appropriate vaginal deliveries and length of stay, while no anticipatory effects and no significant post-policy changes are observed for any of the remaining outcomes of interest. It is apparent that the main effect fades away after one year. This might be due to the fact that at the new equilibrium, once the new incentives scheme is incorporated in the decision making process of physicians, the other rationales driving the overuse of c-sections play a larger role.

Figure 3: Leads and Lags - Delivery Methods

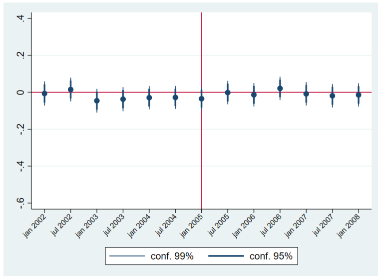
(a) C-sections



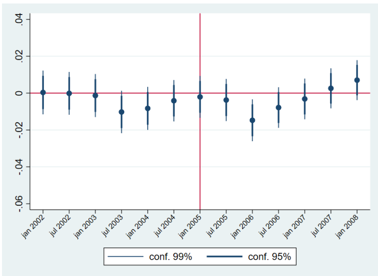
(b) C-sections w/o Complications



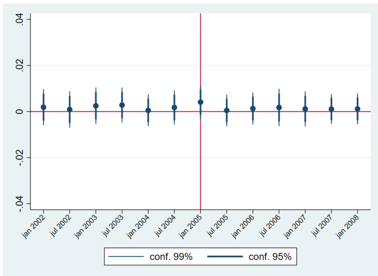
(c) C-sections w/ Complications



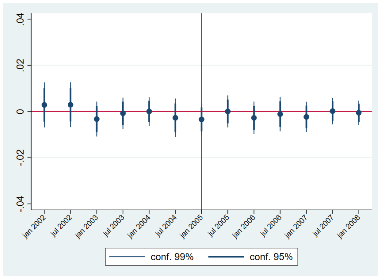
(d) Inappropriate C-sections



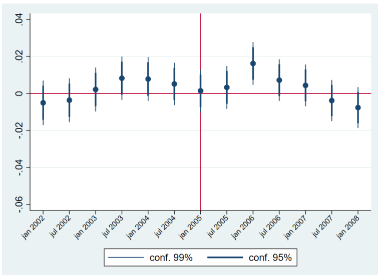
(e) Inappropriate Vaginals



(f) Appropriate c-sections

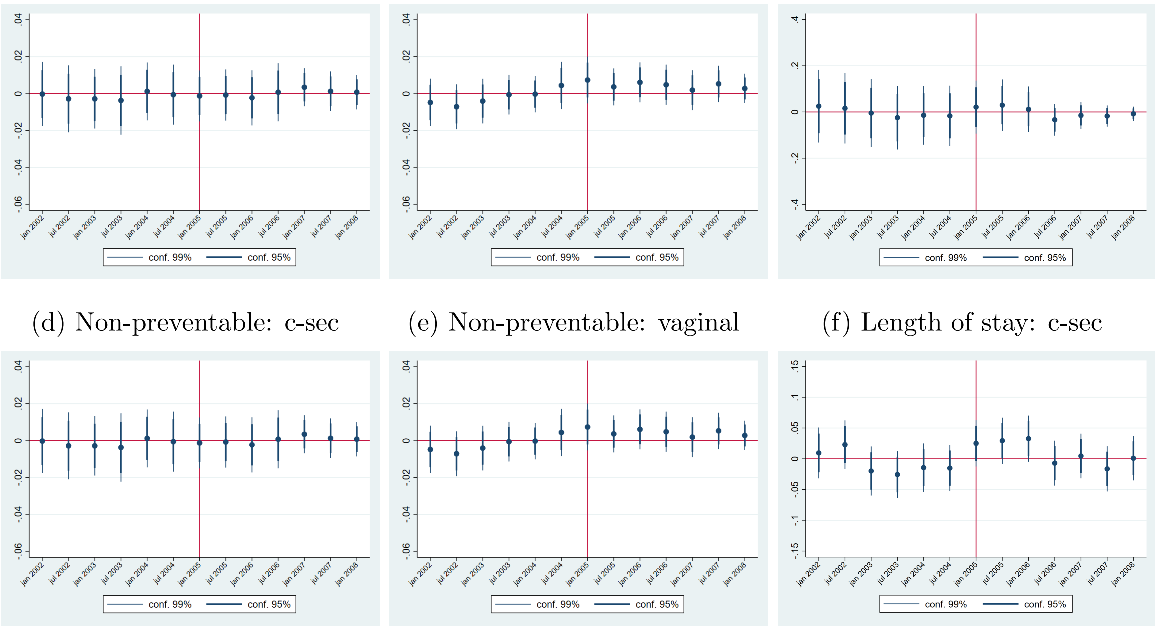


(g) Appropriate vaginals



Note: The figures plot the leads and lags by semester taking Jul– Dec 2008 as the reference semester.

Figure 4: Leads and lags - Complications



(a) Preventable: c-sec (b) Preventable: vaginal (c) Length of stay: vaginal

(d) Non-preventable: c-sec (e) Non-preventable: vaginal (f) Length of stay: c-sec

Note: The figures plot the leads and lags by semester taking Jul– Dec 2008 as the reference semester.

5.2 Back-of-the-envelope Calculations

To better understand the implications of the equalization policy, we perform some back-of-the-envelope calculations of its monetary costs. In the years following its implementation (2005-2008), 278,472 natural deliveries without complications occurred in Lombardy, each of which cost 70 euros more than natural deliveries prior to 2005, for an overall additional cost of 19,493,040 euros. Since cesarean deliveries numbered 126,025, the 2.6% lower c-section rate since the policy means that 3,364 c-sections were averted and Lombardy paid 5,795 euros to avoid each one (19,493,040/3,364). To provide a complete picture, the calculations should include changes in patients' health outcomes. We show that the observed reduction in c-sections is not associated with changes in patients' health status during or immediately following delivery. However, the shift towards vaginal deliveries entails important potential health improvements in the medium/long term that we cannot assess. For example, the exposure to maternal and surrounding environmental bacteria during vaginal delivery strengthens the baby's immune system and intestinal colonization (Neu and Rushing, 2011; Dominguez-Bello et al., 2016; Scudellari, 2017), while the process of labor during vaginal delivery reduces respiratory morbidity (Hyde et al., 2012). Similarly, mothers delivering naturally are less likely to require a c-section in subsequent pregnancies, to undergo a hysterectomy, or to suffer from abnormal placentation and uterine rupture (Sandall et al., 2014). Hence, overall, we cannot conclude that equalizing payments was a poor investment policy-wise; rather, the findings provided should encourage more informed discussions among policy makers.

6 Validity and Robustness Checks

To check the robustness of our results, we run a placebo by estimating Equation 1 on the sample of weekend deliveries. As explained in Section 4.2, c-sections occurring on weekends are more likely to be due to emergency reasons. Then, nullifying the economic incentive should have no/less impact on performance of c-sections on weekends. Table 5 (column 1 and 2) shows that when we assess the reference policy on weekend deliveries, no effect is observed.

Further, we perform several tests to exclude possible unintended effects that the equalization of the DRG tariffs of delivery methods could trigger and that could be driving our findings. First, our results could be explained by a change in the composition of patients treated. Increasing the DRG tariff for vaginal deliveries up to the tariff of c-sections could incentivize to try to attract more healthier, and thus less risky and costly, patients (*i.e.*, cream skimming). If this were the case, we would observe a drop in c-sections also as a consequence of a change in the risk profile of deliveries. We investigate patient selection in two ways. We checked whether the equalizing policy modified the predicted probability of undergoing a c-section (PPC) as in Baicker et al. (2006) and Amaral Garcia et al. (2015). If the removal of the price differential affects the PPC as a function of maternal risk conditions at the hospital level, then it follows that patient composition has changed. Then, we estimate Equation 1 on *Low–risk mothers*. This is a dummy that equals one if the woman does not present any pre-delivery risk conditions.[15] As is apparent from columns 3 and 4 in Table 5, the policy did not affect either the probability of treating a low-risk mother or the predicted probability of undergoing a c-section as a function of maternal risk conditions.

Second, if the policy reduces the incentive for Lombardy hospitals to opt for a c-section, women residing in Lombardy and seeking such a procedure could choose to deliver in neighboring regions in the first place (*i.e.*, patient sorting). We test this scenario by checking whether treated hospitals experienced any change in the monthly number of deliveries managed, and the monthly number of deliveries of women residing in Lombardy. As shown in Table 5 (columns 5 and 6), neither measure is significantly affected.

[15] Following the medical literature, we define a low-risk mother as a woman who does not suffer from any of the following pre-delivery risk conditions: fetus malposition, previous c-section, diabetes, prolonged pregnancy, early labor, poor or excessive fetal growth, multiple gestation, fetal abnormality, antepartum hemorrhage, placenta previa, pre-eclampsia, eclampsia, toxemia, hypertension, polyhydramnios, oligohydramnios, and infection of the amniotic cavity (Bertoli and Grembi, 2019).

Third, while the policy removes the price differential between vaginal and cesarean deliveries, it still differentiates between deliveries with and without complications. This could create an incentive to favor vaginal deliveries with complications above all, that is, to "upcode" the severity of vaginal deliveries so as to profit more. However, as reported in column 7 in Table 5, there is no statistically significant effect of the equalizing policy on vaginal deliveries with complications as defined on the basis of the related DRG code (*i.e., DRG 372*). Therefore, upcoding does not seem to play a relevant role.

Table 5: Robustness Checks

	Weekend deliveries		**PPC**	**Low-risk mothers**	**Deliveries**	**Resident deliveries**	**Vaginal with complications**
	All	without complications					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
δ	-0.001	-0.002	0.000	-0.000	4.063	4.083	-0.001
	(0.003)	(0.003)	(0.002)	(0001)	(3.011)	(2.947)	(0.001)
Obs.	225,548	216,871	716,445	716,445	6,374	6,374	716,445
Mean	0.189	0.180	0.304	0.637	112.401	109.516	0.021
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: PPC is the predicted probability of undergoing a c-section estimated through a logistic regression as discussed in Section 4.3. *Low-risk mothers* indicates those who did not suffer from any of the following pre-delivery risk conditions: fetus malposition, previous c-section, diabetes, prolonged pregnancy, early labor, poor or excessive fetal growth, multiple gestation, fetal abnormality, antepartum hemorrhage, placenta previa, pre-eclampsia, eclampsia, toxemia, hypertension, polyhydramnios, oligohydramnios, and infection of the amniotic cavity (Bertoli and Grembi, 2019). *Deliveries* is computed as the monthly number of managed deliveries per hospital, while *Resident deliveries* is the monthly number of managed deliveries by women residing in the same region where the related hospital is located. *Vaginal with complications* identifies any vaginal delivery under the 372 DRG code. Controls include $X1$, $X2$ and $X3$ as listed in Table A.2. Robust standard errors in parentheses. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

A last concern could be related to the quality of deliveries. In 2005, following the request of its Regional Working Group on Childbirth, Lombardy decided to include epidural anesthesia among the services to be provided free of charge by its hospital network Regione Lombardia (2010). As a consequence, hospitals could have taken advantage of the simultaneous increase in the tariff for vaginal deliveries to improve the services provided, that is, to favor vaginal deliveries under epidural anesthesia. If this is the case, hospitals would no longer be reacting to economic incentives. Epidural anesthesia started to be consistently reported on the hospital discharge records following a 2004 massive campaign of the Italian Society of Anesthesia, Analgesia and Intensive Care (SIAARTI) which raised the attention of the public opinion on the use of this type of anesthesia.[16] Hence, we cannot test the effect of the equalizing policy directly on the

[16]On the 2004 International Women's Day (*i.e.*, March 8th) SIAARTI did a massive press campaign to foster the use of epidural anesthesia during delivery and submitted a motion at the Italian Parliament to include epidural anesthesia during labor and delivery among the services ensured free of charge by

use of epidurals, but only indirectly.

Table 6: DD - Delivery Methods by Hospital Use of Epidural Anesthesia

	C-sections		
	All	Without complications	With complications
	(1)	(2)	(3)
Not Using Epidural Anesthesia			
δ	-0.016***	-0.014***	-0.007
	(0.003)	(0.003)	(0.020)
Obs.	220,471	212,303	8,168
Mean	0.333	0.326	0.516
Using Epidural Anesthesia			
δ	-0.001	-0.002	0.018
	(0.003)	(0.002)	(0.015)
Obs.	495,974	473,436	22,538
Mean	0.305	0.295	0.512
Controls	Yes	Yes	Yes
Quarter-year FE	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes

Notes: Controls include $X1$, $X2$ and $X3$ as listed in Table A.2. Robust standard errors in parentheses. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

The extra 70 euros granted by the equalizing policy can be expected to cover the cost connected to epidural anesthesia only in those hospitals that, pre-policy, were already equipped with a well-developed Anesthesia Unit.[17] Then, these hospitals may have exploited fee equalization to offer a better service (*i.e.*, vaginal deliveries under epidural anethesia) rather than to profit from the price increase. By contrast, hospitals whose cost of epidurals was higher than the price increased for vaginal deliveries are more likely to have followed the monetary incentives. We use the number of epidurals in 2005 to identify these two types of hospitals: the former coincides with hospitals with at least 1 epidural in 2005, the latter with hospitals with 0 epidurals in 2005. Then, we test the effect of the policy in these two groups to see if the observed drop in c-sections is driven by a change in the use of this procedure in both hospital types or not. Table 6 shows that fee equalization triggered a decrease in c-sections only among the hospitals

the Italian health care system. This motion received the approval by all political parties. However, epidural anesthesia was included among the Essential Levels of Care guaranteed by the Italian NHS only in 2008.

[17]When not capable to offer epidural anesthesia free of charge, hospitals can still offer it but charging a price which results to be quite high as it must first of all cover the cost of hiring the anesthetist. To date, the price of epidural anesthesia ranges between 800 and 2,000 euros (see, for example, https://www.nostrofiglio.it/gravidanza/parto/epidurale-parto-indolore).

for which epidurals were not cost effective before the policy. Although hospitals may have responded to the policy with also a change in the quality of vaginal deliveries, the reduction in c-sections are driven by the hospitals pursuing the monetary incentives.

7 When Is the Effect Stronger?

Finally, we focus on hospital and physician characteristics that can affect the intensity of the reaction to a change in financial incentives. This last step offers important policy implications, since it is helpful to understand when hospitals are more responsive to economic incentives and under what circumstances fee equalization can be more or less effective in reducing the overuse of medical treatments such as c-sections. We explore the role of capacity constraints, quality and patients' socio-economic background. For physicians, we analyze the availability of specialists and the incidence of women within the relevant specialty group, comparing numbers of Ob-Gyn and other types of specialists. We generate dummies, D, for each characteristic and interact the dummies with $Treated_h * Post_t$. For each characteristic, we report the results for $Treated_h * Post_t$ in each subsample defined by D and the significance of the difference between the two samples.

7.1 Capacity Constraints

Capacity constraints limit the degree of adjustment and discretion when deciding to keep a patient for an additional day or, by the same token, who requires more attention and care. Intuitively, this should constraint the decision to choose more aggressive treatments that require longer hospitalizations and more care. Hospitals facing more stringent capacity constraints should substitute more vaginal deliveries for c-sections, that, as surgical procedures, imply a longer occupancy of beds and more medical assistance during the recovery.

We proxy capacity constraints using the number of used beds weighted on the overall number of doctors and nurses and the number of available beds because these resources determine the capacity of a ward. We take the median value of each of these measures and define hospitals with above-median values as more constrained.

The results in columns 1, 2, and 3 in Table 7 confirm our prior: the tighter the constraint, the greater the shift to natural deliveries. Constraints on beds appears to be the most relevant, and constraints on the numbers of nurses are more significant than those of doctors. Indeed, This may be because nurses are the one more involved during the recovery of patients, thus benefit more from shorter and smoother patient recovery. This reinforces the idea that policies operating on financial incentives are effective even in a context in which physicians are civil servants and receive a fixed wage. However, additional information seems to significantly affect the decision process (*e.g* overall characteristics of the ward in terms of available beds, used beds, personnel).

7.2 Quality

We consider hospital quality following the idea that better-quality hospitals are, by definition, those in which decisions are more closely adherent to patient's medical needs. Hence, financial incentives are expected to be more relevant in low-quality hospitals, and the removal of financial incentives should have a stronger impact on the use of c-sections in this context.

We proxy high/low quality in three ways. Following the literature that identifies high levels of competition with higher quality (Bloom et al., 2013), we label a hospital as high quality if it faces an Herfindal-Hirschman Index (HHI) below the median HHI in our sample (*i.e.*, <3,882). As a second measure, we use the number of wards in a hospital. The presence of more wards signals a lower degree of hospital specialization. Therefore, better quality hospitals (obstetrically speaking) are expected to have a below-the-median number of wards (*i.e.*, <41). Finally, we use the estimated hospital fixed effects from our baseline specification to proxy quality. Fixed effects capture unobserved time-invariant hospital characteristics, such as management and practice styles, which in the short run do not experience significant variation (McClellan and Staiger, 1999). Greater fixed effects are associated with lower quality (Bertoli and Grembi, 2017b); thus, higher quality is represented by below-the-median fixed effects (*i.e.*, <-0.181).

In Table 7, columns 4 to 6 show that the effect is higher for low-quality hospitals, as defined according to the different proxies.

7.3 Patients' Characteristics

Previous works have underlined how patients characteristics may interact with physician incentives (Johnson and Rehavi (2016)). In the context of deliveries, physicians seem to be less likely to perform unnecessary c-sections on better educated and higher income mothers who tend to be more informed of the risk of alternative procedures and who may more carefully select the hospital where they want to be treated.

We introduce two measures to proxy the wealth and education of patients: the rate of graduated individuals and the average income at the level of the patient's municipality of residence.[18] We define more educated and higher income individuals as those

[18] Due to data limitations, individual socio-economic information are not available. We use as proxies aggregated information, available at the municipality level. The municipality is the smaller administrative unit in Italy, with an average of 13,000 inhabitants in the sample considered.

from municipalities where the indexes are above-the-median values (*i.e.*, above 28.8% graduated individuals; annual income above 21,394 euros).

In Table 7, columns 7 and 8 show that the response to the policy is not affected by the socio-economic background of patients.

7.4 Specialized Workforce

Finally, we explore the role of specialized workforce characteristics focusing on the availability of specialists and their gender composition. Our expectations are that the policy has been more effective the greater the availability of specialists and the higher the prevalence of females' Obstetric-Gynecologists. Following Molitor (2018), we expect geographic variations in local practice environment to affect to some extent physicians' individual behaviours. We test this hypothesis considering a specific feature of the practice environment (*i.e.*, the availability of specialists) and verifying whether physicians operating in more concentrated environments are more responsive in the adaptation to a new practice style (*i.e.*, reduction of c-section use). The rational is that knowledge spillovers and larger reputation concerns are more likely to occur in more concentrated environments. Considering the gender composition, previous studies found significant differences between male and female physicians' practice both in the use of preventive services and surgery interventions (Lurie et al. (1993), Bickell et al. (1994), Mitler et al. (2000), Wee et al. (2001)).[19]. Looking at the non-medical determinants of the variability in c-section use, Mitler et al. (2000) found that physician's gender significantly affects the probability of undergoing a c-section, with a higher probability associated to males physicians. Males and females are indeed likely to weight differently the factors that enter the decision process, such as financial incentives, reputation concerns, and patient needs.

With a focus on the LHA district where the hospital is located, we consider two measures describing the workforce characteristics of the main medical-speciality groups (*i.e.* Obstetric-Gynecologists, Surgery, Psychiatry, Pediatrics, and Rehabilitation): the number of available specialists per 10,000 inhabitants and the incidence of women within the speciality-group.[20]

[19] Female physicians are found to be more likely to offer preventive services. More precisely, Lurie et al. (1993) find female physicians to be more likely to offer to women patient gender-specific preventive care services, like mammograms and PAP smears. Conversely, female specialists are less likely to perform surgery interventions, like hysterectomies and c-sections (Bickell et al., 1994; Mitler et al., 2000)

[20] Median values considered as relevant thresholds in the analysis. With reference to Obstetric-Gynecologists, Surgery, Psychiatry, Pediatrics, and Rehabilitation, the median values for specialists' availability are respectively 1.79, 8.44, 1.58, 1.19, 0.62. The median values for the incidence of women within the specialty-group are 0.56, 0.29, 0.55, 0.69, 0.43.

As expected, we find stronger responses to the policy the higher the availability of Obstetric-Gynecologists and the larger the incidence of women within the speciality-group of Obstetric-Gynecologists. (Table 8 columns 1-6). As a placebo, we show that the same measures produce no significant results if we consider speciality-groups not affected by the policy as Psychiatry or Pediatrics (Table 8 columns 2-5 and 7-10).

Table 7: Heterogeneous effects by hospital characteristics

	Capacity constraint			**Hospital quality**			**Patient characteristics**	
	Doctors (1)	Nurses (2)	Beds (3)	HHI (4)	Wards (5)	FE (6)	Education (7)	Income (8)
	Less constrained	**Less constrained**	**Less constrained**	**High quality**	**High quality**	**High quality**	**Low education**	**Low income**
δ	-0.008***	-0.007***	-0.004***	-0.001	-0.000	0.003	-0.008***	-0.006***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
	More constrained	**More constrained**	**More constrained**	**Low quality**	**Low quality**	**Low quality**	**High education**	**High income**
δ	-0.011***	-0.011***	-0.014***	-0.012***	-0.006***	-0.019***	-0.008***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Difference	-0.003	-0.004*	-0.010***	-0.011*	-0.006***	-0.022***	-0.000	-0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Obs.	716,445	716,445	716,445	716,445	716,445	716,445	716,445	716,445
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: *Less constrained* indicates that the number of used beds out of the total number of doctors (column 1), nurses (column 2), and available beds (column 2) in a hospital is a below-the-median value. *High-quality* indicates a hospital with a below-the-median HHI (column 4), a hospital with a below-the-median number of wards (column 5), or a hospital with a below-the-median value of fixed effects (column 6). *High-education* indicates patients coming from municipalities where the rate of people with at least a high school diploma is above-the-median (column 7); *High-income* patients come from municipalities where the average income is above-the-median (column 8). Robust standard errors in parentheses. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 8: Heterogeneous effects by physician characteristics

	Availability of specialists (per 10,000 inhab.)					Incidence of women specialists				
	Ob/Gyn (1)	Surgery (2)	Psychiatry (3)	Pediatrics (4)	Rehabilitation (5)	Ob/Gyn (6)	Surgery (7)	Psychiatry (8)	Pediatrics (9)	Rehabilitation (10)
	Low	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**
δ	-0.006***	-0.006***	-0.010***	-0.006***	-0.009***	-0.005**	-0.010***	-0.009***	-0.010***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
	High	**High**	**High**	**High**	**High**	**High**	**High**	**High**	**High**	**High**
δ	-0.010***	-0.010***	-0.007***	-0.009***	-0.006***	-0.010***	-0.007***	-0.008***	-0.007***	-0.007***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Difference	-0.004*	-0.003	0.003	-0.003	0.003	-0.005**	0.002	0.001	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Obs.	716,445	716,445	716,445	716,445	716,445	716,445	716,445	716,445	716,445	716,445
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: *High* availability of specialists indicates the number of physicians weighted per 10,000 inhabitants above the median in the LHA district where the hospital is located.*High* incidence of women identifies LHAs where the prevalence of women within each specialty group is above the median. Robust standard errors in parentheses. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

8 Conclusions

Financial incentives faced by health care professionals are traditionally considered to be a main driver of unnecessary treatments. By setting a single payment for a broader package of treatments, fee equalization may significantly discourage the overuse of health care.

We evaluate the introduction of a fee equalization scheme in Italy, where the Lombardy region equalized the DRGs for vaginal and cesarean deliveries in 2005 to reduce unnecessary c-sections. Using Veneto as control region and applying a difference-in-differences strategy, we find that the policy led to a 2.6% decrease in c-sections. This reduction is associated with an improvement in treatment selection, as low-risk mothers were less likely to undergo a c-section when the price differential is removed. We do not find any statistically significant effects on patient health outcomes.

Overall, our analysis supports the potential of equalizing policies by showing that a relatively small increase in the price for natural deliveries (+4.2%) still produces a decrease in the incidence of c-sections. However, even though hospital physicians respond to the removal of the price differential, financial incentives turn out to play a limited role in driving the so-called treatment overuse. Elimination of financial incentives does not appear to be sufficient to make vaginal and cesarean delivery equally attractive, conditional on patient conditions.

Finally, analysis of the channels of the effect on c-sections shows that the observed decrease is driven by a strong reaction of lower quality hospitals and hospitals facing stricter capacity constraints defined according to several proxies. A greater availability of Ob-Gyn specialists in the LHA districts where the hospital is located increases the response to the policy, pointing at possible spillover effects, together with a greater presence of women within the medical-specialty group.

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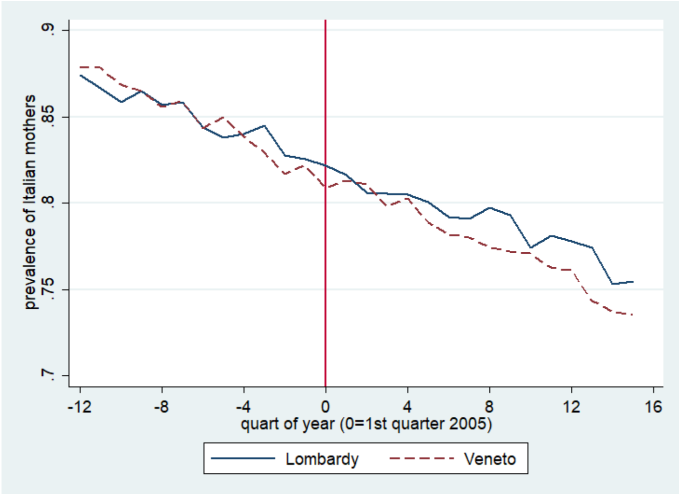
Appendix A: Additional Tables and Figures

Figure A.1: Prevalence of Italian mothers by region



Note: The figures plots the trend in the prevalence of Italian mothers in both Lombardy and Veneto.

Table A.1: Summary Statistics

	Overall		Treated: Lombardy		Control: Veneto	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Primary Outcomes						
C-section	0.31	(0.46)	0.31	(0.46)	0.32	(0.47)
Inappropriate c-sec	0.14	(0.34)	0.13	(0.34)	0.15	(0.36)
Inappropriate vaginal	0.01	(0.12)	0.01	(0.12)	0.01	(0.11)
Appropriate c-sec	0.18	(0.38)	0.18	(0.38)	0.17	(0.38)
Appropriate vaginal	0.67	(0.47)	0.67	(0.47)	0.67	(0.47)
Secondary Outcomes - Maternal and Infant Morbidity						
Prevent c-sec	0.03	(0.17)	0.03	(0.16)	0.04	(0.19)
Prevent vaginal	0.04	(0.19)	0.03	(0.18)	0.05	(0.22)
Non-preventable c-sec	0.10	(0.30)	0.10	(0.30)	0.10	(0.30)
Non-preventable vaginal	0.03	(0.17)	0.03	(0.16)	0.03	(0.17)
length of saty csec	5.11	(1.60)	5.06	(1.61)	5.21	(1.58)
length of saty vag	3.25	(0.78)	3.22	(0.79)	3.31	(0.75)
Additional Outcomes						
Low-risk deliveries	0.64	(0.48)	0.63	(0.48)	0.66	(0.47)
PPC	0.30	(0.31)	0.30	(0.31)	0.31	(0.30)
Vaginal with complications	0.02	(0.14)	0.02	(0.15)	0.02	(0.13)
Deliveries	112.40	(76.39)	119.48	(82.52)	99.58	(61.78)
Resident deliveries	109.52	(74.87)	116.13	(80.72)	97.54	(61.12)
Demographics						
Age	31.56	(5.11)	31.57	(5.11)	31.54	(5.10)
Italian	0.81	(0.39)	0.81	(0.39)	0.81	(0.40)
Married	0.66	(0.47)	0.73	(0.44)	0.50	(0.50)

Table A.2: Controls

X1	**X2**^{a}	**X3**^{b}
Age	Anemia	Multiple delivery
Italian	Hypertension	Immaturity/preterm
Married	Cardiovascular problems	Prolonged labor
	Diabetes	Precipitous labor
	Sexually transmitted diseases	Placenta previa
	Previous c-section	Problems of the amniotic cavity
	Renal failure	Fetus rhesus isoimmunization
	Thyroid dysfunction	Fetus abnormality
	Obesity	Ante-partum hemorrhage
	Pelvic abnormality	Breech
	Drug addiction	Umbilical cordon problems
	Eclampsia	

Note: (a) Maternal risk factors are consistent with those used in Dubay et al. (1999), Dubay et al. (2001), Currie and MacLeod (2008), Dranove and Watanabe (2009), Dranove et al. (2011), Shurtz (2013) and Shurtz (2014).

Table A.3: Logistic Regression - Delivery methods

	C-sections		
	All	With complications	Without complications
	(1)	(2)	(3)
δ	-0.048***	0.041	-0.052***
	(0.015)	(0.067)	(0.016)
Obs.	716,445	30,706	685,739
Mean	0.314	0.513	0.305
Controls	Yes	Yes	Yes
Quarter-year FE	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes

Notes: Controls include $X1$, $X2$ and $X3$ as listed in Table A.2. Robust standard errors in parentheses. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table A.4: PPC as Control - Delivery methods

	C-sections		
	All	With complications	Without complications
	(1)	(2)	(3)
δ	-0.007***	0.017	-0.008***
	(0.002)	(0.011)	(0.002)
Obs.	716,445	30,706	685,739
Mean	0.314	0.513	0.305
PPC as control	Yes	Yes	Yes
Quarter-year FE	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes

Notes: Robust standard errors in parentheses. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table A.5: DD - Delivery Methods: Independent Hospitals

	C-sections		
	All	Without complications	With complications
	(1)	(2)	(3)
δ	-0.021***	-0.018***	-0.030
	(0.005)	(0.005)	(0.028)
Obs.	346,168	330,718	15,450
Mean	0.319	0.311	0.504
Controls	Yes	Yes	Yes
Quarter-year FE	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes

Notes: Controls include $X1$, $X2$ and $X3$ as listed in Table A.2. Robust standard errors in parentheses. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table A.6: DD - Delivery Methods: Excluding the Private Sector

	C-sections		
	All	Without complications	With complications
	(1)	(2)	(3)
A: Without privately paid deliveries			
δ	-0.008***	-0.009***	0.013
	(0.002)	(0.002)	(0.010)
Obs.	712,050	681,517	30,533
Mean	0.312	0.303	0.512
B: Without private hospitals			
δ	-0.007***	-0.008***	0.013
	(0.002)	(0.002)	(0.010)
Obs.	714,605	683,903	30,702
Mean	0.313	0.303	0.513
C: Without privately paid deliveries & private hospitals			
δ	-0.008***	-0.008***	0.013
	(0.002)	(0.002)	(0.010)
Obs.	710,210	679,681	30,529
Mean	0.311	0.302	0.512
Controls	Yes	Yes	Yes
Quarter-year FE	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes

Notes: Private hospitals include both private accredited and purely private hospitals. Controls include $X1$, $X2$ and $X3$ as listed in Table A.2. Robust standard errors in parentheses. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Appendix B: Additional Institutional Details on the Health Care Systems of Lombardy and Veneto

As explained in Section 2, to evaluate the impact of Lombardy's policy, we use Lombardy hospitals as the treated group and those of the neighboring region of Veneto as the control group. The specific Italian context, where each region is largely independent in the management of its health care services to the extent that it is possible to identify 21 regional health care systems (*i.e.*, one per each region and autonomous province), requires the selection of a specific control area. Veneto best serves this purpose considering the functioning and performance of its health care system, the implementation and functioning of regional DRG tariffs, and the health and socio-economic profile of mothers.

According to the classification proposed by Jommi et al. (2001), the Lombardy system is the only example of the purchaser-provide split model in the entire country. It is the only region where LHAs act exclusively as purchasers as they do not manage any hospital, but rather buy services from public independent and private accredited hospitals. Differently, the regional health care system of Veneto is organized according to the LHA-centered model.[21] As a result, LHAs are simultaneously providers of health care services through their own-managed hospitals and purchasers of health care services from public independent and private accredited hospitals and hospitals run by other LHAs in the region. Given the different types of providers in the two regions, concerns might arise regarding the comparability of hospitals and their economic incentives in Veneto and Lombardy. Private hospitals are expected to be the most responsive to the monetary driver because they enjoy the greater organizational and financial autonomy and the tariffs received from LHAs represent their actual income. Still, the role of the private sector in the two regions is basically non-existent when childbirth is at stake. In 2004, almost all deliveries (*i.e.*, 99.8%) in Veneto occurred in a public (LHA-managed or public independent) hospital.

[21] Jommi et al. (2001) identify two further models in the Italian context: the region-centered model and the traditional cost-reimbursement model. Under the former, regional governments act as purchasers, whereas there is a wide range of providers that includes LHAs with their own hospitals and public independent and private accredited hospitals. DRG tariffs are used for the reimbursement of IHs and private accredited hospitals, whereas LHAs-managed hospitals are commonly funded on a capitated basis. Under the latter, DRG tariffs are disregarded and the reimbursement is done on the basis of past or current yearly expenditures regardless of the type of provider. On the contrary, the purchaser-provider split and LHA-centered models are the ones under which there is the strongest application of DRG tariffs (Fattore and Torbica, 2006).

Similarly, in Lombardy, the deliveries occurred in a public independent hospital accounted for 93.4% and those in a private accredited hospital for 6%, whereas only 4% took place in a purely private facility (Ministero della Salute, 2005).[22]

The marginal role of the private sector might not be sufficient to wipe out all concerns since public independent hospitals are commonly believed to be still more responsive than LHA-run hospitals. This expectation is due to the greater administrative and financial autonomy of public independent hospitals compared to LHA-run hospitals. Managers of the former are at the top of an organizational structure composed of two layers with doctors at the bottom, whereas managers of the latter operate in a 3-layer hierarchy with LHAs above them. However, the existing empirical evidence do not support this common expectation as shown by (Verzulli et al., 2016; Cavalieri et al., 2014). Several factors are at play to explain this lack of difference also in our regional contexts of interest.

To contain expenditures, both regions imposed funding targets and ceilings to both types of hospitals. Under the former, if billed services exceed the target, excess provision is discouraged by decreasing tariffs with volumes. Under the latter, billed services are in principle capped and if they still exceed the related ceiling, tariffs decrease proportionally. These planning requirements ultimately make public hospitals accountable to the same upper level entity, that is, the regional government regardless of their type.

In addition, LHA-run hospitals in Veneto face high financial pressure given the restrictive rules to bail out hospitals in financial distress[23], while they might add possible profits to their reserves and be allowed to spend them to invest in inpatient care, widen the range of services or increase managerial perks (Siciliani, 2006; Verzulli et al., 2016).

[22] In both regions, the remainig 0.2% of deliveries occurred outside an health care facility (*e.g.*, home deliveries). We test the robustness of our results to the exclusion of private hospitals and, as shown in Table A.6, our results are confirmed.

In addition, public hospitals of both regions accept privately paying patients. Still, this is a quite rare event for childbirths since related costs are entirely covered by universal coverage. As a result, pregnant women decide to pay out-of-pocket to have a private room (the so-called regime of *differenza alberghiera*) or to have the doctor of their choice following the delivery (the so-called regime of*libera professione*). Again, in both regions, these scenarios are quite unusual to the extent that, during our period of observation, only 6% and 1% of deliveries were fully or partially paid by patients in Lombardy and Veneto, respectively. We further test our baseline findings to the exclusion of deliveries that were fully or partially paid by mothers obtaining consistent results as reported in Table A.6.

[23] In principle, in case of financial distress, regional governments can grant extra funding to both independent public and LHA-run hospitals. Two are the channels to provide these extra resources: lump sum funding and extraordinary funding. The latter is a discretionary form of financing and is mainly done to the bailing out of hospitals in financial troubles. The former is applied when the DRG-based reimbursement is considered inappropriate as in the case of emergency care. Still, there are generally no clear rules for its allocation, thus it is often seen as a disguised form of extraordinary funding (Annessi-Pessina et al., 2004). Veneto makes a very limited use of these extra funds that is quite comparable to the use done by Lombardy in favor of its public independent hospitals. For example, lump sum funding and extraordinary funding jointly accounted to 8% and 5% of health spending in Lombardy and Veneto in 2000, respectively (Annessi-Pessina et al., 2004).

In case of deficits, the possible adverse events are similar for the two types of hospitals. Budget overruns of LHA-managed hospitals undermine the financial stability of LHAs and, ultimately, of regions. Hence, also LHA-run hospitals in deficit might have their managers replaced/downgraded or they might be downsized. Thanks to their constant financial oversight and financial restraints, Veneto and Lombardy are considered as an institutional target for other Italian regions so that, to date, they have always been included among the benchmark regions to evaluate the health care needs of regional populations and the related standard costs for the provision of the essential level of care in the country.

The different nature of public providers also affects to some extent their reimbursement procedure. In both regions, the reimbursement of independent public and private accredited hospitals are DRG-based. However, differently from other Italian regions, Veneto rely on DRG tariffs to also reimburse LHA-managed hospitals. In fact, Veneto's LHAs use DRG tariffs to also pay for the care their residents receive from hospitals run by other LHAs located in the region and to construct the budget of their own managed hospitals.[24] In this way, even in the LHA-centered model of Veneto, LHAs-managed, public independent and private accredited hospitals compete against each other with respect to the total internal budget of their LHA. Therefore, they are incentivized to increase efficiency without lowering quality to not lose patients to other hospitals in the region as this means losing fundings to other providers.[25]

In this perspective, a further aspect that makes Veneto a good control area for Lombardy is the common strong commitment in the implementation and application of DRG tariffs as stressed in the study by Cantú and Carbone (2007). DRG tariffs are set following the same methodology, that is, the so-called analytical method. Regional fees are calculated by analyzing the costs incurred by a panel of hospitals located in the region.[26] Then, these costs net of the costs incurred for the provision of outpatient services are used to compute the standard costs to be assigned to each DRG taking into account also the related case-mix (Carbone et al., 2006). Lombardy introduced its own DRG list in 1997, followed by Veneto in 1998 and since then they both periodically refine their listings to control for the evolution of the cost of their hospitals. As a result, they are among the regions that more often review their DRG tariffs. For example, between 2000 and 2005, Lombardy and Veneto made 7 and 5 revisions, respectively.

[24] The financing procedure of LHAs is common to the two regions. Regional governments fund their LHAs on a weighted capitation basis, then LHAs reimburse the hospitals that provided care to their residents.

[25] We test our results also by restricting the sample as to include only the deliveries occurred in public independent hospitals. Table A.5 shows that our finding are again confirmed.

[26] Lombardy considers all public independent hospitals operating within its borders, whereas Veneto looks at a pool of 14 hospitals including both public independent and LHA-managed hospitals.

They both also tend to bring down their regional fees compared to the DRG levels set by the central government and the deviations from the national tariffs show a high variability (Carbone et al., 2006). This signals the effort done in the implementation of DRGs: both regions are committed in adapting tariffs to the actual costs and resources needed for the provision of health care in their territory, rather than simply relying on the national listing. Finally, a last crucial aspect with respect to DRGs is that Veneto did not undergo any dramatic changes to its delivery payment policy during our observation period. The price differences remained stable during the period with c-sections costing 58% more than vaginal deliveries in all public hospitals.

Veneto and Lombardy are quite similar also in terms of the performance of their regional health care systems. The regions are commonly ranked among the top 4 performers for health care (CREA sanitá, 2018), and they have proved to be among the most virtuous regions in the country as far as c-section rates are concerned. Their share of c-sections is consistently below the national average; for example, in 2004, 36.4% of childbirths in Italy occurred through a c-section (Ministero della Salute, 2004), while the statistics for Veneto and Lombardy were 27.2% and 26.5%.

Neighborhoods, Networks, and Delivery Methods*

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Abstract

We investigate information transmission among patients when explaining territorial variations in the use of C-sections in Italy. We define networks as mothers living in the same municipality. If in the 12 months preceding delivery the incidence of C-sections within the mother's network increases by one standard deviation, her probability of receiving a C-section increases by 3%. This result captures mainly network effects for Italian mothers, while it captures both network- and place-specific (*i.e.,* neighborhood) effects for foreign mothers. Both groups adjust for the transmission of additional information, such as the incidence of C-section complications. The selection of mothers across hospitals does not uniquely explain our results, which are robust to alternative sample selections and specifications.

JEL Classification: I1, I12

Keywords: Cesarean sections, Networks, Neighborhood effects

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1 Introduction

While in labor economics and education economics, much attention has been given to the role of networks in the determination of important outcomes (*e.g.,* finding a better-matching working position), this has not been the case in health economics. Existing examples refer mainly to the provider's side (*e.g.,* the decision process of physicians, as proposed by Molitor (2018)), with scant attention to the demand side, despite there being substantial scope for spillovers in healthcare-seeking behaviors. Patients often make medical decisions (*e.g.,* the selection of a specialist or a hospital) based on the experience of people in their networks who have had similar medical conditions.[1]

Information transmission among (potential) patients could help explain, for instance, geographical variations in healthcare expenditures and in the use of medical treatments, which are generally explained by looking only at the supply side.[2] However, disentangling the role of information transmission from the role of providers is extremely challenging since information recovered through patients is affected by the health "environment" generated by suppliers. We provide a contribution in this direction. Building on Aizer and Currie (2004), we examine the role of place-specific characteristics and potential channels of information transmission in driving the high and medically unexplained geographical variation in the use of C-sections in Italy.

Deliveries are among the first causes of hospitalization for people in many countries, and the large variance in the incidence of C-sections, even within a country, is only partially explained by supply-side factors (Currie and MacLeod, 2008; Shurtz, 2014; Currie and MacLeod, 2017; Bertoli and Grembi, 2019; Costa-Ramón et al., 2018). C-section rates do not match the actual distribution of risk factors in the reference population, and concerns about the adoption of C-sections without medical indications are driven not only by budget constraints but also by the potential health consequences for both mothers and newborns

[1] Finkelstein et al. (2016) attribute approximately half of the variation in healthcare utilization to patient-related factors.

[2] This literature specifically emphasizes the role of the economic incentives of providers and of the organization of the healthcare system (e.g., Skinner (2011); Frakes (2013); Molitor (2018); Ho and Pakes (2014); Clemens and Gottlieb (2014); Doyle et al. (2017); Alexander and Schnell (2019); Cutler et al. (2019)).

(Tonei, 2019; Costa-Ramón et al., 2019; Card et al., 2019). Finally, the role of patients in choosing the delivery method is *ex ante* different from null, as shown for the very specific category of physician mothers by Johnson and Rehavi (2016).

In this respect, Aizer and Currie (2004) provide a useful reference. They analyze the drivers of prenatal care services in California, finding a strong correlation within ethnic groups, particularly among Hispanic mothers. However, they argue that much of this correlation is explained by unmeasured characteristics of the location of the group, so-called neighborhood effects (*e.g.,* attitude towards the use of healthcare services, and ease of access to health facilities), rather than by information sharing between mothers, defined as network effects. A similar analysis is performed by Grossman and Khalil (2020), who analyze the role of neighborhood networks in the use of Medicaid benefits for prenatal care. They estimate that currently, pregnant women are more likely (+8% relative to their reference group) to be enrolled in Medicaid if they are exposed to mothers from the same census block who also have participated in the program.

We address the role of neighborhood and network effects in the choice between a C-section and a vaginal delivery, defining networks as groups of mothers living in the same municipality.[3] Given the nonrandom distribution of women across municipalities, we can observe geographic correlation in the use of C-sections that is driven by underlying characteristics of the specific location (*e.g.*, distance from healthcare services) or the people living there (*e.g.*, education, income, and occupational status) rather than by information transmission between mothers.

To minimize potential differences in the incentives to perform C-sections across geographical areas, we select one Italian region, Lombardy, which has approximately 10 million inhabitants (16% of the Italian population). Since 2005, Lombardy has eliminated the economic incentives to prefer C-sections over vaginal deliveries through a policy equalizing the reimbursement for these delivery methods (Barili et al., 2020). Using 2006-2014 hospital

[3] People living in the same residential area are assumed to be the relevant reference group for the diffusion of information through informal channels, such as relatives and friends. Nevertheless, we are aware that there are other dimensions of information sharing that do not necessarily coincide with the residential area and still might be relevant in affecting patient perceptions and preferences (*e.g.,* coworkers and online communities) (Amaral-Garcia et al., 2019).

discharge data provided by the Italian Ministry of Health, for each mother delivering at time t (741,154 deliveries), we define an index of *exposure* to C-section use at the municipality level. This exposure is defined as the share of C-sections used by mothers residing in the same municipality during the 12 months preceding delivery.

We control for place-specific effects (*i.e.,* neighborhood effects) using several measures. To control for the suppliers' practice style, we employ fixed effects for the hospital in which the delivery took place since Italian physicians work in just one hospital. To control for the general approach to healthcare (*e.g.,* more or less invasive), we exploit the geographical organization of the Italian healthcare system in local health authorities (*i.e.,* LHAs, 15 in Lombardy). We add LHA fixed effects and LHA time trends to take into account managerial changes over the years. Finally, we control for changes in the practice style affecting the residential area (*e.g.,* a gynecologist who strongly prefers C-sections) using the delivery hospital time trends and, alternatively, a weighted index capturing the incidence of C-sections across hospitals treating patients from the same municipality (Section 4).

If in the 12 months preceding delivery the exposure to C-sections in the mother's municipality of residence increases by one standard deviation, the likelihood of the mother having a C-section increases by 3% at the mean of C-sections. We perform several simulations to provide a sense of the magnitude for which *Exposure* accounts for explaining territorial differential variations in the incidence of C-sections, and we estimate an impact of approximately 13%. To provide a benchmark, using the same institutional setting, Barili et al. (2020) estimate that equalizing the reimbursement of vaginal deliveries to C-sections generated a 2.6% decrease in C-sections.

Our effect is robust to the selection of several samples, such as the decrease in mothers from Milan, which is the largest city in Lombardy (approximately 1.3 million inhabitants), or the decrease in mothers coming from other regions. Our results are also robust to the use of extra supply-side controls such as the presence of family care centers or the rate of gynecologists (at the LHA level) and to the introduction of local labor market (LLM) fixed effects and trends.

The magnitude of the estimated effect follows a cubic relationship: the larger the exposure is, the stronger its relevance for the individual probability of receiving a C-section, with a saddle point at the median of the exposure distribution. This means that the response to exposure is heterogeneous, with both positive (exposure to low levels of C-section use) and negative (exposure to high levels) spillovers. We show that mothers also adjust their choice based on complementary information, such as the incidence of C-section complications and the use of C-sections on low-risk mothers (i.e., nonmedically motivated C-sections). Finally, we provide additional descriptive evidence on the potential channels of information transmission in maternal care by exploiting data collected through a flash online survey run in October-November 2020.

We test the hypothesis of information transmission by refining the concept of networks with the use of two more homogeneous groups of mothers – Italians vs. foreigners – within the same municipality and addressing the impact of complementary information separately. First, we observe that the baseline results are robust to the subsample of foreign mothers, despite controlling for their nationality and the C-section rate in their country of origin. Following Aizer and Currie (2004), we then compute indexes for exposure, distinguishing Italian versus foreign mothers. Given that information is assumed to be more likely to be shared within more homogeneous groups, if there are only network effects, mothers should be significantly affected only by the incidence of C-sections in their own group. While this is true for Italian mothers, we cannot exclude the existence of a neighborhood effect for foreign mothers, who are indeed affected by the incidence in both groups. This effect might indicate the relevance of place-specific characteristics, as in Aizer and Currie (2004), or could partially capture that integrated foreign mothers obtain information from both their group and Italian mothers (Bertoli et al., 2021). The adjustments due to complementary information are confirmed for both groups but stronger for foreign mothers.

Our estimates are driven by mothers giving birth on weekdays, while the effect is not significant for deliveries taking place on weekends: elective C-sections, which are planned during pregnancy, are more likely to occur on weekdays, whereas emergency C-sections are often performed after an attempted vaginal delivery. On the supply side, we observe that the potential sorting of a subset of mothers into hospitals with high fixed effects leads to a weaker role of exposure, meaning that as the incidence of nonmedically motivated C-sections increases, patients' role decreases. Other drivers follow the expected direction, as the role of exposure weakens as hospitals become more constrained. However, these drivers are not always significant due to their low variability in the data. Based on our results, we discuss the opportunity to implement information campaigns to make potential mothers more aware of the pros and cons of undergoing a C-section with no medical indications.

The paper proceeds as follows. Section 2 provides an overview of the institutional background. The data used are described in Section 3, while the quantitative indexes and the econometric strategy are described in Section 4. The results, robustness checks and drivers of the effect are discussed in Sections 5, 6, and 7, respectively. Section 8 describes the policy implications, and 9 concludes.

2 Institutional Background

The Italian healthcare system provides universal coverage to all citizens and is funded mainly through general taxation. The system is organized at the regional level (21 regions). Each region is divided into health districts, the LHAs, which encompass groups of municipalities. Each LHA may run its own hospitals and local clinics or buy health services from independent public hospitals or private accredited hospitals. Figure A1 shows how municipalities and hospitals are grouped into LHAs in Lombardy, the region considered in the analysis. Providers are reimbursed on a prospective system based on diagnosis-related groups (DRGs) (Bertoli and Grembi, 2017), and physicians work in only one hospital and receive a monthly salary. Patients are free to choose the hospital they prefer, facing no constraints other than the cost represented by the distance between their municipality of residence and the hospital. In the case of deliveries, mobility is limited: 40% of mothers in our sample selected the closest hospital. At the national level during the period, 95% (98% in Lombardy) of deliveries took place in public or private accredited hospitals, while home births were extremely rare. During pregnancy, women are followed primarily by their Ob-Gyn, who they can choose freely and who provides them with information regarding, among others, the delivery method. Women can also attend prenatal courses that are offered, free of charge, by public and private accredited hospitals or local clinics.

Since 2002, the Ministry of Health has published guidelines to discourage C-sections when not justified by the clinical conditions of either the mother or the newborn.[4] If a mother requests a C-section, physicians must explain the potential side effects of the procedure and give sufficient support to overcome any requests driven by fear and misinformation. However, some regional regulations, such as those adopted in Lombardy (*DGR 22957/2003 - Direzione Generale SanitÃ - Regione Lombardia*), do not allow a physician to refuse a C-section if, after being properly informed, a mother still demands one. In such a case, the mother has to sign a disclaimer for the physician (*i.e., Consenso informato per taglio cesareo elettivo*). There are no available data on the distribution of these disclaimers. Hence, to provide a sense of how relevant this phenomenon is, we rely on a national survey conducted in 2012 with a representative sample of mothers who gave birth in the years 2009-2010 (ISTAT, 2012). Mothers were explicitly asked why they received a C-section, and the possible answers included "mother's request not related to medical conditions". Overall, 8% of the respondents who underwent an elective C-section chose to have it; the percentage increased up to 13% among first-birth mothers. Descriptive evidence on the preferences of Italian women on the delivery method was collected by the NGO ONDa in 2010 (Torloni et al., 2013).[5] Twenty percent of women declared a preference for a C-section over a vaginal delivery, if free to choose. Preferences for surgical intervention were higher among women younger than 25 (35%), who were less likely to have a previous delivery. Educational attainment significantly affects preferences: 20.5% of less educated women preferred C-sections, in contrast to 13.4% of highly educated women. According to the respondents, the main sources of information to define the preferred delivery method were healthcare workers (51.9%) and friends or relatives (44.5%). Among women who declared that they preferred a C-section, 38.7% indicated the reason being the positive experiences reported by others, either friends or relatives (Table A1).

Additional descriptive evidence regarding the relevance of informal channels of informa-

[4]See the Piano Sanitario Nazionale 2002-2004 and its updates. With a national rate of 36.7% in 2011, Italy is characterized by a C-section incidence far above the suggested thresholds (15% according to the WHO estimates), with substantial geographic heterogeneity, as shown in Figure A2).

[5]ONDa: Osservatorio Nazionale sulla Salute della Donna - National Observatory on Women's Health. The survey was performed on a sample of 1,000 women through telephone interviews, and a questionnaire posted on an Italian magazine dedicated to women (*i.e.,* Io Donna)

tion comes from an online flash survey we performed between October and November 2020.[6] We collected 544 responses from Italian women; approximately 52% resided in Lombardy, and 60% had at least one child. Respondents answered a set of questions on their socioeconomic background and health-related information, while mothers younger than 50 years old at the time of the survey answered questions in an additional section related to their first pregnancy.[7] Overall, it appears that one's personal network has a relevant role in the selection of an Ob-Gyn, particularly among mothers. (Figure B1). More information on the results of the survey is available in Appendix B.

3 Data

Our main data source is hospital discharge cards at the individual level provided by the Ministry of Health. The original dataset consists of all childbirths covered by the Italian public healthcare system between 2006 and 2014. It includes detailed information on the medical conditions of the mother and the newborn. Since hospital discharge cards are completed primarily for medical purposes, the only demographics provided on the mother are age, marital status, citizenship, and municipality of residence. No information is provided on the use of prenatal care, which is free of charge in any hospital or local clinic in Italy.

We restrict the analysis to deliveries that occurred in a single Italian region, Lombardy, for 3 reasons. We can reduce concerns about the effect of financial incentives on providers since, during our observation period, Lombardy applied the same reimbursement levels for vaginal deliveries and C-sections. Second, given that we define networks at the municipality level, Lombardy has the advantage of including a remarkable number of municipalities (1,546). Moreover, to Lombard municipalities, we can add municipalities of people coming

[6]The survey was anonymous and designed on Google Forms without incentives to participate and shared through social networks and associations' websites. Authorization was provided by the University of Pavia - Department of Economics and Management (Registry Number 118887, 15/10/2020).

[7]We proposed a section related to pregnancy only to those younger than 50 years of age since older women may have experienced very different settings in terms of information (*e.g.,* lack of access to internet) when they had the first child than younger women. Women answering the section on pregnancy were between 25 and 50 years old, with a median age of 39.

from other regions, since Lombardy features the greatest net within-country migration flows for work reasons (more than 55,000 individuals per year relocate to Lombardy from other Italian regions), with a net-migration flow higher than 10,000 units per year (ISTAT, 2014). As a matter of fact, for the scope of our analysis, we impose only that the delivery must be performed in Lombardy while allowing mothers to be registered in any Italian municipality. Indeed, individuals can relocate within the country without moving their officially registered municipality of residence if they believe their move to be on a temporary basis. In that situation, it is reasonable to assume that each mother is more affected by the information she gets from the municipality where she is officially registered and to which she has stronger ties.[8] Third, the large share of immigrants located in Lombardy allows us to replicate the exercise proposed by Aizer and Currie (2004) to distinguish between own-group and other-group exposure using Italian and foreign mothers (Section 6.3).

As shown in Figure A3a, most mothers come from small municipalities (*i.e.,* up to 5,000 inhabitants) where information transmission through informal channels within the network is likely to be effective.[9] Mothers coming from small municipalities also contribute the most to the number of observed deliveries (Figure A3b); therefore, they have a major role in driving the effect. During our observation period, the average incidence of C-sections in Lombardy was 28.6%, mothers had an average age of 31.7 years and delivered in 51 hospitals, and 78.6% were classified as low-risk patients.

We enrich the existing data with additional information at the municipality and hospital levels provided by the National Institute of Statistics, the Ministry of Health, and the National Board of Physicians, as explained in more detail in Table C1.

4 Econometric Strategy

We assume that the probability of receiving a C-section is a combination of network effects, neighborhood effects, the individual risk profile of the mother, and the characteristics of the

[8]The potential mismatch between the municipality of residence and the municipality of relocation accounts for 4% of our sample; it is computed as the number of women delivering in Lombardy but officially registered outside Lombardy.

[9]In Appendix B, we support this point with evidence from a survey on the health conditions of Italians.

healthcare system. For each mother i giving birth in hospital h in year t, Equation 1 predicts the probability that she receives a C-section, $Csection_{iht}$. We control for a wide range of factors ($X1'_{iht}$) that could unambiguously affect the likelihood of receiving a C-section ($Csection_{iht}$), as listed in Table 1: her age, marital status, citizenship, and a long list of risk factors that the medical literature recommends taking into account when selecting the delivery method (*e.g.*, breech baby and eclampsia). $X2'_{imt}$ contains socioeconomic information, which is proxied by the characteristics of the municipality of residence (m) of the mother, such as the level of urbanization, population density, average education, and income level. We use quarter-year fixed effects (ρ_q) to control for seasonality issues that might affect the pregnancy and the delivery day-of-the-week fixed effects (σ_d) to control for other factors affecting the probability of having a vaginal delivery or of having an elective rather than an emergency C-section. Year-of-delivery fixed effects are captured by π_t, while delivery hospital fixed effects (ω_h) account for any time-invariant characteristics at the provider level, such as average quality standards or differences in practice styles. If a patient lives in an area where the surgical approach is much more frequent than the equally effective nonsurgical approach, she might develop an overall preference (or a lack of resistance) for surgical treatments (*i.e.*, C-sections). This case is described by Finkelstein et al. (2016), who observe that the component of healthcare utilization specific to the patient could be correlated to place-specific elements such as the share of "cowboy" doctors who consistently recommend intensive care beyond the current medical guidelines (Cutler et al., 2019). As far as the general habit is place-specific, its effect can be absorbed by health market fixed effects. In our setup, these coincide with γ_{lha} and are defined as the time-invariant characteristics of the LHA (lha) responsible for the mother's municipality. Since LHAs are also responsible for time-varying factors affecting the provision of care (*e.g.,* the territorial management of health services, the monitoring of providers' activity, and the release of guidelines targeted to both providers and patients), as a robustness specification, we include LHA time trends (η_{lhat}) to absorb year-specific variations at the LHA level. When we add LHA time trends, equation 1 is modified by substituting factor γ_{lha} with η_{lhat}.

$$Csection_{iht} = \delta Exposure_{mt-12} + \beta X1'_{iht} + \beta X2'_{imt} + \pi_t + \rho_q + \sigma_d + \omega_h + \gamma_{lha} + \epsilon_{iht} \quad (1)$$

$Exposure_{mt-12}$ is our variable of interest, computed as the share of C-sections in the relevant time and spatial dimension. Consistently, δ captures the network effect: influence on mother i of the delivery method experienced by women whom the mother has potentially been in contact with (*i.e.,* network). Since we are not able to reconstruct the group with whom the mother has interacted during her pregnancy (*e.g.,* relatives, friends or coworkers), we approximate her network with her municipality of residence. Municipalities considered have a median size of approximately 13,800 inhabitants, which decreases to approximately 10,000 inhabitants when Milan is dropped. The incidence of fertile women (*i.e.,* women 15-49 years old) is 20% on average. Figure A3 plots the distribution of the municipalities in our sample based on their size.

The study of the behavior of mothers who deliver at the same point in time could be biased by the reflection problem, which is extensively studied in the peer effect literature (Manski, 1993; Bramoullé et al., 2009; Ajilore, 2015). To eliminate this bias, we compute all indexes that proxy information transmission in the 12 months preceding delivery (month of delivery excluded). It is indeed unlikely that the experience of the i^{th} individual at time t could affect the behavior of mothers in previous periods, while we aim to test whether the behavior of others (which precedes the event involving the i^{th} individual) could explain an increase in probability for the i^{th} individual of having a C-section. Accordingly, our main variable of interest is $Exposure_{mt-12}$, which is computed as the share of C-sections during the 12 months preceding the delivery of the i^{th} mother at her municipality of residence m. Imagine *Mother A* residing in municipality m who has a delivery in March 2008; the index $Exposure_{mt-12}$ would be equal to the share of C-sections in municipality m considering the period from March 2007 to February 2008. We also provide a comparison with the index $Exposure_{mt}$, which captures the average C-section rate in municipality m in the same calendar year (mother i^{th} excluded from the calculation). The results are available in Appendix C. Figure A4 shows the positive correlation between the level of exposure and the probability of undergoing a C-section.

To a first approximation, our identification strategy compares two mothers who deliver at the same hospital, live in the same LHA, and have a different level of exposure to C-section rates based on the municipalities in which they live and the timing of their deliveries. Mothers have a different level of exposure either because they live in different towns (within the same LHA) or because they deliver at different points in time (e.g., 2007 vs 2010). Based on Equation 1, the identification of δ stems from both between- and within-municipality variation. Hence, we first check the nature of the variation of our index, providing more descriptives of its distribution across municipalities and time in Table C2. Quite intuitively, $Exposure_{mt-12}$ is more stable in larger cities due to the stability of the number of deliveries, with standard deviations decreasing as the municipality size increases. Large municipalities report, on average, higher values for exposure than smaller municipalities. Among county seat cities, the lowest average value is reported by Lecco (0.214), while the highest is reported by Mantova (0.380). Standard deviations vary between the lowest, reported by Milan (0.008), and the highest, reported by Monza (0.071). Additionally, Table C3 highlights the share of variation in $Exposure_{mt-12}$ explained by variation between municipalities or within municipalities when regressing $Exposure_{mt-12}$ only on year FE, municipality FE or both. The R-squared and adjusted R-squared do not vary substantially within and between models. However, there is also a certain degree of within municipality variation, as apparent from Figure C1, where we plot the trends in exposure by year-month for the 4 largest cities (population starting at approximately 7,500 inhabitants in Chiavenna-Province of Sondrio) in each of the 12 provinces in Lombardy.

4.1 Unobservable characteristics at the municipality level

A potential threat to our identification is that while it is reasonable to assume that women are homogeneous within municipalities, they might be heterogeneous between municipalities along several dimensions that remain unobservable but are relevant for the probability of having a C-section. An example could be some genetic predisposition towards pain tolerance. A way to address this challenge would be to introduce municipality fixed effects. However, this approach would identify δ by only exploiting the within-municipality variation. This would significantly undermine two important aspects of our analysis. On the one hand, if the transmission of information at the municipal level goes through unobservable factors (*e.g.,* more talkative people), municipality fixed effects reduce their relevance to zero. On the other hand, municipality fixed effects do not allow us to exploit the absolute values (levels) of

$Exposure_{mt-12}$ (the average exposure at municipality is absorbed by fixed effects), limiting our analysis to percentage point (pp) increases. Consider four mothers from two different municipalities, A and B, observed at two subsequent points in time, 1 and 2: mothers 1A and 2A from municipality A and mothers 1B and 2B from municipality B. From period 1 to period 2, $Exposure_{mt-12}$ increases by 5 pp in both municipalities. $Exposure_{At-12}$ increases from 0.1 at time 1 to 0.15 at time 2, while $Exposure_{Bt-12}$ increases from 0.3 at time 1 to 0.35 at time 2. The two cases would be considered equivalent, but as shown later by our analysis, the effect of exposure in predicting the probability of having a C-section increases as the level of the index increases.

To cope with the potential challenges stemming from the lack of municipality fixed effects, we rely on 4 different strategies. First, we compute the index at the local labour market level, $Exposure_{llmt-12}$, and we add municipality fixed effects. LLMs are defined by looking at daily commuting flows as registered in census data; thus, their identification is independent of administrative characteristics, and a given LLM can cross provinces. Individuals belonging to the same LLM are likely to commute within the area for working reasons and daily life activities and to share similar hidden characteristics (*e.g.,* attitude towards pain). In Lombardy, there are more than 50 LLMs grouped into a median number of 21 municipalities (30 on average) and a median value of approximately 60,000 inhabitants each (on average, approximately 190,000 inhabitants). Moreover, our dataset also includes 20,957 observations from mothers outside Lombardy who belong to 536 out of Lombardy LLMs. Considering $Exposure_{llmt-12}$ in place of $Exposure_{mt-12}$ reduces possible biases driven by large variations in the index observed in smaller municipalities. Even if we are interested in the effect of $Exposure_{mt-12}$, this test including municipality fixed effects provides a sense of the relevance of place-specific hidden characteristics. Second, we use LLM fixed effects and trends while keeping $Exposure_{mt-12}$. Third, we add additional controls for the health services available, which could shape some unobservable structural preferences toward a specific delivery method (*i.e.,* the availability of family care centers, the availability of specialists and Ob-Gyn specialists, and the prevalence of women among specialists and Ob-Gyn specialists). Finally, we propose a subgroup analysis at the municipal level, defining exposure for Italian and foreign mothers independently. For each group of mothers, we check whether the level of exposure of the other is relevant since, according to Aizer and Currie (2004), this would be a sign of neighborhood effects. The first three approaches are reported in the robustness checks section (Section 6.1), while we develop the subgroup analysis in Section 6.3.

4.2 Previous deliveries

Personal experience obviously matters. We do not have information on the number of previous deliveries due to data limitations; thus, we cannot isolate first-birth mothers. However, we can reduce concerns about the relevance of previous deliveries. First, we exclude mothers who had already experienced a C-section since having a C-section significantly increases the probability of having a C-section in future pregnancies.[10] Second, we reproduce the analysis using subsamples based on the age of the mother, as younger mothers are more likely to be first-birth mothers.

However, mothers could be affected by previous vaginal deliveries, but this would bias our results upward only if previous natural births always coincide with a negative experience for second-time mothers. This does not seem to be the case. In our sample, only 4% of mothers who had a vaginal delivery experienced major complications that, in some cases, prevented future childbirth (*e.g.,* a hysterectomy or a retained placenta), while 12% reported minor complications (*e.g.,* uterine trauma).[11] Additionally, previous experience should be a major concern in the case of high fertility rates, which capture the likelihood that mothers already had a delivery. Fertility rates are extremely low in the selected sample, limiting the probability that the respondents had more than one delivery.[12] Nevertheless, we test whether the results are sensitive to this aspect by estimating Equation 1 with an additional control for the average fertility rate at the provincial level (12 provinces). Clearly, we cannot rule

[10] Our data show an 8% rate of vaginal deliveries among women who had a previous C-section, which is in line with the national average of approximately 10% reported by the Ministry of Health (Ministero della Salute, 2009, 2010, 2011, 2012, 2013, 2014, 2016).

[11] Moreover, if previous natural births always coincide with a negative experience for mothers, we would expect higher rates of elective C-sections due to the mother's choice among not-first-birth mothers. However, the survey ISTAT (2012) reports that elective C-sections due to the mother's choice are 13% for first births and 8% for not first births.

[12] Table A2 shows trends in fertility rates.

out the effect of previous vaginal deliveries because, for instance, mothers could be affected by the emotional stress related to their previous experience (*e.g.,* emotional distress due to the length of the labor). The stronger this bias is, the higher the probability that our results represent a lower bound of the true effect of exposure.

4.3 Hospital selection

Since patients have full discretion in the choice of provider, mothers cannot be expected to randomly end up in a hospital. However, the choice of the provider *per se* may determine a different use of procedures (Mcclellan et al., 1994; Chandra and Staiger, 2007). We absorb possible effects driven by the chosen provider imposing hospital fixed effects. This allows us to compare identical mothers delivering in the same hospital who differ only in terms of their exposure to different degrees of use of the procedure at the local level in the relevant period.

A driver of the selection of the delivery hospital could be the desire to give birth by C-section. If all mothers perfectly self-selected into hospitals based on their willingness to have a C-section, δ in Equation 1 would not be different from zero. Due to this self-selection, hospital fixed effects, ω_h, would capture the individual willingness to have a C-section. This possible sorting can be examined by looking at the difference between $Exposure_{mt-12}$ and the C-section incidence at the delivery hospital in the 12 months preceding the delivery for each mother in our sample: a self-selection motivated by demand for a C-section would imply a difference equal to zero (*i.e.,* a perfect match between individual preferences formed through exposure and provider practice style). We plot the distribution of this difference in Figure 1, which also distinguishes between mothers who do and do not give birth at the closest hospital. As a matter of fact, the selection might not necessarily be captured by the traveled distance: even the choice of the nearest hospital could be motivated by the willingness to have a C-section. As apparent from Figure 1, variation exists between maternal exposure and average hospital practice. This confirms that other drivers might be at work when choosing the hospital, such as flexible visiting hours, the distance to relatives, child rooming-in policy, the availability of psychological support, or the availability of single rooms.

Overall, we cannot rule out that for a portion of our sample, the mother-hospital match is attributable to ex ante preferences for C-sections. Nevertheless, this only means that the mothers who are perfectly matched with hospitals do not contribute to the identification of the effect of $Exposure_{mt-12}$. To prove our point, we perform a robustness check by replicating the analysis after dropping perfectly matched patients.

5 Results

5.1 Baseline specification

We estimate Equation 1 on six samples to verify whether the results are driven by specific categories of mothers. The first sample includes all observations. Then, we drop mothers whose municipality of residence is Milan since, given the size of the city, the network effect is less likely to be proxied by the municipality. In the third sample, we drop weekend deliveries, as C-sections are unlikely to be scheduled on weekends; in the fourth sample, we drop mothers coming from outside Lombardy since they are likely to have peculiar unobservable characteristics. The fifth sample considers only low-risk mothers, as they should be less likely to have a C-section motivated by medical reasons, and the sixth sample includes only mothers who do not give birth at the closest hospital. Figure 2 graphically shows the estimated effects by sample, while detailed coefficients are reported in Table A3.

According to the baseline estimation for the overall sample, a one-standard-deviation (*i.e.,* 0.08) increase in $Exposure_{mt-12}$ (Table A3 - Column (2)) translates into a 3% higher probability that the i^{th} mother undergoes a C-section. As expected, the magnitude and significance of the coefficients is not affected by the exclusion of "perfect-match mothers" (*i.e.,* mothers reporting exposure levels equal to the C-section rate of the selected provider), confirming the hypothesis that those mothers do not contribute to the estimation of the effect (Table A4).

The level of exposure matters. Estimating the baseline model using deciles of exposure in place of the continuous index, we observe a cubic relationship between exposure levels and patient preferences: the higher the exposure is, the stronger its effect on patient behaviors and vice versa (Figure 3). This means that the response to exposure is heterogeneous, with mothers at the top of the exposure distribution being the most affected and those at the bottom being the least affected. This implies a strong transmission of both positive (*i.e.,* less likely) and negative (*i.e.,* more likely) spillovers derived from different patterns in the use of healthcare procedures.

To provide an idea of the economic significance as well as the statistical significance of the results, we perform some simulations using the 12 county seat cities. As an example, we present the simulation performed between Mantova and Lecco, with the former having a C-section rate of 0.273 and an average $Exposure_{mt-12}$ of 0.380 and the latter having a C-section rate of 0.153 and an average $Exposure_{mt-12}$ of 0.214. Pairing two cities at the time, we first compute the difference in the average $Exposure_{mt-12}$ (*e.g., 0.166* in our example). Then, given the estimated effect (δ) equal to 0.084 at the baseline, we compute the increase in probability associated with each difference in exposure, which quantifies in percentage points the increase in probability of having a C-section due to the difference in $Exposure_{mt-12}$ (*e.g., 0.166*0.084=0.014*). We can weight this value on the difference in C-sections to get a sense of the role played by the information transmission channel in explaining the geographic variation in C-section rate (*e.g., 0.014* can be weighted on the difference in the C-section rate, which is equal to *0.120*. This results in a 11.6% explained effect). In the sample considered, we obtain an average impact of 13%, which we interpret as the share of variation in C-section rates explained by $Exposure_{mt-12}$. Even if a proper estimation should consider all possible combinations between municipalities, this exercise can give an indication of the magnitude of the effect. The information transmission channel appears to explain variation that is both statistically and economically relevant.

5.2 Complementary information

The propensity of other women to deliver by C-section (*i.e.*, $Exposure_{mt-12}$) may be the *primary information* that influences a woman's choice to use that method. *Complementary information* that influences her choice may be the incidence of C-section complications and the incidence of C-sections on low-risk mothers in the municipality.[13] The responses to this

[13]According to medical literature, C-section complications include fever, postpartum hemorrhage, complications related to anesthesia, a retained placenta, surgical wounds, infection, postpartum anemia, postpartum

complementary information require a deeper knowledge and observation of the experiences of other women. While sharing information about the delivery method is quite common, women might be less willing to share detailed information about their personal health conditions before and after delivery. Hence, we expect *complementary information* to have a significant effect on the likelihood of receiving a C-section but with a smaller magnitude than *primary information*. More precisely, we expect the incidence of C-section complications to discourage new mothers from undergoing the same procedure (*i.e.,* C-section) and thus to negatively affect the probability of undergoing a C-section. C-sections on low-risk mothers are interpreted as a proxy for a low appropriateness of C-section use. Their incidence may increase the perception of C-sections as a common procedure not necessarily related to objective health conditions; therefore, we expect it to be positively related to the probability that a new mother undergoes a C-section.

We modify our baseline model by adding a control for *complementary information* that may influence the individual attitude toward the use of C-sections (Equation 2). The variable $Complementary_{mt-12}$ is alternatively equal to the incidence of C-section complications and the incidence of C-sections on low-risk mothers in the 12 months before delivery in the mother's municipality of residence.

$$\begin{aligned} Csection_{iht} = {} & \delta_1 Exposure_{mt-12} + \delta_2 Complementary_{mt-12} \\ & + \beta X1'_{iht} + \beta X2'_{imt} + \pi_t + \rho_q + \sigma_d + \omega_h + \gamma_{lha} + \epsilon_{iht} \end{aligned} \tag{2}$$

Figure 4 shows stable results for exposure to the use of C-sections ($Exposure_{mt-12}$), while complementary information plays a significant but minor role in the expected direction. The results are robust throughout the different samples. In terms of magnitude, the primary information produces the same findings as those presented in Section 5.1; a one-standard-deviation increase in the incidence of C-section complications reduces the likelihood of receiving a C-section by 1%, whereas a one-standard-deviation increase in C-sections on low-risk mothers increases the likelihood by 0.8%. This means that the effect of exposure to

cardiovascular disease, an embolism, and a hysterectomy. The risk factors that are considered as controls in the regression are also used to compute the *individual risk level of the pregnancy* by applying a logit model to the probability of having a C-section. Mothers are considered low risk if they score 0.4 or less (Currie and MacLeod, 2008; Bertoli and Grembi, 2019).

the use of C-sections is partially updated according to the type of complementary information available. This behavior can result from two mechanisms. On the one hand, observing a higher incidence of C-section complications may reduce the willingness to receive a C-section, with other factors being equal. On the other hand, a higher use of C-sections, even when not medically justified, may reinforce the belief that C-sections are a safe choice.

6 Alternative Specifications

6.1 Robustness checks

The results are robust to the inclusion of more controls on supply-side characteristics such as the number of family care centers and specialist availability, as reported in Table 2. Finally, all the results are robust to the inclusion of LLM fixed effects and trends, as shown in the coefficients in Table 3.

When we replace $Exposure_{mt-12}$ with $Exposure_{llmt-12}$, we aggregate the incidence of C-sections at the level of the LLMs, thus adding emphasis on the working environment as a channel for information transmission. This level of aggregation allows us to aggregate municipalities with similar underlying characteristics (descriptive statistics in Table C4). Since each index in time is computed on a larger population (*i.e.,* mothers who had a delivery in the preceding 12 months in the same local labor market in place of the municipality), $Exposure_{llmt-12}$ shows similar average scores but lower standard deviations compared to $Exposure_{mt-12}$, particularly when considering smaller municipalities. Table 4 shows the results when we use $Exposure_{llmt-12}$ and add both municipality and hospital fixed effects (comparable to our preferred specification in the baseline analysis): a one-standard-deviation increase in $Exposure_{llmt-12}$ translates into a 3.3% increase in the probability of undergoing a C-section. The estimated effect is similar to the one obtained in the baseline, indicating that time-invariant municipality characteristics do not drive our results.

Finally, our baseline results are also robust to the inclusion of an additional control for the yearly fertility rates at the LHA level, as shown in Table A5.

6.2 Underlying city trends in the use of C-sections

Our model controls for the general level of invasiveness – or *Practice style* – of the healthcare market using LHA fixed effects or their time trends. However, the municipal-specific delivery practice style might be slightly different. We address this issue following two strategies.

First, we estimate the baseline model imposing hospital-year time trends. These trends will absorb any change in the average practice style at the hospital level (*e.g.,* a gynecologist with a high use of C-sections who retires at a certain point). This approach has two limitations: it is dependent on the calendar year in which the delivery took place (not the 12 months preceding it), and it only captures changes in the hospital where the delivery occurs. This last point makes it an imperfect proxy for municipality-level trends in practice style to the extent that mothers from the same municipality can opt for different hospitals.

To cope with these limitations, we define a measure for the practice style adopted for deliveries that occur in the relevant time period and to which each mother is exposed on the basis of her municipality of residence. This measure will absorb underlying city trends in practice style strictly related to the delivery method. The intuition is to check whether underlying city trends in hospital practices significantly affect the effect observed for $Exposure_{mt-12}$. If this were the case, then $Exposure_{mt-12}$ could capture, in addition to information transmission, city trends. We thoughtfully examine this point in Appendix A and show that $Exposure_{mt-12}$ is not significantly affected by practice style changes in the healthcare market in which the mother resides, as shown in Figure A5.

6.3 Subgroup analysis

To gauge whether the estimated effects are driven by information sharing rather than individual or place-specific unobservable characteristics, we perform additional analyses comparing Italian and foreign mothers. The two groups are more homogeneous within but highly heterogeneous between, particularly in terms of unobservables (*e.g.,* genetic background, cultural beliefs, general attitudes and approach to the use of health services). Foreign mothers are identified on the basis of their nationality and constitute a large portion of the sample (approximately 25% of observed mothers).[14]

Having verified that the exposure at the local level is relevant even within the group of foreigners controlling for country-of-origin fixed effects and for the incidence of C-sections in the country of origin (see Appendix A), we go one step further in exploring the information sharing channel. Following Aizer and Currie (2004), the information is assumed to be more likely to be shared within more homogeneous groups, identified by nationality. Substituting the index $Exposure_{mt-12}$ with group-specific exposure indexes, we should be able to disentangle the network effect (*i.e.,* arising from information sharing) and the neighborhood effect (*i.e.,* unobservable place-specific characteristics – behaviors or access to care – that may vary over time). Given this assumption, a significant effect of own-group exposure would mean larger relevance of the information-sharing channel, while a significant effect of the other-group exposure would point to place-specific characteristics not related to the network. We therefore compute two measures for exposure, considering the C-section rate at the municipality level for Italian and foreign mothers separately. We associate each mother with both the exposure to C-section use among her own group (*i.e.,* $Exposure\ own_{mt-12}$: Italian mother-Italian exposure, foreign mother-foreign exposure) and the other group (*i.e.,* $Exposure\ other_{mt-12}$: for Italian mothers, foreign exposure; for foreign mothers, Italian exposure). Following Aizer and Currie (2004), we interpret $Exposure\ own_{mt-12}$ as a proxy for within-group information sharing (*i.e.,* network effect), while $Exposure\ other_{mt-12}$ as a place-specific feature that changes over time and that affects all women in the residential area (*i.e.,* neighborhood effects).

We reproduce the baseline analysis on the two groups of mothers separately, substituting the standard measure for exposure ($Exposure_{mt-12}$) with $Exposure\ own_{mt-12}$ and $Exposure\ other_{mt-12}$, alternatively or in combination (Equations 3-5).

$$\begin{aligned} Csection_{iht} = {} & \delta_{own} Exposure\ \ own_{mt-12} \\ & + \beta X1'_{iht} + \beta X2'_{imt} + \pi_t + \rho_q + \sigma_d + \omega_h + \gamma_{lha} + \epsilon_{iht} \end{aligned} \tag{3}$$

[14] The most represented nationalities among foreign mothers are Moroccans, Romanians, and Albanians. They do not come from countries neighboring Italy and are likely to be different from Italian mothers in terms of both their potential genetic background and their cultural approach to the use of healthcare services.

$$Csection_{iht} = \delta_{other} Exposure\ \ other_{mt-12} + \beta X1'_{iht} + \beta X2'_{imt} + \pi_t + \rho_q + \sigma_d + \omega_h + \gamma_{lha} + \epsilon_{iht} \tag{4}$$

$$Csection_{iht} = \delta_{own} Exposure\ \ own_{mt-12} + \delta_{other} Exposure\ \ other_{mt-12} + \beta X1'_{iht} + \beta X2'_{imt} + \pi_t + \rho_q + \sigma_d + \omega_h + \gamma_{lha} + \epsilon_{iht} \tag{5}$$

The results presented in Table 5 confirm the existence of a network effect for both groups (δ_{own} is always significant in both Equation 3 and Equation 5). The magnitude of this effect increases in Equation 5 when we control for both group-specific exposures, reinforcing the hypothesis of information sharing within groups. The coefficient δ_{other} is never significant for Italian mothers, while it is relevant for foreigners (Equations 4 and 5). In the full model (Equation 5), the magnitude of the effect is a 4.5% (Italians) and 2% (foreigners) increase in the probability of having a C-section if $Exposure\ \ own_{mt-12}$ increases by one standard deviation. An increase of one standard deviation in $Exposure\ \ other_{mt-12}$ is not significant for Italians, while it has a magnitude of 4.3% for foreigners. To guarantee more homogeneous variances in the two indexes, we impose a lower threshold of at least 5 Italian and 5 foreign mothers in the 12 months preceding the delivery, and the results for this sample (Table A6) confirm our baseline.

While the results for Italians confirm the hypothesis (*i.e.,* the presence of a network effect), the evidence for foreigners is mixed. Following Aizer and Currie (2004), we conclude that the characteristics of the place where the mother is located significantly affect the use of healthcare for the specific group of foreign mothers. This could be related to features at the municipality level that are specific to foreigners and are not part of the local healthcare system.[15] Nevertheless, the assumption that information is shared only within groups does

[15] From this perspective, the role of immigrant associations and nonprofit organizations that target foreigners is crucial (Bertoli et al., 2021). Over time, the number of these associations and organizations has been growing, and they play a relevant role in helping foreigners deal with the healthcare system. According to a 2006 survey by the Italian Volunteering Foundation (FIVOL), almost 60% of immigrant associations in the country operate in the area of social assistance providing medical and psychological support services Frisanco (2007) (*e.g.,* translation of informational material on pregnancy and the healthcare system, meetings with healthcare professionals, introductory courses on the healthcare system, and antenatal classes).

not consider the possibility that foreign mothers could be integrated into the local community. If we relax this assumption, the significance of δ_{other} for foreigners can partially capture a network effect driven by integrated mothers that have both foreign and Italian mothers in their network. Hence, even though the effect of $Exposure\ other_{mt-12}$ is larger than the effect of $Exposure\ own_{mt-12}$ for foreign mothers, we cannot conclude that specific-place characteristics play a stronger role than the network effect.

The adjustments due to complementary information are confirmed (Table 6). A one-standard-deviation increase in the incidence of C-section complications reduces the probability of having a C-section by 1.4% and 1% for Italian and foreign mothers, respectively, while a one-standard-deviation increase in the incidence of C-sections without medical indications increases the likelihood of having a C-section by 0.9% and 1.1%, respectively. In the first situation, the Italian response is much higher than that of foreign mothers. This may be due to the possibility of accessing richer information, together with a higher ability to correctly interpret it and to take it into account in the decision process. Conversely, if we look at the information related to appropriateness, foreign mothers show a stronger response. This likely means that foreign mothers are more sensitive to the exposure to the inappropriate use of healthcare and are more likely to consider a procedure as appropriate if it is widely used within their group. Consistent with the previous analysis, foreign mothers appear to be affected by the exposure of both groups exposures, while this is not the case for Italians.

7 Heterogeneity

When checking whether specific characteristics of the patient or the provider act as drivers, we estimate the following model:

$$\begin{aligned} Csection_{iht} = {} & \delta Exposure_{mt-12} + \lambda D_x * Exposure_{mt-12} + \nu D_x \\ & + \beta X1'_{iht} + \beta X2'_{imt} + \pi_t + \rho_q + \sigma_d + \omega_h + \gamma_{lha} + \epsilon_{iht} \end{aligned} \tag{6}$$

D_x groups the characteristics of the patient (*i.e.,* individual information or characteristics of the municipality of residence) or of the provider (*i.e.,* characteristics of the hospital or the ward in which the delivery occurs). If the driver is continuous, D_x equals 1 when the values of the variable driver (x) are above the median. On the patient side, we focus on proxies for socioeconomic status (*i.e.,* marital status), the opportunity for the patient to participate in the decision process (*i.e.,* the day of delivery since elective C-sections are rarely performed during weekends), access to care (*i.e.,* the distance between the municipality of the mother and the nearest hospital or the hospital in which the delivery took place), and access to medical information (*i.e.,* the presence of family care centers in the municipality and the availability of specialists). On the provider side, we analyze the role of hospital capacity constraints (*i.e.,* constraints on beds or personnel), hospital quality (*i.e.*, hospital fixed effects and readmission rates after childbirth), and characteristics of the medical team working in the maternity ward (*i.e.,* composition in terms of specialization, qualifications, and graduation year).

7.1 Patient side

The analysis on the patient side has a strong limitation because individuals can freely choose where to be treated. Patients with similar underlying characteristics (*e.g.,* education, income, and preferences) may choose the same hospital, information absorbed by the hospital fixed effects. Moreover, discharged hospital cards offer very little information at the individual level other than the medical characteristics of the mother and the newborn. We cope with this limitation by enriching individual observations with information on the municipality and LHA of residence.

First, we focus on the marital status of the mother, which is considered a proxy for the economic stability of the household and, therefore, for socioeconomic status. We assume married mothers have a higher socioeconomic status than unmarried mothers, even though cohabitation is quite common in Italy. Married mothers represent 62% of the full sample (61% among Italian mothers). Unmarried mothers are generally younger than married mothers, with the median age for unmarried and married Italian mothers being 31 and 32, respectively (32 and 33 among Italian mothers).[16] The result shows a decreasing effect among married mothers (*i.e.,* married women are less affected by exposure), even though

[16]Only 49% of mothers younger than 25 are married. The percentage increases to 63% for those between 25 and 32 and 64% for those over 32.

the difference between married and unmarried women is not statistically significant (Table 7 - Column (1)). This might signal that mothers of higher socioeconomic status are less sensitive to the information they receive from exposure to others' experience and are more likely to obtain access to more precise medical information.

Since we cannot distinguish between elective and emergency C-sections, we rely on the information on the day of the week when delivery occurs to determine the degree of discretion. Elective C-sections are indeed planned in advance and are generally not scheduled for weekends. Consistent with the findings by Finkelstein et al. (2016), we expect exposure to be significant only when patients have more discretion in the decision process (*i.e.,* weekdays) but not significant on weekends, when the C-sections that occur are likely to be emergency C-sections only. Consistently, the results show strongly significant effects only on weekdays, confirming that the information enters the decision process only when the patient has a margin of choice (Table 7 - Column (2)). If place-specific unobservable characteristics were the only information captured by exposure, we should observe no differences based on the day of delivery. This is a strong result in favor of the hypothesis of information transmission at the local level.

Following Gowrisankaran et al. (2015), we assume that access to care decreases as the distance between the mother's municipality and the hospital increases. There are no significantly different effects driven by access to care as proxied by the distance to the nearest hospital or the distance to the hospital chosen for delivery (Table 7 - Columns (3)-(4)). If anything, the farther away the hospital is from the mother's residence, the stronger the effect of exposure. This may signal that mothers are willing to travel more (eventually not choosing the closest hospital) if they strongly prefer a certain procedure.

The absence of family care centers in the mother's municipality largely increases the significance of the exposure (Table 7 - Column (5)). These centers provide check-up visits and prenatal classes to inform women about pregnancy, delivery and the postpartum period. Their absence significantly increases the significance of exposure, which points to a larger role of information sharing between patients when objective medical information is more difficult to access. The estimates for patients having access to family care centers are larger in magnitude but much less significant. The presence of family care centers might increase the heterogeneity in the information available, the provision of more precise information (therefore decreasing the effect of exposure) as well as the opportunity to interact with more people in one's condition (increasing the amount of information related to others' experience).

The availability of specialists in the LHA of the patient seems to reduce the significance of the exposure (Tables 7 - Columns (6) (7)). This may be related to the higher possibility of accessing information through the more formal and safer medical channel. Moreover, the gender composition of the specialists in the LHA may affect the role of exposure, indicating that the women in the sample have more confidence in female physicians (see Mitler et al. (2000)).

7.2 Provider side

Regarding hospital characteristics, there is no evidence of any significantly different effect due to capacity constraints on personnel or beds (Table 8 - Columns (1)-(2)). We define capacity constraints *on personnel* as the ratio between the number of employees and the used beds, while constraints *on beds* is the ratio between used beds and available beds. The rationale for checking the role of capacity constraints is related to the longer hospitalization and the higher number of personnel involved in a C-section, since it is a surgical intervention. The lack of significance is likely to be due to the limited variation over time of capacity constraints, and the effect of capacity constraints might be partially captured by the inclusion of hospital fixed effects. Hence, it is not surprising that the observed differences between the degrees of constraint are not statistically significant. If anything, the effect of exposure decreases as the constraint increases.

We then consider the estimated hospital fixed effects from Equation 1, which capture the time-invariant characteristics at the hospital level, predicting a higher incidence of C-sections after controlling for risk factors, seasonal, yearly, and environmental elements. Hence, the higher the fixed effects are, the greater the hospital's weight in explaining the incidence of C-sections. Table 8 - Column (3) shows how the effect of $Exposure_{mt-12}$ decreases as fixed effects increase, with the difference being statistically significant. This confirms the hypothesis that the potential sorting of a subset of mothers into high fixed effects hospitals leads to a minor role of exposure. Despite patients' preference to select a provider, the higher use of a treatment at the provider level is entirely absorbed by time-invariant hospital characteristics.

Hospital quality is proxied by readmission rates during the 42 days following delivery, a standard measure used by the Ministry of Health to monitor the quality of its birth centers (Table 8 - Column (4)). Even if the results are the right direction, this index for quality has no power to capture a significant difference between hospitals. Higher-quality hospitals may be better able to cope with patient fear and misinformation, reducing the relevance of individual preferences in the adoption of medical procedures.

Moving to the characteristics of the medical team working in a maternity ward, we explore the role of physicians' demographics and professional experience.[17] The effect is driven by less specialized medical teams (Table 8 - Column (5)). The degree of specialization was computed as the average number of medical specializations (max 4) obtained by the physicians on the medical team. This result is consistent with previous findings (Currie et al., 2016) that more-skilled physicians can better match patients with the appropriate treatment than less-skilled physicians. It is also reinforced by the results in 8 - Column (6), where the degree of attractiveness of the ward is considered. We assume that hospitals with a high rate of physicians born outside the region are more attractive to doctors and, consequently, are the hospitals where the best and most motivated physicians self-select. Public hospitals are subject to national agreements on salary and contract conditions, and the process of hiring is made through public calls. However, given equal employment conditions, providers may differ in terms of their career perspectives, research environment and other unmeasured benefits. Overall, this translates into different levels of attractiveness. Considering the geographic composition of the group of physicians, we observe lower effects with the higher attractiveness and, ideally, higher quality of the team.

Moreover, $Exposure_{mt-12}$ plays a stronger role in the case of younger physicians (Table 8 - Column (7))–those specialized after 1992.[18] The main explanation could be that younger (*i.e.,* less experienced) physicians might more frequently opt for a C-section for foreign moth-

[17] Due to data limitations, we cannot match the mother with the physician. We therefore perform the analysis by aggregating individual information on the physicians at the ward level. This analysis implicitly takes into account potential spillovers between physicians working in the same medical team.

[18] Analogous results can be found considering the year of birth or the year of graduation.

ers, given the difficulties in communicating with these patients and the recent developments in cases of malpractice by the Italian jurisprudence. In 1992, the Supreme Court for civil and criminal law found a doctor who did not obtain full consent from the patient before a clinical intervention guilty of murder in the second degree rather than manslaughter (*Decision 5639/92 Caso Massimo*). This decision is considered a turning point in addressing the importance of patient-informed consent in the Italian healthcare system, and it is a benchmark case for medical malpractice claims. Accordingly, it is a topic widely discussed during the university training of physicians.

8 Policy Implications

Understanding the role of information transmission among patients is of pivotal importance for designing effective policies when the target is increasing health-enhancing behaviors or decreasing health-diminishing behaviors. Looking at maternity care quality measures, the health policy literature highlights how women, particularly first-birth mothers, often rely on informal channels, including friends or relatives (Maurer et al. (2016), Declercq et al. (2007), Gourevitch et al. (2017), Gourevitch et al. (2019)). New evidence from Amaral-Garcia et al. (2019) underlines the importance of informal channels such as online resources, confirming the potential spillover effects of inappropriate care. However, informal channels can also affect health behaviors in an efficient way, as in the case of, among others, peer referrals to screenings (Goldberg et al., 2019).

Several policies that operate on the supply side to reduce the number of C-sections without medical indications (*e.g.,* medical liability rules and changes in the prices of treatments), while initiatives directed toward patients are extremely rare both worldwide and in our setting. However, information campaigns are commonly used to increase awareness of the negative consequences of unhealthy behaviors (*e.g.,* smoking-Cohen et al. (2007)-), but they tend to be disregarded in terms of the use of healthcare services, even though they could be an important policy tool.

Torloni et al. (2020) provides the first systematic review of media campaigns to reduce the use of nonmedically motivated C-sections. They observe that campaigns regarding the delivery methods are extremely rare and generally performed by independent agencies (*e.g.,* NGOs and volunteer associations), with no plans for a systematic assessment of the results. Looking at Italy, Torloni et al. (2020) identify a 30-second TV spot produced by the NGO ONDa, which had a limited diffusion in time (Montilla et al., 2020). The spot, available exclusively in Italy, insists that having a delivery through a surgical intervention is not natural and produces no emotional memories of the delivery without providing information to overcome barriers to the use of vaginal deliveries (*e.g.,* the possibility to access epidural anesthesia for pain control).

In the spirit of Van Den Putte et al. (2011), we propose the use of an information campaign providing objective information regarding the opportunity to choose a C-section. Using a panel survey and considering an anti-smoking media campaign, they formally test whether interpersonal communication about the topics of the campaign are related to the exposure to the campaign itself and that conversation has a positive impact on the intention to quit smoking and (indirectly) smoking cessation. The campaign therefore will act through increasing awareness about the topic and stimulating discussion. As suggested by Van Den Putte et al. (2011), the campaign should take into account the potential positive role played by the informal channel, possibly providing messages in a patient-friendly setting and able to stimulate the sharing of information.

Moreover, our results highlight the importance of family care centers, which make available increasingly precise information while allowing pregnant women to interact and share their experience and information with women in the same condition. Hence, another important policy tool could be to favor the spread of these centers.

9 Conclusion

We investigate the role of information transmission between patients in shaping the choice of delivery method. The informal channel for mother i is proxied by the incidence of C-sections among the mothers residing in her same municipality in the 12 months preceding her delivery. We find that the experiences of other people with whom the patient may interact affect her healthcare consumption, increasing the incidence of C-sections by approximately 3%;

on average, this explains 13% of the municipality variation in the incidence of C-sections. Our results are robust to multiple specifications and support the fact that patients can obtain information in many informal ways. Even though we consider a practice that should be discouraged (*i.e.,* the adoption of C-sections without documented medical indications), the rationale behind our analysis can be applied to both other practices that should be discouraged (*e.g.,* use of antibiotics without a medical need) and practices that should be encouraged (*e.g.,* the increase in prevention take-ups).

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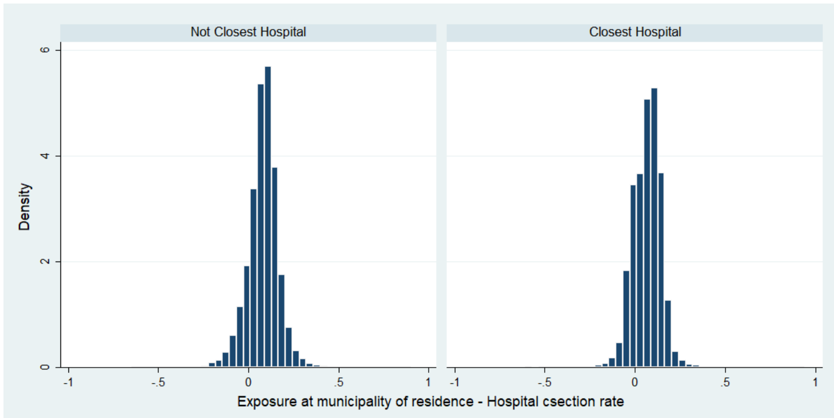
10 Tables and Figures

Table 1: **Controls**

X1			**X2**
Age	Anemia	Multiple deliveries	Urbanization
Italian	Hypertension	Abnormal fetus heart rate	Population density
Married	Cardiovascular problems	Placenta previa	Average income
	Diabetes	Precipitous labor	Average education
	Sexually transmitted diseases	Uterus trauma	
	Drug addiction	Problems with the amniotic cavity	
	Renal failure	Fetus rhesus isoimmunization	
	Thyroid dysfunction	Fetus abnormality	
	Obesity	Breech	
	Pelvic abnormality	Eclampsia	

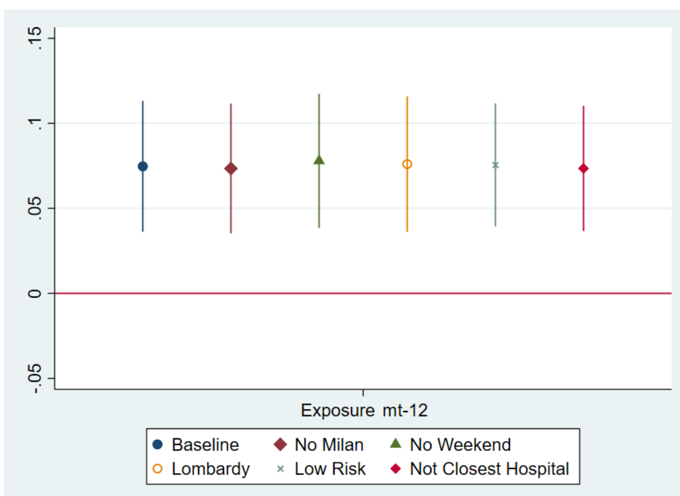
Notes: $X1$ are controls at the mother level. $X2$ are controls at the level of the municipality of residence of the mother. Maternal risk factors are consistent with those used in Dubay et al. (1999), Dubay et al. (2001), Currie and MacLeod (2008), Dranove and Watanabe (2009), Dranove et al. (2011), Shurtz (2013, 2014) and Bertoli and Grembi (2019).

Figure 1: **Difference in C-section rates between patient municipalities and delivery hospitals**



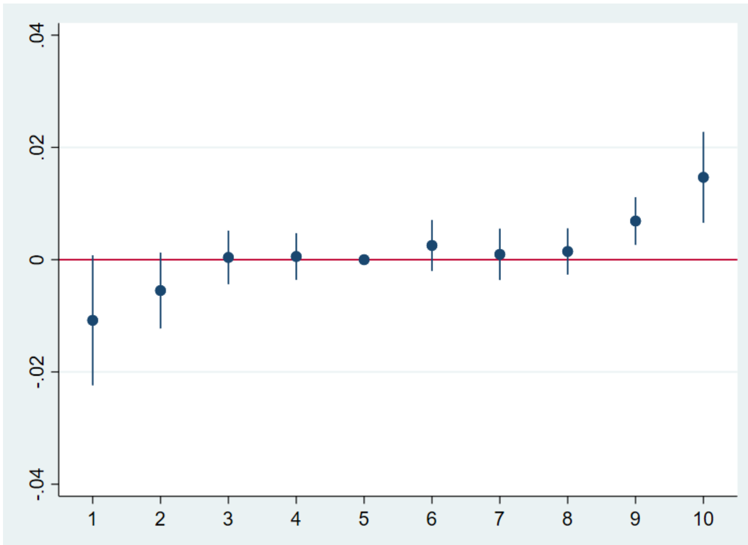
Notes: The variation is computed as the difference between the rate of incidence of C-sections at the municipality of residence and the rate of incidence of C-sections at the hospital selected for delivery for each time period. A zero means that the two measures are the same, which is what we define as a "perfect match" between patient exposure and hospital practice.

Figure 2: **Effects of municipality exposure on the probability of C-sections**



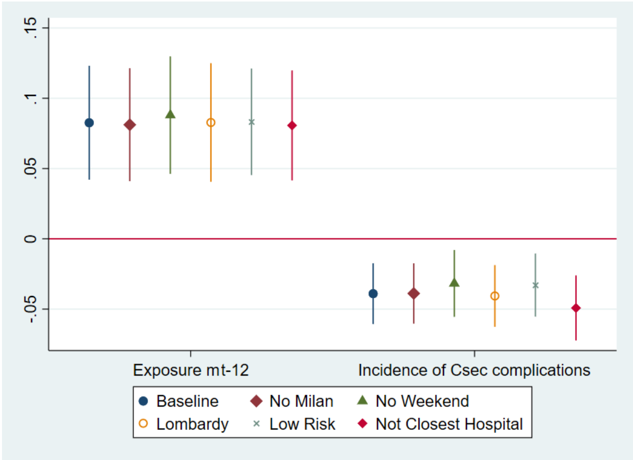
Notes: Estimated effects for Equation 1. Each estimated coefficient represents the specific effect of exposure to C-section use on the individual probability of having a C-section. The estimation is repeated over alternative samples: the baseline (*i.e.*, all observations), the exclusion of mothers from the municipality of Milan, the exclusion of deliveries that occurred during the weekend, the exclusion of mothers officially registered outside Lombardy, the selection of low-risk mothers, and the selection of mothers not choosing the closest hospital. Confidence intervals at 95%. The plotted coefficients are reported in Table A3.

Figure 3: **Effects of deciles of municipality exposure on the probability of C-sections**

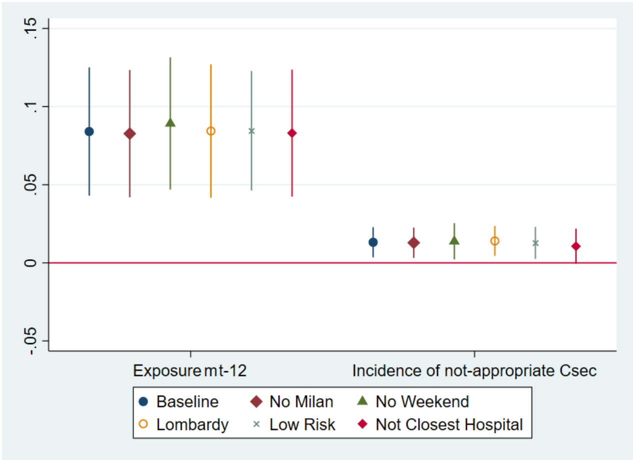


Notes: Estimated effects for Equation 1, where deciles of $Exposure_{mt-12}$ are used in place of the continuous variable $Exposure_{mt-12}$. Each coefficient estimated stands for the specific effect of the exposure deciles with respect to the 5^{th} category. The results are presented for the baseline specification in which all observations are taken into account. Confidence intervals are at 95%.

Figure 4: **Effects of municipality exposures on the probability of C-section complications - C-sections without medical indications**



(a) *C-section complications*



(b) *C-sections without medical indications*

Notes: Estimated coefficients for Equation 2. We estimate both the effect of $Exposure_{mt-12}$ and the effect of complementary information. In the simple model, we estimate only the effect of complementary information. The estimation is repeated over alternative samples: the baseline (*i.e.,* all observations), the exclusion of mothers from the municipality of Milan, the exclusion of deliveries that occurred on a weekend, the exclusion of mothers officially registered outside Lombardy, the selection of mothers with Italian citizenship, the selection of low-risk mothers, and the selection of mothers not choosing the closest hospital. Confidence intervals are at 95%.

Table 2: **Robustness check: Supply-side controls**

	(1)	(2)	(3)	(4)	(5)
Sample selection: All Observations (Baseline)					
δ	0.077***	0.080***	0.071***	0.077***	0.067***
	(0.020)	(0.019)	(0.020)	(0.020)	(0.021)
Number of Obs	734,092	734,092	734,092	734,092	693,759
Controls	Yes	Yes	Yes	Yes	Yes
Time FE, Hospital FE	Yes	Yes	Yes	Yes	Yes
LHA FE		Yes			
LHA trend			Yes		
Hospital trend				Yes	
$Practice\ Style_{mt-12}$					Yes

Notes: *Dependent variable* is a binary variable taking a value of 1 if the patient has a C-section. *Controls* are those specified in $X1$ and $X2$, as described in Table 1. LHA = local health authority. LHA *trend* refers to the local health authority's annual trends. Additional controls include the presence of family care centers, the availability of specialists in the LHA of reference (both overall and gynecologists), and the prevalence of females among specialists in the LHA of reference (both overall and gynecologists). Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Table 3: **Robustness check: Local labor market FE and trends**

	(1)	(2)	(3)	(4)	(5)	(6)
Local Labor Market FE						
δ	0.132***	0.100***	0.092***	0.072***	0.060***	0.109***
	(0.034)	(0.020)	(0.020)	(0.016)	(0.016)	(0.031)
Number of Obs	737,412	737,412	737,412	737,412	737,412	724,606
Controls, Time FE	Yes	Yes	Yes	Yes	Yes	Yes
LLM FE	Yes	Yes	Yes	Yes	Yes	Yes
LHA FE		Yes				
LHA trend			Yes			
Hospital FE				Yes		
Hospital trend					Yes	
$Practice\ Style_{mt-12}$						Yes
Local Labor Market Trends						
δ	0.119***	0.087***	0.085***	0.056***	0.054***	0.145***
	(0.037)	(0.021)	(0.022)	(0.017)	(0.017)	(0.038)
Number of Obs	737,412	737,412	737,412	737,412	737,412	724,606
Controls, Time FE	Yes	Yes	Yes	Yes	Yes	Yes
LLM Trend	Yes	Yes	Yes	Yes	Yes	Yes
LHA FE		Yes				
LHA trend			Yes			
Hospital FE				Yes		
Hospital trend					Yes	
$Practice\ Style_{mt-12}$						Yes

Notes: *Dependent variable* is a binary variable taking a value of 1 if the patient receives a C-section. *Controls* are those specified in $X1$ and $X2$, as described in Table 1. LLM = local labor market. LHA = local health authorities. $LLM\ trend$ and $LHA\ trend$, respectively, refer to the local labor market and local health authority's annual trends. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Table 4: **Robustness check: Municipality FE and** $Exposure_{llmt-12}$

	(1)	(2)	(3)	(4)	(5)	(6)
Sample selection: All Observations (Baseline)						
δ	0.144***	0.173***	0.167***	0.157***	0.156***	0.196***
	(0.025)	(0.025)	(0.026)	(0.026)	(0.025)	(0.028)
Number of Obs	737,412	737,412	737,412	737,412	737,412	724,606
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time FE, Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
LHA FE		Yes				
LHA trend			Yes			
Hospital FE				Yes		
Hospital trend					Yes	
$Practice\ Style_{mt-12}$						Yes

Notes: *Dependent variable* is a binary variable taking a value of 1 if the patient receives a C-section.$Exposure_{llmt-12}$ represents the exposure computed at the local labor market level. *Controls* are those specified in $X1$ and $X2$, as described in Table 1. $Municipality$ = municipality. LHA = local health authorities. *LHA trend* refers to the local health authority's annual trends. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Table 5: **Effects of municipality exposure on the probability of C-sections among Italian and foreign mothers**

	Sample: Italian Mothers					*Sample: Foreign Mothers*				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Equation 3 - Exposure: own group										
δ_{own}	0.075***	0.070***	0.061***	0.064***	0.079***	0.023**	0.022**	0.020**	0.019*	0.023**
	(0.017)	(0.016)	(0.016)	(0.017)	(0.018)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Number of Obs	555,535	555,535	555,535	555,535	546,726	176,982	176,982	176,982	176,982	176,522
Equation 4 - Exposure: other group										
δ_{other}	0.014	0.016*	0.016	0.013	0.016	0.083***	0.085***	0.079***	0.075***	0.084***
	(0.010)	(0.009)	(0.009)	(0.010)	(0.009)	(0.023)	(0.023)	(0.024)	(0.024)	(0.023)
Number of Obs	390,217	390,217	390,217	390,217	389,933	168,404	168,404	168,404	168,404	168,253
Equation 5 - Exposure: both groups										
δ_{own}	0.095***	0.100***	0.086***	0.076***	0.104***	0.025**	0.025**	0.023**	0.021*	0.026**
	(0.026)	(0.024)	(0.025)	(0.028)	(0.026)	(0.011)	(0.010)	(0.011)	(0.011)	(0.011)
δ_{other}	0.007	0.010	0.011	0.008	0.009	0.075***	0.078***	0.071***	0.067***	0.076***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.022)	(0.022)	(0.023)	(0.023)	(0.021)
Number of Obs	390,205	390,205	390,205	390,205	389,923	167,777	167,777	167,777	167,777	167,645
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE, Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LHA FE		Yes					Yes			
LHA trend			Yes					Yes		
Hospital trend				Yes					Yes	
Practice Style$_{mt-12}$					Yes					Yes

Notes: Subgroup analysis in which Italian and foreign mothers are considered separately (Equations 3, 4, and 5). *Dependent variable* is a binary variable taking a value of 1 if the patient receives a C-section. δ_{own} is the effect of the exposure within the group to which the mother belongs; δ_{other} is the reverse effect. *Controls* are those specified in $X1$ and $X2$ as described in Table 1. LHA = local health authorities. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Table 6: **Effects of municipality exposure on the probability of C-section complications and C-sections without medical indications among Italian and foreign mothers**

	Sample: Italian Mothers			*Sample: Foreign Mothers*		
	(1)	(2)	(3)	(4)	(5)	(6)
Exposure to own group and C-section complications						
δ_{own}	0.100***	0.108***	0.109***	0.023**	0.023**	0.023**
	(0.027)	(0.025)	(0.027)	(0.011)	(0.011)	(0.011)
$compl_{own}$	-0.057***	-0.056***	-0.057***	-0.022*	-0.021*	-0.022*
	(0.014)	(0.013)	(0.014)	(0.012)	(0.011)	(0.012)
$compl_{other}$	-0.008	-0.008	-0.008	-0.042*	-0.038*	-0.042*
	(0.007)	(0.007)	(0.007)	(0.021)	(0.021)	(0.022)
Number of Obs	377,229	377,229	377,012	161,581	161,581	161,485
Exposure yo own group and C-sections without medical indications						
δ_{own}	0.103***	0.110***	0.112***	0.024**	0.023**	0.023**
	(0.028)	(0.026)	(0.028)	(0.011)	(0.011)	(0.011)
$nomedical_{own}$	0.012	0.014*	0.012	0.010**	0.010***	0.010**
	(0.008)	(0.007)	(0.008)	(0.004)	(0.004)	(0.004)
$nomedical_{other}$	0.005	0.006*	0.005	0.027***	0.028***	0.027***
	(0.003)	(0.003)	(0.003)	(0.008)	(0.008)	(0.008)
Number of Obs	377,229	377,229	377,012	161,581	161,581	161,485
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time FE, Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes
LHA FE		Yes			Yes	
$Practice\ Style_{mt-12}$			Yes			Yes

Notes: Subgroup analysis in which Italian and foreign mothers are considered separately (Equation 2). *Dependent variable* is a binary variable taking a value of 1 if the patient receives a C-section. δ_{own} is the effect of the exposure within the group to which the mother belongs; δ_{other} is the reverse effect. The estimations include additional controls for the exposure to complementary information. *Controls* are those specified in $X1$ and $X2$, as described in Table 1. LHA = local health authority. *C-sections without medical indications* are defined as the incidence of C-sections in the group of low-risk mothers. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Table 7: **Heterogeneity analysis - Patients**

	Individual		**Municipality**			**LHA**	
	Marital Status	Day-of-the-week	Distance Closest Hosp	Distance Used Hosp	Family Care Centre	Spec Available	Spec F Available
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Not Married	**Weekend**	**Near**	**Near**	**No**	**Low**	**Low**
δ	0.087***	0.028	0.075***	0.065***	0.078***	0.095***	0.094***
	(0.023)	(0.021)	(0.025)	(0.023)	(0.017)	(0.022)	(0.024)
	Married	**Weekdays**	**Far**	**Far**	**Yes**	**High**	**High**
δ	0.077***	0.099***	0.076***	0.080***	0.095*	0.055*	0.060**
	(0.021)	(0.020)	(0.018)	(0.023)	(0.037)	(0.031)	(0.026)
$Difference$	-0.010	0.071***	0.001	0.015	0.017	-0.039	-0.034
	(0.023)	(0.017)	(0.023)	(0.031)	(0.027)	(0.037)	(0.034)
Number Obs	734,092	734,092	734,092	734,092	734,092	734,092	734,092
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LHA FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Estimated effects for Equation 6 for the full sample. The table presents the potential patient-related drivers of heterogeneity. They are individual socioeconomic status, proxied by marital status; the degree of discretion; and the access to care, measured as the distance between the municipality of the mother and the nearest hospital, the presence of family care centers and the availability of specialists. The degree of discretion is identified by the day when the delivery occurs (*i.e.,* discretion is higher on weekdays than on weekends). Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Table 8: **Heterogeneity analysis - Providers**

	Hospital				Medical Team		
	Constraint 1: beds	Constraint 2: personnel	Hospital FE	Quality: readmission	Specialization	Attractiveness	Year of Graduation
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Low	**Low**	**Low**	**Low**	**Low**	**Low**	**Before 1992**
δ_{own}	0.094***	0.086***	0.110***	0.027	0.116***	0.138***	0.059***
	(0.024)	(0.023)	(0.031)	(0.023)	(0.030)	(0.033)	(0.013)
	High	**High**	**High**	**High**	**High**	**High**	**After 1992**
δ_{own}	0.078***	0.083***	0.050***	0.015	0.042**	0.038***	0.118***
	(0.019)	(0.021)	(0.016)	(0.012)	(0.020)	(0.012)	(0.038)
$Difference$	-0.016	-0.003	-0.060*	-0.012	-0.075*	-0.100**	0.059
	(0.019)	(0.024)	(0.035)	(0.030)	(0.037)	(0.034)	(0.040)
Number Obs	647,594	647,576	734,092	226,716	577,211	577,211	577,211
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LHA FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

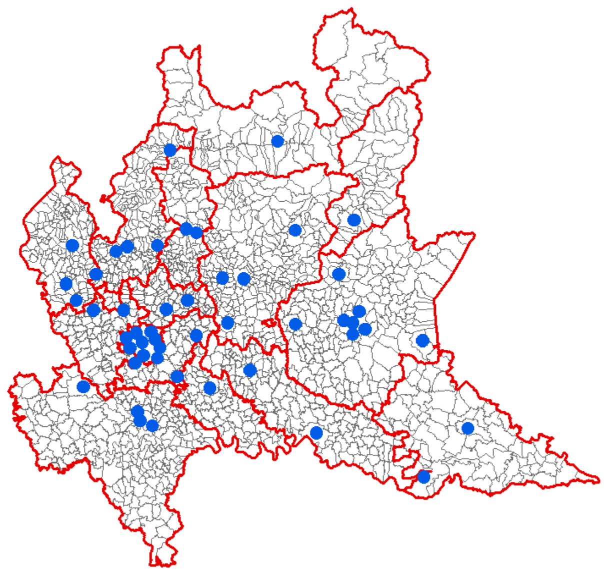
Notes: Estimated effects for Equation 6 for the full sample. The table presents the potential provider-related drivers of heterogeneity, considering characteristics of the hospital or the medical team. Ay the hospital level, they are defined as practice style (*i.e.,* estimated fixed effects, capturing the relevance of "nonmedical factors" for the medical decision process); capacity constraints (*i.e.,* constraints on the available beds – Constraint 1– or on personnel – Constraint 2); and a quality indicator (*i.e.,* quality proxied by the readmission rate during the 42 days following the delivery). Observing the characteristics of the medical team working in the maternity ward, we identify the role of the degree of specialization (*i.e.,* the average number of specializations held by the team members), attractiveness (*i.e.,* composition of the team in terms of individuals who were born or graduated in other regions), and the year of graduation (*i.e.,* 1992 is a crucial year in terms of the relation between patients and physicians due to a change in medical liability rules). All the thresholds are based on the median of the variable distribution. To facilitate the interpretation, the results for Constraint 2 are categorized as *high* for a low ratio of personnel to beds and *low* for a high ratio of personnel to beds. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Appendix A

This Appendix provides additional tables and figures to support the evidence in the main text, as well as two sections that further discuss them. In particular, we present the following:

- Lombardy: distribution of municipalities, local health authorities, and hospitals (Figure A1);
- Survey ONDa (Table A1);
- Exposure variability: national level vs. Lombardy (Figure A2);
- Descriptive statistics by municipality size (Figure A3);
- Fertility rates (Table A2);
- Estimated coefficients: $Exposure_{mt-12}$ in the municipality (Table A3);
- Robustness check: dropping perfect-match patients (Table A4);
- Robustness check: controlling for fertility rates (Table A5);
- Effects of municipality exposure on the probability of C-sections – Italian and foreign mothers (Table A6);
- Trend in the average C-section rate by exposure deciles (Figure A4);
- Alternative specifications (Section A1 and Figure A5);
- Country-of-origin fixed effects (Section A2);
- Effects of municipality exposure on the probability of C-sections – Foreign mothers (Table A7).

Figure A1: **Lombardy: Distribution of municipalities, local health authorities, and hospitals**



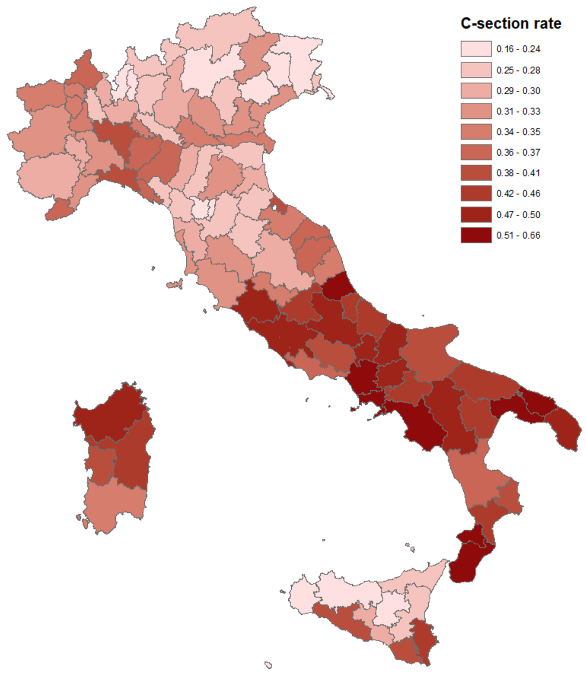
Notes: The gray borders define municipalities, the red borders define local health authorities, and the blue dots represent hospitals.

Table A1: **Survey ONDa**

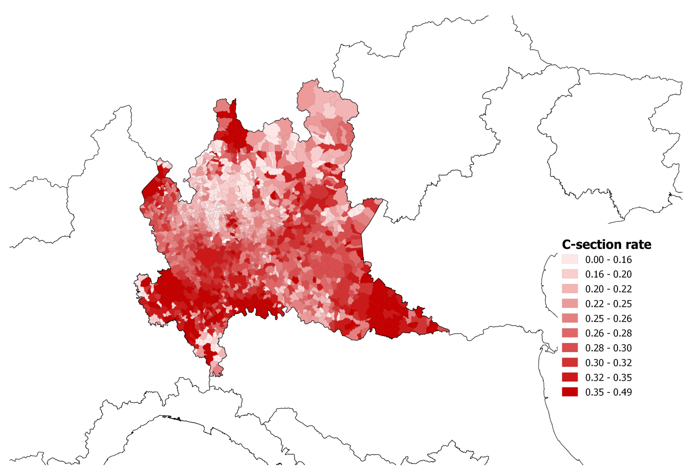
Prevalence	Reason
77%	Fear for the pain of birth
74.5%	Convenience of scheduling the delivery
64%	Perception of the surgical procedure as safer for the mother or the newborn
43.6%	Easier return to sexual activity
38.7%	Positive experience reported by others, either friends of relatives
36.7%	Having a previous C-section as a risk factor
32.3%	Not having certainty about the access to epidural anesthesia

Notes: Data come from the survey conducted by the NGO ONDa in 2010 (Torloni et al., 2013). The table presents the full list of the main motivations among women who declare they would prefer a C-section.

Figure A2: **Exposure variability: National level vs. Lombardy**



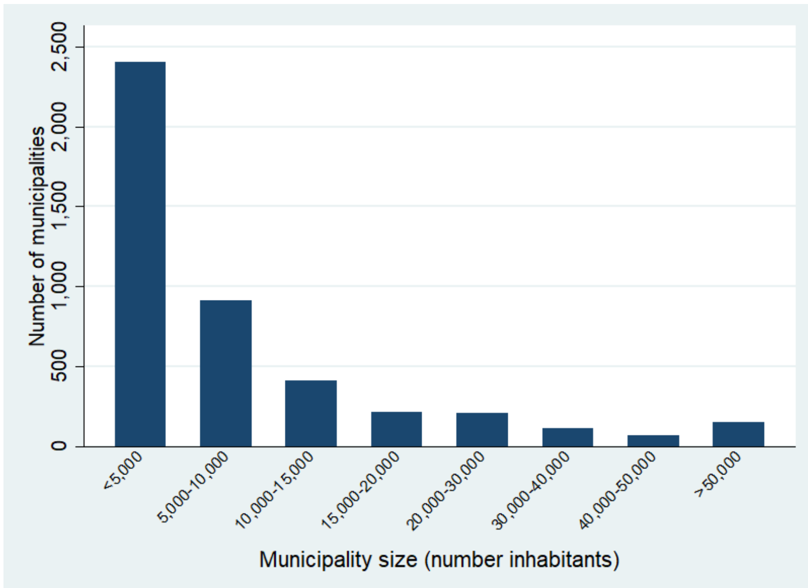
(a) Italy - Provincial level



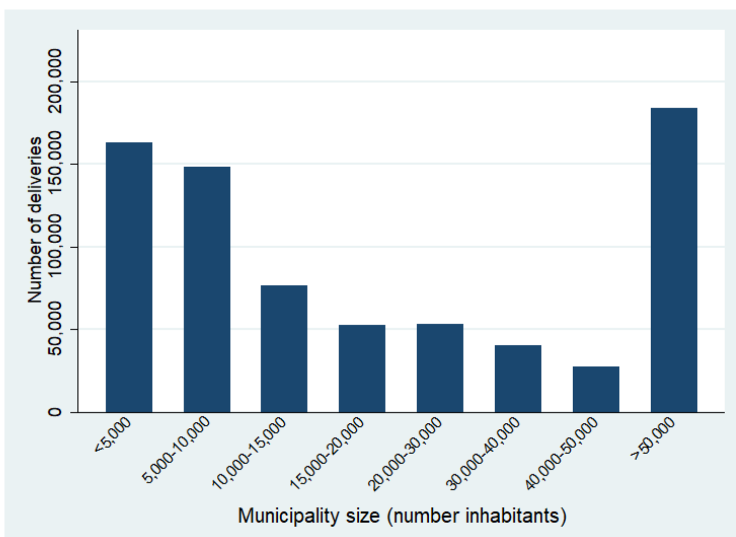
(b) Lombardy - Municipality level

Notes: Descriptive statistics on the spatial variability in C-section use in Italy. The map in Figure A2a gives an overall picture of the country, considering provinces as units of analysis (each region is divided into a certain number of provinces; they represent an intermediate administrative level and generally coincide with LHAs). The map in Figure A2b focuses on the region of Lombardy and presents statistics at the municipality level. The whole period of analysis is taken into account when computing the averages (2006-2014).

Figure A3: **Descriptive statistics by municipality size**



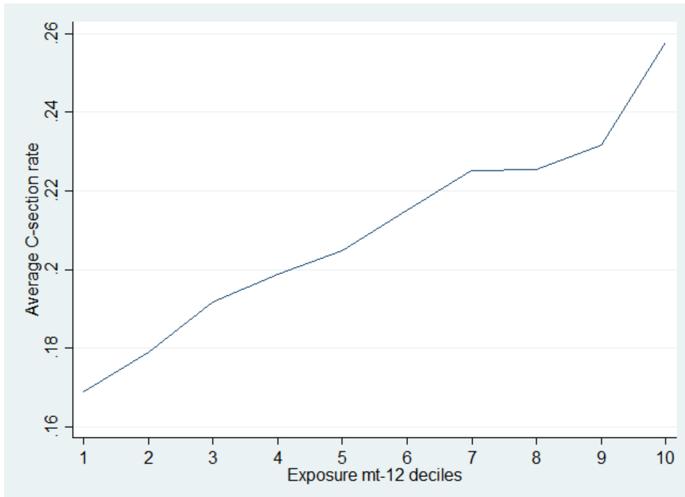
(a) Frequency of municipalities in the sample per municipality size



(b) Frequency of deliveries in the sample per municipality size

Notes: Distribution of the number of different municipalities and the number of deliveries by municipality. Official information on the municipality dimension is provided by ISTAT.

Figure A4: **Trend in the average C-section rate by exposure deciles**



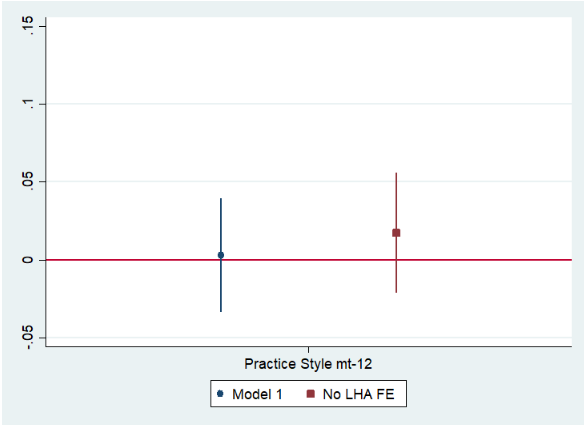
Notes: Descriptive evidence of the relation between $Exposure_m$ and the probability of undergoing a C-section.

Table A2: **Fertility rates**

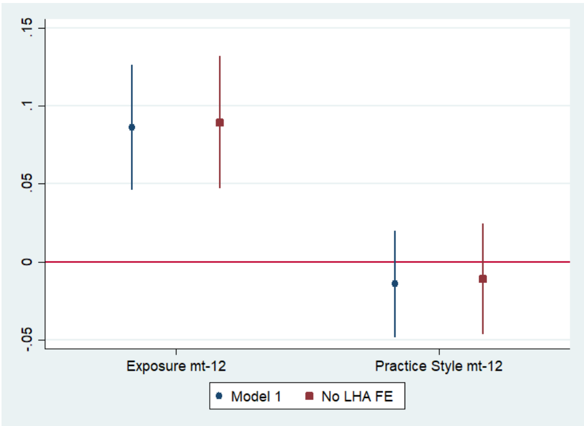
Citizenship	Sample	2006	2007	2008	2009	2010	2011	2012	2013	2014
Overall	Italy	1.37	1.40	1.45	1.45	1.46	1.44	1.42	1.39	1.37
	Lombardy	1.43	1.47	1.54	1.57	1.57	1.53	1.51	1.48	1.46
Italian	Italy	1.28	1.30	1.34	1.33	1.34	1.32	1.29	1.29	1.29
	Lombardy	1.25	1.28	1.32	1.32	1.34	1.31	1.29	1.29	1.29
Foreign	Italy	2.92	2.80	2.65	2.55	2.43	2.36	2.37	2.10	1.97
	Lombardy	3.14	3.04	2.98	3.01	2.80	2.58	2.56	2.31	2.17

Notes: Fertility rates by citizenship of the mother as reported by the national institute of statistics (ISTAT). Rates are computed as the average number of children per woman aged 15 to 49 in the reference sample.

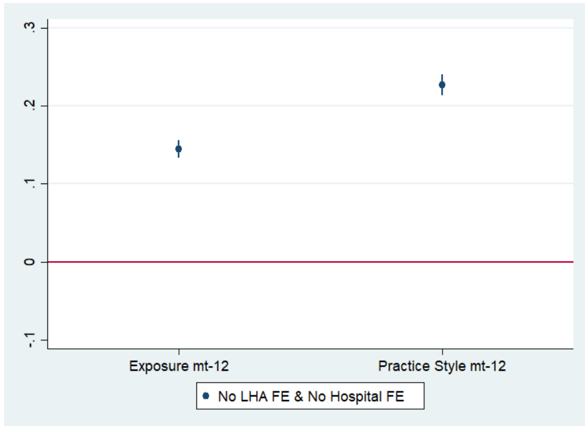
Figure A5: **Alternative specifications**



(a) $Practice\ Style_{mt-12}$



(b) *Both indexes included*



(c) *No hospital fixed effects*

Notes: Comparison between alternative models. Figure A5a compares the results for Equation 1 and Equation 1 without LHA fixed effects when $Practice\ Style_{mt-12}$ substitutes $Exposure_{mt-12}$. In contrast to the baseline specification, Figures A5b and A5c present results when both $Exposure_{mt-12}$ and $Practice\ Style_{mt-12}$ are included. Figure A5b reports the estimates when Equation 1 and Equation 1 without LHA fixed effects are applied (with the additional inclusion of $Practice\ Style_{mt-12}$). Figure A5c reports the estimates when hospital fixed effects are omitted from Equation 1 (with the additional inclusion of $Practice\ Style_{mt-12}$). Confidence intervals are at 95%.

Table A3: **Estimated coefficients:** $Exposure_{mt-12}$ **by municipality**

	(1)	(2)	(3)	(4)	(5)
Sample selection: All Observations (Baseline)					
δ	0.087***	0.084***	0.075***	0.076***	0.109***
	(0.020)	(0.019)	(0.019)	(0.020)	(0.023)
Number of Obs	737,412	737,412	737,412	737,412	693,759
Sample selection: Municipality of origin not Milan					
δ	0.086***	0.083***	0.073***	0.075***	0.107***
	(0.020)	(0.018)	(0.019)	(0.020)	(0.023)
Number of Obs	642,280	642,280	642,280	642,280	598,627
Sample selection: Not Weekend delivery					
δ	0.090***	0.088***	0.078***	0.080***	0.112***
	(0.020)	(0.019)	(0.020)	(0.021)	(0.024)
Number of Obs	547,914	547,914	547,914	547,914	515,369
Sample selection: Municipality of residence in Lombardy					
δ	0.083***	0.085***	0.076***	0.071***	0.106***
	(0.021)	(0.019)	(0.020)	(0.022)	(0.025)
Number of Obs	718,042	718,042	718,042	718,042	675,791
Sample selection: Italian citizenship					
δ	0.089***	0.085***	0.075***	0.078***	0.108***
	(0.019)	(0.019)	(0.019)	(0.020)	(0.023)
Number of Obs	554,760	554,760	554,760	554,760	519,505
Sample selection: Low-risk mothers					
δ	0.089***	0.085***	0.076***	0.078***	0.112***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.021)
Number of Obs	651,413	651,413	651,413	651,413	613,056
Sample selection: Not Closest Hospital					
δ	0.088***	0.083***	0.073***	0.078***	0.104***
	(0.019)	(0.018)	(0.018)	(0.020)	(0.021)
Number of Obs	447,786	447,786	447,786	447,786	417,400
Controls	Yes	Yes	Yes	Yes	Yes
Time FE, Hospital FE	Yes	Yes	Yes	Yes	Yes
LHA FE		Yes			
LHA trend			Yes		
Hospital trend				Yes	
$Practice\ Style_{mt-12}$					Yes

Notes: *Dependent variable* is a binary variable taking a value of 1 if the patient receives a C-section. *Controls* are those specified in $X1$ and $X2$, as described in Table 1. LHA = local health authority. *LHA trend* refers to the local health authority's annual trends. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Table A4: **Robustness check: dropping perfect-match patients**

	(1)	(2)	(3)	(4)	(5)
Sample selection: All Observations (Baseline)					
δ	0.086***	0.084***	0.076***	0.077***	0.109***
	(0.020)	(0.019)	(0.019)	(0.020)	(0.023)
Number of Obs	661,063	661,063	661,063	661,063	620,442
Sample selection: Municipality of origin not Milan					
δ	0.085***	0.083***	0.075***	0.077***	0.108***
	(0.020)	(0.019)	(0.019)	(0.020)	(0.023)
Number of Obs	568,805	568,805	568,805	568,805	528,184
Sample selection: Not Weekend delivery					
δ	0.090***	0.088***	0.079***	0.080***	0.112***
	(0.020)	(0.019)	(0.020)	(0.021)	(0.024)
Number of Obs	491,667	491,667	491,667	491,667	461,373
Sample selection: Municipality of residence in Lombardy					
δ	0.082***	0.085***	0.077***	0.072***	0.106***
	(0.021)	(0.020)	(0.020)	(0.022)	(0.025)
Number of Obs	643,102	643,102	643,102	643,102	603,803
Sample selection: Italian citizenship					
δ	0.088***	0.085***	0.076***	0.079***	0.108***
	(0.019)	(0.018)	(0.019)	(0.020)	(0.023)
Number of Obs	498,569	498,569	498,569	498,569	465,731
Sample selection: Low-risk mothers					
δ	0.088***	0.084***	0.076***	0.078***	0.111***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.021)
Number of Obs	583,445	583,445	583,445	583,445	547,785
Sample selection: Not Closest Hospital					
δ	0.087***	0.083***	0.075***	0.080***	0.105***
	(0.019)	(0.018)	(0.018)	(0.019)	(0.021)
Number of Obs	399,492	399,492	399,492	399,492	371,275
Controls	Yes	Yes	Yes	Yes	Yes
Time FE, Hospital FE	Yes	Yes	Yes	Yes	Yes
LHA FE		Yes			
LHA trend			Yes		
Hospital trend				Yes	
$Practice\ Style_{mt-12}$					Yes

Notes: *Dependent variable* is a binary variable taking a value of 1 if the patient receives a C-section. *Controls* are those specified in $X1$ and $X2$ as described in Table 1. LHA = local health authority. LHA *trend* refers to the local health authority's annual trends. Perfect matched patients are defined according to the difference between $Exposure_{mt-12}$ and the incidence of C-sections at the delivery hospital. When this difference is zero, we define it as a perfect match. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Table A5: **Robustness check: controlling for fertility rates**

	(1)	(2)	(3)	(4)	(5)
Sample selection: All Observations (Baseline)					
δ	0.086***	0.083***	0.075***	0.076***	0.108***
	(0.020)	(0.019)	(0.019)	(0.020)	(0.023)
Number of Obs	737,312	737,312	737,312	737,312	693,663
Sample selection: Municipality of origin not Milan					
δ	0.084***	0.082***	0.073***	0.075***	0.106***
	(0.020)	(0.018)	(0.019)	(0.020)	(0.023)
Number of Obs	642,180	642,180	642,180	642,180	598,531
Sample selection: Not Weekend delivery					
δ	0.089***	0.087***	0.078***	0.079***	0.110***
	(0.021)	(0.019)	(0.020)	(0.021)	(0.024)
Number of Obs	547,836	547,836	547,836	547,836	515,295
Sample selection: Municipality of residence in Lombardy					
δ	0.083***	0.084***	0.076***	0.072***	0.106***
	(0.021)	(0.019)	(0.020)	(0.022)	(0.025)
Number of Obs	718,042	718,042	718,042	718,042	675,791
Sample selection: Italian citizenship					
δ	0.087***	0.084***	0.075***	0.077***	0.106***
	(0.020)	(0.018)	(0.019)	(0.020)	(0.024)
Number of Obs	554,672	554,672	554,672	554,672	519,420
Sample selection: Low-risk mothers					
δ	0.087***	0.083***	0.075***	0.078***	0.110***
	(0.018)	(0.018)	(0.018)	(0.019)	(0.021)
Number of Obs	651,331	651,331	651,331	651,331	612,977
Sample selection: Not Closest Hospital					
δ	0.086***	0.082***	0.073***	0.078***	0.102***
	(0.020)	(0.018)	(0.018)	(0.020)	(0.022)
Number of Obs	447,686	447,686	447,686	447,686	417,304
Controls	Yes	Yes	Yes	Yes	Yes
Time FE, Hospital FE	Yes	Yes	Yes	Yes	Yes
LHA FE		Yes			
LHA trend			Yes		
Hospital trend				Yes	
$Practice\ Style_{mt-12}$					Yes

Notes: *Dependent variable* is a binary variable taking a value of 1 if the patient receives a C-section. *Controls* are those specified in $X1$ and $X2$, as described in Table 1. LHA = local health authority. *LHA trend* refers to the local health authority's annual trends. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Table A6: **Effects of municipality exposure on the probability of C-sections - Italian and foreign mothers**

Restriction: at least 5 Italian and 5 foreign mothers in the 12 months preceding delivery

	Sample: Italian Mothers					*Sample: Foreign Mothers*				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Equation 3 - Exposure: own group										
δ_{own}	0.090***	0.085***	0.073***	0.077***	0.095***	0.037***	0.037***	0.033**	0.031**	0.038***
	(0.019)	(0.018)	(0.019)	(0.020)	(0.020)	(0.013)	(0.013)	(0.014)	(0.014)	(0.013)
Number of Obs	527,432	527,432	527,432	527,432	520,138	162,606	162,606	162,606	162,606	162,421
Equation 4 - Exposure: other group										
δ_{other}	0.014	0.016	0.016	0.013	0.016	0.091***	0.094***	0.087***	0.083***	0.093***
	(0.011)	(0.010)	(0.011)	(0.012)	(0.011)	(0.024)	(0.024)	(0.025)	(0.026)	(0.024)
Number of Obs	370,616	370,616	370,616	370,616	370,431	157,920	157,920	157,920	157,920	157,849
Equation 5 - Exposure: both groups										
δ_{own}	0.099***	0.105***	0.088***	0.077**	0.109***	0.030**	0.030**	0.027*	0.024	0.031**
	(0.028)	(0.025)	(0.027)	(0.030)	(0.028)	(0.014)	(0.013)	(0.014)	(0.014)	(0.014)
δ_{other}	0.004	0.008	0.009	0.005	0.007	0.085***	0.089***	0.083***	0.079***	0.089***
	(0.009)	(0.008)	(0.009)	(0.009)	(0.008)	(0.023)	(0.022)	(0.024)	(0.024)	(0.023)
Number of Obs	370,616	370,616	370,616	370,616	370,431	157,920	157,920	157,920	157,920	157,849
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE, Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LHA FE		Yes					Yes			
LHA trend			Yes					Yes		
Hospital trend				Yes					Yes	
Practice Style$_{mt-12}$					Yes					Yes

Notes: Subgroup analysis in which Italian and foreign mothers are considered separately (Equations 3, 4, and 5). *Dependent variable* is a binary variable taking a value of 1 if the patient recei
δ_{own} is the effect of the exposure within the group to which the mother belongs; δ_{other} is the reverse effect. *Controls* are those specified in $X1$ and $X2$, as described in Table 1. LHA = local h
Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

A1 Alternative specifications

Since mothers from the same municipality deliver in different hospitals, we allow the practice style index to be sensitive both to changes in the C-section rate at the hospital level and changes in referral patterns (*i.e.,* changes in the hospitals chosen by mothers registered in the same municipality). Each of these components is computed in the relevant time period ($t-12$, month of delivery excluded). The index described in Equation 7 is defined as the weighted average of the practice styles to which each mother is exposed, where the practice styles are the average C-section rates in each hospital covering municipality m in $t-12$. Defining N as the overall number of hospitals used by at least 1 mother registered in municipality m in the period $t-12$, $Practice\ style_{mt-12}$ is equal to

$$Practice\ style_{mt-12} = \sum_{j=1}^{N} \lambda_{mjt-12} X_{jt-12} \tag{7}$$

where X_{jt-12} is the C-section rate in hospital j during the 12 months preceding the delivery (*i.e.,* the average practice style at hospital level) and λ_{mjt-12} is the share of mothers registered in m who gave birth in j during the relevant time period (*i.e.,* weight assigned to each hospital).[19] As a result, the index is a weighted average of averages, which is unlikely to be sensitive to individual observation but instead captures broad changes in practice styles.

We estimate the baseline model including the measure of $Practice\ style_{mt-12}$ as a control in place of LHA fixed effects. Both of the methods used to control for dynamic changes in physicians' practice styles, the hospital time trend and $Practice\ style_{mt-12}$, produce results significantly different from the baseline estimation (Tables A3, A4 - Columns (4) (5), A5). If anything, when we control for $Practice\ style_{mt-12}$, the magnitude of $Exposure_{mt-12}$ slightly increases, producing a percentage effect of 4% (in contrast to 3% for our baseline). These

[19]For example, assume a hypothetical municipality in which 30% of mothers gave birth in hospital A, 25% in hospital B and the remaining 45% in hospital C in the period $t-12$. Then, given a C-section incidence of 16% in hospital A, 30% in hospital B and 25% in hospital C in the relevant period, we compute $Practice\ style_{mt-12}$ as 0.16*0.3+0.3*0.25+0.25*0.45=0.048+0.075+0.113=0.236. Hospitals not used by mothers from municipality m in period $t-12$ are implicitly assigned a weight equal to 0 and are therefore excluded from the calculation. During the period considered, 2006-2014, the median number of hospitals serving each municipality was 3.

results confirm that $Exposure_{mt-12}$ is not significantly affected by practice style changes in the healthcare market in which the mother resides.[20]

A2 Country-of-origin fixed effects

In the spirit of Fernandez and Fogli (2009), we first verify whether unobservable information related to the country of origin plays a role in explaining the choice between delivery methods. Our expectations are that, if this is the case, $Exposure_{mt-12}$ should have no relevance for foreigners. Considering the sample of foreign mothers only, we perform three subsequent estimations. First, we estimate the baseline model, verifying whether $Exposure_{mt-12}$ *per se* is still relevant (*Baseline*). Following Fernandez and Fogli (2009), we then add nationality fixed effects (λ_{nat}) to control for country-specific information such as language proximity, fertility trends, cultural beliefs and general behavior (*Specification A*). This estimation implicitly compares foreign mothers who have the same nationality but who live in different municipalities and therefore have different $Exposure_{mt-12}$. Last, we introduce a control, $Country_{it}$, for the C-section rate in the country of origin (*Specification B*).[21] This allows us to control for country-specific unobservables strictly related to the choice between delivery methods (*e.g.,* mothers' physical characteristics, trust in the healthcare system, religious concerns, and women's fertility decisions). The results are presented in Table A7 (*Baseline - Specification A - Specification B*). The effect of $Exposure_{mt-12}$ is robust and stable through the three specifications, meaning that unobservable characteristics of the mother do not play a major role in explaining the effect, at least within the subgroup of foreign mothers. Interestingly, the additional information on the C-section rate in the country of origin (*Specification B*) has a significant effect in explaining the individual probability of undergoing a C-section (*i.e.,* the higher the C-section rate is in the country of origin, the

[20]The use of $Practice\ style_{mt-12}$ in place of $Exposure_{mt-12}$ does not produce significant estimates in Equation 1. This reinforces the hypothesis that mothers are affected by what happens to women close to them, while the average practice style to which they are exposed does not provide additional information relevant to the decision process. When hospital fixed effects are not included, both indexes show larger and strongly significant results, confirming the relevant role played by the choice of hospital.

[21]Information on C-section rates in the country of origin in the relevant year is derived from official sources such as Eurostat, the OECD, the DHS Program, the WHO, and UNICEF.

higher the probability that the i^{th} mother will undergo a C-section), but it plays only a minor role with respect to exposure at the municipality level and does not affect its estimation.

Table A7: **Effects of municipality exposure on the probability of C-sections - Foreign mothers**

	Baseline	Specification A	Specification B
	(1)	(2)	(3)
δ	0.081***	0.082***	0.082***
	(0.024)	(0.025)	(0.025)
δ_{origin}			0.036*
			(0.018)
Number Obs	182,654	182,168	181,120
Controls	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes
LHA FE	Yes	Yes	Yes
Nationality FE		Yes	Yes

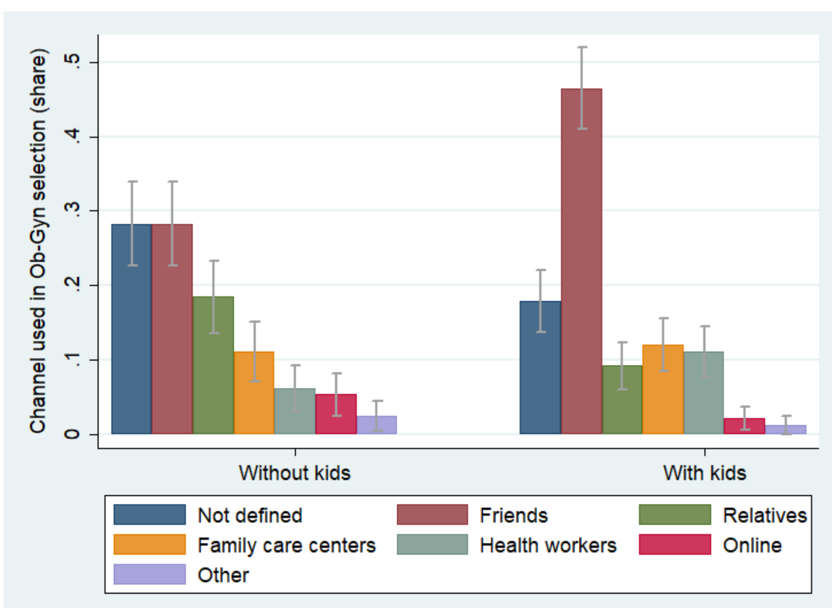
Notes: Estimated coefficients for Equation 1 when only foreign mothers are taken into account (*i.e.,* mothers without Italian citizenship). *Specification 1* includes mother's nationality fixed effects, while *Specification 2* additionally controls for the C-section rate in the country of origin in the relevant year. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Appendix B

This Appendix provides additional results and figures from the flash survey we ran in October-November 2020 and surveys from (ISTAT, 2012) on access to care. It also includes two sections which further discuss the results from the flash survey and the surveys from (ISTAT, 2012). In particular, we present the following:

- Ob-Gyn selection (Figure B1);
- C-sections requested by the mother (Figure B2);
- Role of mothers' preferences of delivery method (Section B1, Figures B3 and B4);
- Channels of information by topic (Figure B5);
- Preventive care use in the absence of medical indications (Section B2, Figure B6).

Figure B1: **Ob-Gyn selection**



Notes: Main channels through which women select Ob-Gyn specialists. The relevance of the inner circle, either friends or relatives, is the most relevant channel, particularly true for women who have children. Data were collected by the authors on a sample of mothers residing in Italy (October-November 2020). Confidence intervals are at 95%.

B1 Role of mothers' preferences of delivery method

Based on the data collected, we first run a basic OLS on the probability that a mother opted for a C-section as a function of parents demographics, household characteristics, and specific information on the pregnancy and maternal status. The estimated coefficients are plotted in Figure B2: the choice is positively correlated with first births and negatively correlated with the mother being employed, which means that working mothers are less likely to opt for a C-section than nonworking mothers. The educational level of both parents does not exert a statistically significant effect (e.g., if any influence exists, the education of the mother is more significant), but mothers belonging to high-income households seem to opt for C-sections without medical indications at a lower rate than those in low-income households.

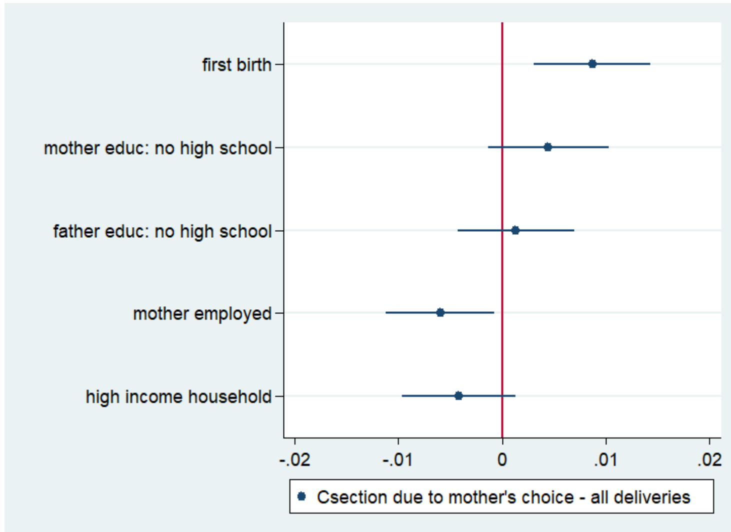
As apparent from Figure B1, in the choice of an Ob-Gyn, the *friends* channel has a primary role. This is particularly true for women having at least one child, for whom the *friends* channel reaches approximately 0.5 share of the sample. For women with children, confidence intervals for the category *friends* do not overlap with those of any of the other categories, meaning that *friends* are largely preferred to the other options. For women without children, the difference between *friends* and *relatives* (and *not defined*) is no longer significant, while the difference between *friends* and other (more formal) channels, such as *family care center*, *health workers*, and *online*, is still significant.

Regarding the delivery method, Figure B3 shows that mothers strongly feel that their opinion matters (*i.e.,* preferences' relevance), particularly when elective C-sections are at stake: the share of those reporting that their opinion has been highly respected ranges from 78% of those having an elective C-section to 59% of those having vaginal deliveries and 43% of those having emergency C-sections. We additionally explore the role of individual factors in affecting the relevance of preferences by means of an OLS regression (Figure B4). In addition to the positive effects associated with being employed and highly educated, having undergone an elective C-section has a positive and significant effect. This result is notable, although there are several sample limitations, as women in the sample tend to actively participate in the treatment selection, especially when an elective C-section is at stake. Deliveries in public hospitals are associated with a lower level of preference relevance, which is consistent with the more rigorous standards applied in those hospitals, which might also face a higher level of constraints. The channel through which the Ob-Gyn specialist is selected has a minor role, with mothers less satisfied when the choice of the Ob-Gyn specialist has been made through online channels (*e.g.,* dedicated websites and social networks). Figure B5 confirms the weak role of the online channel, since mothers score it as the least relevant channel when considering topics such as pregnancy, delivery methods, and the selection of the place to deliver.

B2 Preventive care use in the absence of medical indications

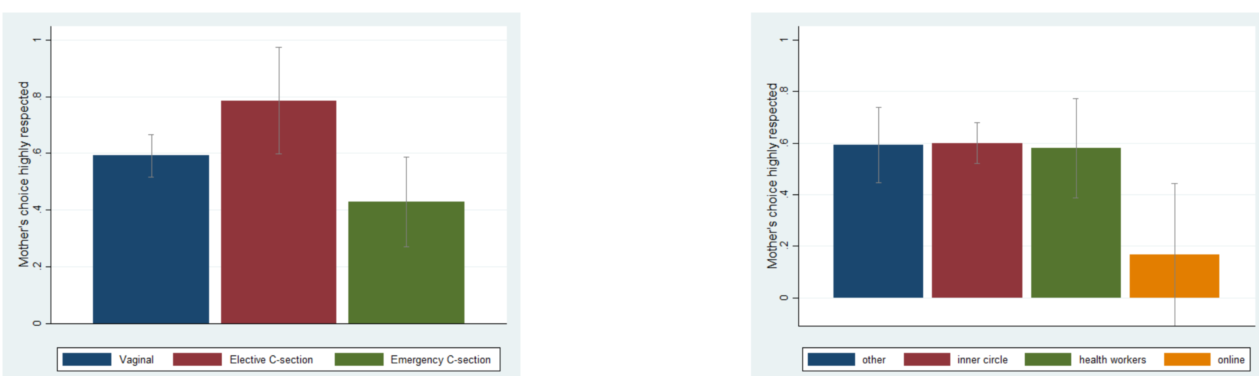
The survey on the health conditions of Italians run by ISTAT in three waves ISTAT (2000, 2005, 2013) confirms that the municipality of residence is a good proxy for an individual network. The survey explicitly asks questions on the use of preventive care (*i.e.,* cholesterol, glycemia and blood pressure screenings) and the reasons for using it (*e.g.,* medical recommendations and the advice of acquaintances), while classifying municipalities based on their population dimensions (*i.e., small*, up to 10,000 inhabitants; *medium*, between 10,000 and 50,000 inhabitants; and *large*, above 50,000 inhabitants). Controlling for several demographics and time trends, we observe that living in smaller municipalities is positively correlated with the adoption of health practices not driven by physician initiatives, with no significant difference between men and women (Figure B6).

Figure B2: **C-sections requested by the mother**



Notes: The outcome variable takes value 1 if the mother reports having explicitly asked for a C-section without medical indication. The analysis was performed on all mothers interviewed, regardless of the delivery method adopted. *Controls* include mother and father demographics (*i.e.,* age, citizenship, education, and the marital status of the mother), as well as additional information on the household (*i.e.,* region of residence, household income, mother's employment status during pregnancy) and medical conditions of the mother (*i.e.,* previous miscarriages, previous deliveries, a twin pregnancy, and the low birth weight of the child). Confidence intervals are plotted at 90%. Dataset: Indagine campionaria sulle nascite 2012. ISTAT (ISTAT (2012)).

Figure B3: **Role of mothers' preference of delivery method (1)**

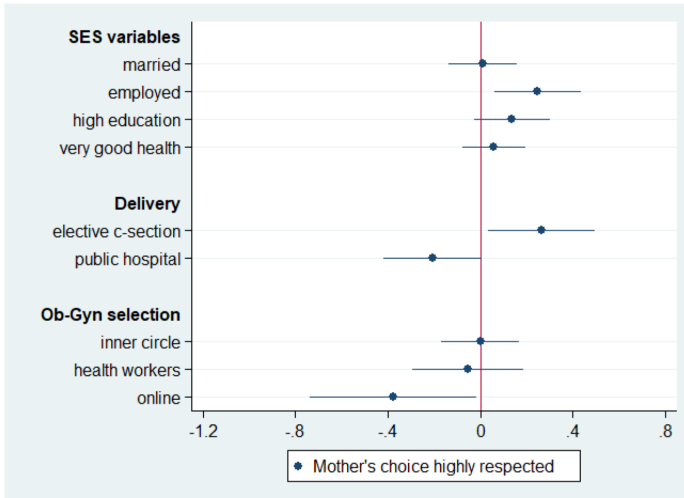


(a) *By delivery type*

(b) *By Ob-Gyn selection*

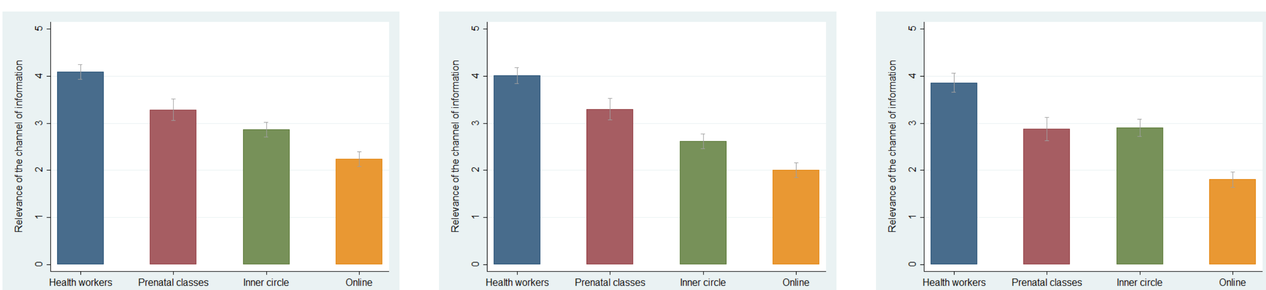
Notes: The share of mothers declaring that their opinion about the delivery method was highly respected (share of mothers answering 5 on a 1 to 5 scale). Data were collected by the authors on a sample of mothers residing in Italy (October-November 2020). Confidence intervals are at 90%.

Figure B4: **Role of mothers' preference of delivery method (2)**



Notes: OLS regression to estimate the role of specific controls on whether the mother felt her opinion about the delivery method was respected. Additional controls: mother age group, year when the delivery took place, and citizenship. Data were collected by the authors on a sample of mothers residing in Italy (October-November 2020). Confidence intervals are at 90%.

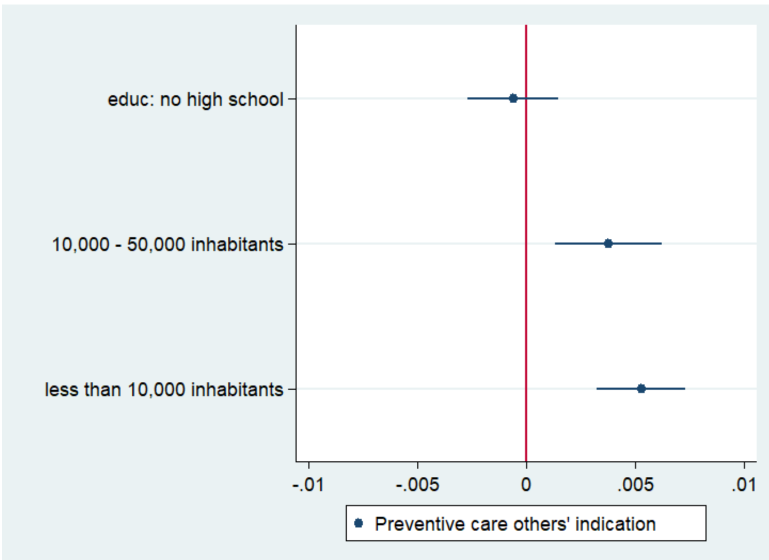
Figure B5: **Channels of information by topic**



(a) *Pregnancy* (b) *Delivery* (c) *Place to deliver*

Notes: Average score assigned to each channel of information by topic; scores are assigned on a 1 (low relevance) to 5 (high relevance) scale. The possible channels are grouped into four categories: health workers (*e.g.,* Ob-Gyns, nurses, and GPs), prenatal classes (*e.g.,* informative courses for pregnant women during the last trimester of pregnancy. Public family care centers regularly organize prenatal classes free of charge), inner circles (*e.g.,* friends and relatives), and online (*e.g.,* websites dedicated to pregnant women and social networks). Data were collected by the authors on a sample of mothers residing in Italy (October-November 2020). Confidence intervals are at 95%.

Figure B6: **Preventive care use in the absence of medical indications**



Notes: The outcome variable takes a value of 1 if the individual reports using preventive care without medical prescriptions (preventive care in the form of cholesterol, glycemia or blood pressure checks). The size of the municipality appears to be strongly related to the informal transmission of health information. *Controls* include individual demographics (*i.e.,* gender, age, citizenship, education, and marital status), as well as additional information of the household (*i.e.,* geographic area of residence, household income, and employment status) and temporal controls (*i.e.,* month of interview and wave). Confidence intervals are plotted at 90%. Dataset: *Indagine sulle Condizioni di Salute ed il Ricorso ai Servizi Sanitari; waves: 1999-2000, 2004-2005, and 2012-2013* ISTAT (2000, 2005, 2013).

Appendix C

This Appendix provides additional descriptive statistics and estimations. In particular, we present the following:

- Variable explanations (Table C1);
- $Exposure_{mt-12}$ - Count Seats Municipalities (Table C2);
- $Exposure$ variance (Table C3);
- City trends in $Exposure_{mt-12}$ by province (Figure C1);
- $Exposure_{llmt-12}$ by year (Table C4);
- Effects of municipality exposure on probability of C-section: $Exposure_{mt}$(Figure C2).

Table C1: **Variable descriptions**

Variable Name	Variable Description	Source	Level
Mother: demographics at the time of delivery			
Age	Age (years)	HDC	I
Citizenship	Citizenship (ISTAT classification)	HDC	I
Marital status	Dummy=1 if married	HDC	I
Residence - municipality	Italian municipality of residence (ISTAT classification)	HDC	I
Residence - region	Italian region of residence (ISTAT classification)	HDC	I
LHA	Patient local health authority	HDC	I
Mother: context			
High education	Share of individuals having at least a high school diploma	ISTAT	M
Average income	Average annual taxable income (euro)	ISTAT	M
Population density	Population/km^2	ISTAT	M
Urbanization	Degree of urbanization (EUROSTAT classification)	ISTAT	M
Family care centre	Dummy=1 if there is at least a family care centre in the municipality of residence	MoH	M
Specialist available	Specialists available in the LHA (over 10,000 inhabs)	HFA	LHA
Share Female Specialists	Share of female specialists over specialists available in the LHA	HFA	LHA
Mother: health status			
Anemia	Dummy=1 if anemia	HDC	I
Thyroid	Dummy=1 if thyroid disfunction	HDC	I
Obesity	Dummy=1 if obesity	HDC	I
Hypertension	Dummy=1 if hypertension	HDC	I
Cardio	Dummy=1 if cardiovascular diseases	HDC	I
Cervix	Dummy=1 if incompetent cervix or other cervix anomalies	HDC	I
Renal	Dummy=1 if renal failure	HDC	I
Diabete	Dummy=1 if diabete	HDC	I
Drugs	Dummy=1 if drug dependence	HDC	I
Std	Dummy=1 if sexually transmitted diseases	HDC	I
Previous C-section	Dummy=1 if at least one previous C-section	HDC	I
Mother: pregnancy			
Breech	Dummy=1 if breech presentation	HDC	I
Eclampsia	Dummy=1 if eclampsia	HDC	I
Placenta previa	Dummy=1 if placenta previa	HDC	I
Prolonged pregnancy	Dummy=1 if prolonged pregnancy	HDC	I
Amnio cavity	Dummy=1 if problems of the amnio cavity	HDC	I
Abnormalities (M)	Dummy=1 if abnormality of organs and soft tissues of pelvi (ante-partum)	HDC	I
Precipitous	Dummy=1 if precipitous labor	HDC	I
Multiple	Dummy=1 if multiple pregnancy	HDC	I
Delivery			
Admission	Date of hospital admission	HDC	I
Event	Date of delivery	HDC	I
Discharge	Date of hospital discharge	HDC	I
C-section	Dummy=1 if C-section intervention	HDC	I
Newborn: health status			
Fetus rh	Dummy=1 if rhesus isoimmunization related to the fetus	HDC	I
Fetus heart	Dummy=1 if abnormality in the fetus heart	HDC	I
Abnormalities (F)	Dummy=1 if fetus abnormality which affect the medical treatment of the mother	HDC	I
Hospital			
Hospital ID	Hospital identification code	HDC	I
Year of birth	Avg year of birth of physicians in the medical team	FNOMCeO	W
Year of graduation	Avg year of graduation of physicians in the medical team	FNOMCeO	W
Year of specialization	Avg year of specialization of physicians in the medical team	FNOMCeO	W
Attractiveness	Share of physicians in the medical team born outside Lombardy	FNOMCeO	W
Specialities	Avg number of specializations of physicians in the medical team	FNOMCeO	W
Bed constraint	Ratio used beds and available beds	MoH	H
Personnel constraint	Ratio personnel and used beds	MoH	H
Used wards	Number of used wards within hospital	MoH	H

Notes: HDC = hospital discharge cards. MoH = Ministry of Health. HFA = Health for All Italy. $ISTAT$ = National Institute of Statistics. $FNOMCeO$ = National Board of Physicians (Federazione Nazionale degli Ordini dei Medici Chirurghi e Odontoiatri). I = Individual level. W = Maternity ward level. H = Hospital level. M = Municipality level. LHA = Local health authority level.

Table C2: $Exposure_{mt-12}$ **- county seats, municipalities**

City	Avg Population	Obs	Mean	Std. Dev.	Min	Max
Milan	1,289,264	107,117	0.321	0.008	0.307	0.339
Bergamo	116,674.6	9,087	0.259	0.015	0.227	0.293
Brescia	190,809.3	16,526	0.311	0.009	0.287	0.326
Como	83,672.4	6,272	0.222	0.031	0.153	0.272
Cremona	71,350.7	4,909	0.253	0.018	0.217	0.297
Lecco	47,390.4	3,748	0.214	0.018	0.177	0.272
Lodi	43,603.19	3,238	0.325	0.025	0.274	0.392
Mantova	47,753.27	3,677	0.380	0.032	0.317	0.446
Monza Brianza	121,226.5	8,281	0.290	0.071	0.206	0.412
Pavia	69,995.08	5,297	0.378	0.016	0.328	0.417
Sondrio	22,012.57	1,525	0.251	0.039	0.154	0.314
Varese	81,050.89	5,920	0.291	0.023	0.241	0.336

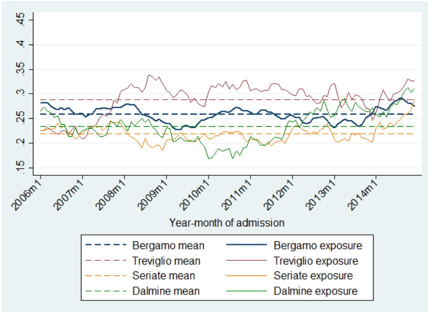
Notes: Summary statistics for $Exposure_{mt-12}$ by city. Only the 12 county seats are taken into account.

Table C3: *Exposure* **variance**

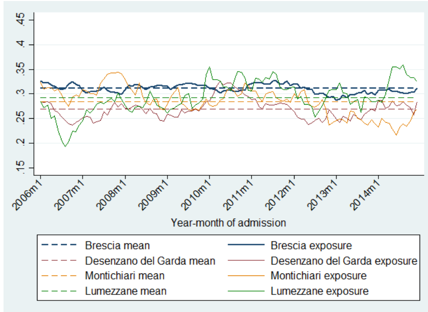
	$Exposure_{mt-12}$			$Exposure_{llmt-12}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Full Sample						
Observations	741,757	741,757	741,757	744,683	744,683	744,683
R-Squared	0.003	0.481	0.484	0.009	0.830	0.839
Adj R-Squared	0.003	0.478	0.481	0.009	0.829	0.839
Panel B: Large Cities						
Observations	183,703	183,703	183,703	183,703	183,703	183,703
R-Squared	0.026	0.775	0.800	0.023	0.910	0.933
Adj R-Squared	0.026	0.774	0.800	0.023	0.910	0.933
Panel C: Small Cities						
Observations	160,039	160,039	160,039	162,443	162,443	162,443
R-Squared	0.002	0.341	0.343	0.007	0.764	0.771
Adj R-Squared	0.002	0.333	0.335	0.007	0.761	0.769
Time FE	Yes	No	Yes	Yes	No	Yes
Municipality FE	No	Yes	Yes	No	Yes	Yes

Notes: The table highlights the share of variation in $Exposure_{mt-12}$ (Columns 1-3) and $Exposure_{llmt-12}$ (Columns 4-6) explained by between-municipality (*i.e.,* year FE) or within-municipality (*i.e.,* municipality FE) factors. With respect to $Exposure_{mt-12}$ computed at the municipality level, the inclusion of time FE produces a marginal increase in R-squared. This means that cities within each panel are not subject to a simultaneous variation in *Exposure*. This evidence ensures that the variable *Exposure* is not sensitive to any common event that may have involved all municipalities at the same time. The inclusion of municipality FE explains about half of the variation in *Exposure* i, which is confirmed in column (3), where we include both time and municipality FE. When moving to the different subsamples, we observe that, as expected, the model with the municipality FE explains a larger share of the variation in the sample of large cities (Panel B). Looking at the same analysis performed over $Exposure_{llmi-12}$ computed at the local labor market level (Columns 4-6), we still observe that municipality FE explain the largest share of the variation respect to time FE, and it is confirmed that municipality FE have a larger explanatory power in the sample of large cities (Panel B).

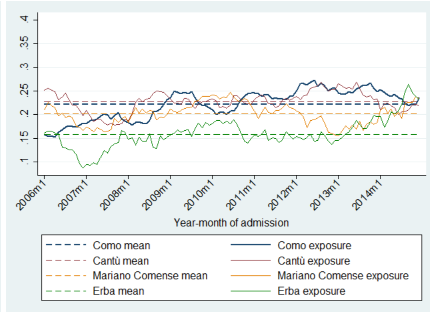
Figure C1: **City trends in $Exposure_{mt-12}$ by province**



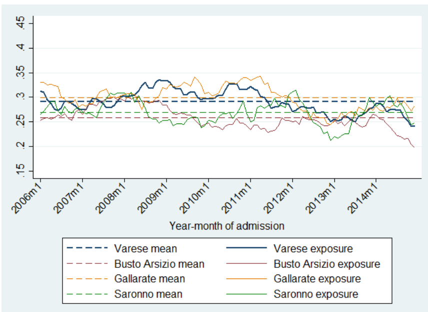
(a) Province: Bergamo



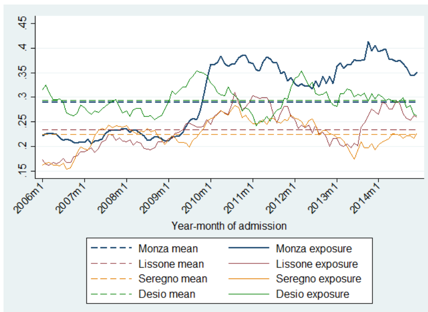
(b) Province: Brescia



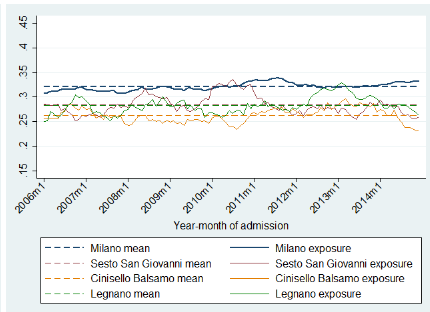
(c) Province: Como



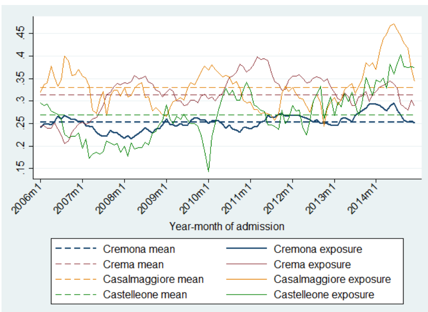
(d) Province: Varese



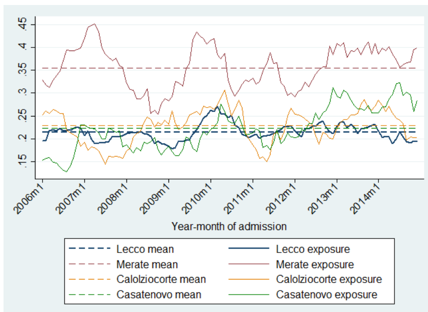
(e) Province: Monza Brianza



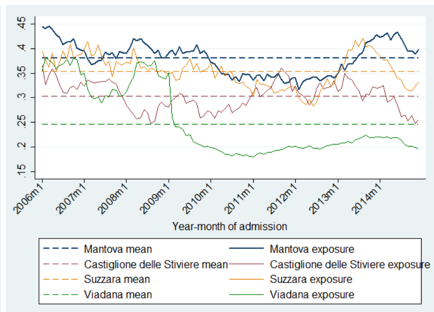
(f) Province: Milano



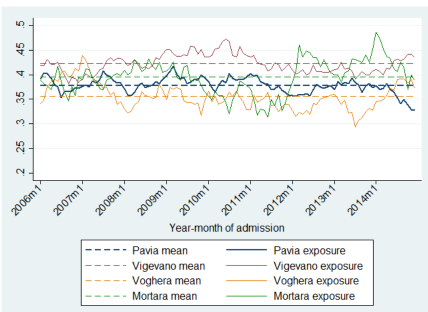
(g) Province: Cremona



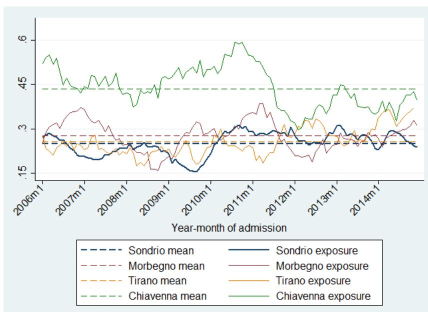
(h) Province: Lecco



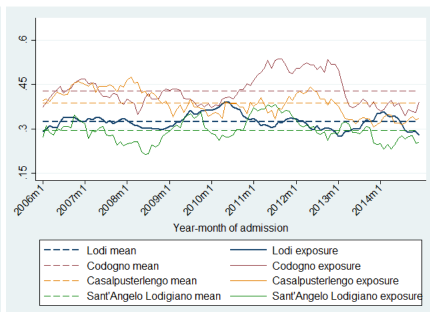
(i) Province: Mantova



(j) Province: Pavia



(k) Province: Sondrio



(l) Province: Lodi

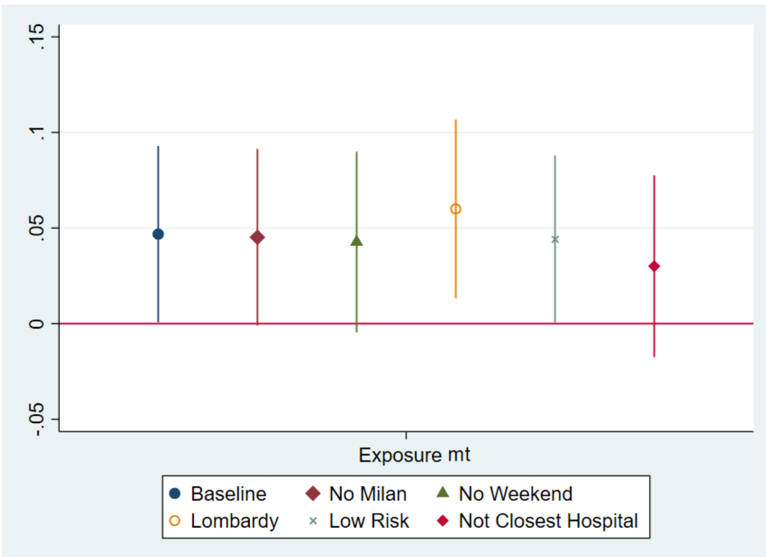
Notes: City trends in exposure. Each figure presents the monthly trends in $Exposure_{mt-12}$ for the four largest cities within each province.

Table C4: $Exposure_{llmt\_12}$ **by year**

Sample	2006	2007	2008	2009	2010	2011	2012	2013	2014
Overall	0.283	0.282	0.285	0.289	0.293	0.297	0.287	0.285	0.287
	(0.048)	(0.048)	(0.046)	(0.048)	(0.046)	(0.044)	(0.041)	(0.042)	(0.042)
Lombardy	0.282	0.281	0.284	0.287	0.291	0.296	0.285	0.284	0.286
	(0.045)	(0.045)	(0.042)	(0.044)	(0.042)	(0.041)	(0.037)	(0.038)	(0.038)
Small Municipalities	0.281	0.279	0.280	0.287	0.290	0.293	0.281	0.279	0.282
	(0.063)	(0.062)	(0.058)	(0.062)	(0.060)	(0.057)	(0.052)	(0.052)	(0.053)
Medium-sized Municipalities	0.283	0.282	0.285	0.287	0.291	0.296	0.286	0.284	0.287
	(0.046)	(0.046)	(0.044)	(0.044)	(0.043)	(0.042)	(0.038)	(0.040)	(0.040)
Large Municipalities	0.285	0.285	0.290	0.294	0.298	0.303	0.294	0.293	0.293
	(0.037)	(0.037)	(0.036)	(0.069)	(0.038)	(0.036)	(0.034)	(0.033)	(0.032)

Notes: Table reporting the summary statistics for $Exposure_{lt\_12}$ by the year of observation. *Overall* includes all observations used in the analysis. *Lombardy* is restricted to mothers having residency in Lombardy, *Small Municipalities* to towns with less than 5,000 inhabitants, *Medium-sized Municipalities* to cities between 5,000 and 50,000 inhabitants, and *Large Municipalities* to cities having more than 50,000 inhabitants.

Figure C2: **Effects of municipality exposure on the probability of C-sections: Exposure mt**



Notes: Estimated effects for Equation 1 when considering the index $Exposure_{mt}$. It captures the average C-section rate in municipality m in the same calendar year (mother i^{th} excluded from the calculation). Considering the same *Mother A*, this index would be computed as the share of mothers having a C-section in 2008 in municipality m (mother i^{th} excluded). We estimate the impact of this alternative definition of exposure to show that our preferred index does not simply adhere to the municipal average practice. $Exposure_{mt}$ is not robust to all the proposed samples, while $Exposure_{mt-12}$ is. Each estimated coefficient represents the specific effect of exposure to C-section use on the individual probability of undergoing a C-section. The estimation is repeated over alternative samples: baseline (*i.e.,* all observations), the exclusion of mothers from the municipality of Milan, the exclusion of deliveries that occurred on the weekend, the exclusion of mothers officially registered outside Lombardy, the selection of low-risk mothers, and the selection of mothers not choosing the closest hospital. Confidence intervals are at 95%.

Appendix D

This Appendix provides additional tables for the robustness checks not necessarily intended for publication. In particular, we present the following:

- Sample composition: Not Lombardy (Table D1);
- Sample coverage by registered births (Table D2);
- Trends in the treatments performed by day of the week (Figure D1);
- Sample coverage by the mother's municipality of residence (Table D3);
- Effects of municipality exposures by sample (Figure D2);
- Alternative specifications (Figure D3);
- Robustness check: Municipality FE (Table D4);
- Effects of municipality exposures by sample (Figure D4);
- $Exposure_{mt-12m}$ by years (Table D5);
- $Practice\ Style_{mt-12}$ - County Seats, Municipalities (Table D6);
- $Exposure_{mt-12}$ - Summary statistics (Table D7);
- Simulated effects (Table D8).

Table D1: **Sample composition: Not Lombardy**

Citizenship	2006	2007	2008	2009	2010	2011	2012	2013	2014
Not Lombardy									
Absolute values	2,286	2,304	2,375	2,433	2,355	2,431	2,460	2,251	2,170
Share over whole sample	2.67%	2.68%	2.71%	2.77%	2.77%	2.97%	3.03%	2.93%	2.94%

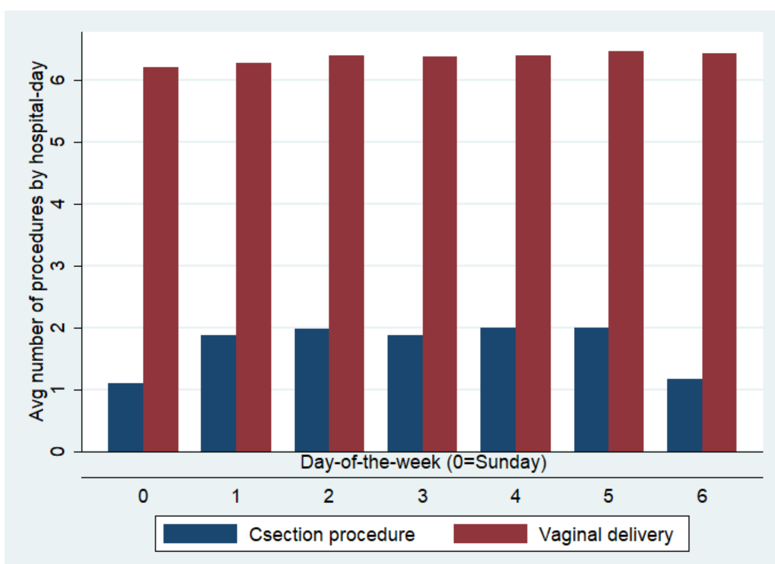
Notes: Sample composition. Absolute values and shares are for the whole sample of mothers not registered in a municipality in Lombardy.

Table D2: **Sample coverage by registered births**

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number of Observations (absolute values)									
Italy	532,191	534,709	539,253	534,178	526,707	515,884	507,357	482,783	467,933
Lombardy	94,258	95,156	97,271	97,250	94,470	91,611	90,312	85,828	82,182
Lombardy - selection	85,779	86,145	87,810	87,823	85,043	82,089	81,281	76,860	74,012
Sample Coverage by registered births									
Italy	95%	95%	94%	94%	94%	94%	95%	94%	93%
Lombardy	99%	99%	99%	98%	97%	97%	98%	97%	95%
Lombardy - selection	90%	89%	89%	89%	87%	87%	89%	87%	86%

Notes: *Absolute values* correspond to all childbirths registered by the Ministry of Health (*i.e.,* deliveries performed in public or private accredited hospitals); *sample coverage* reports their weight relative to the total number of childbirths registered at the administrative level. The childbirths not covered are performed in private hospitals or as home births. The coverage *after selection* shows the amount of observations used in the analysis.

Figure D1: **Trend in the treatments performed by the day of the week**

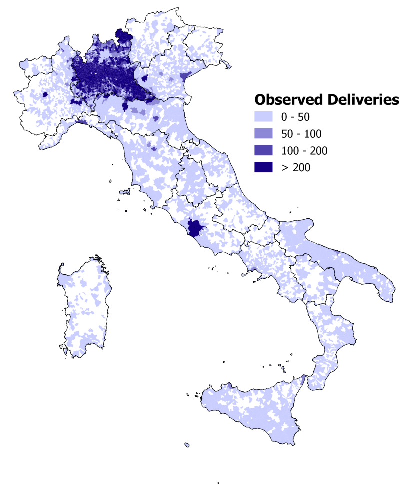


Notes: Due to differences in the composition of the medical team, elective C-sections are generally scheduled for weekdays. Therefore, surgical interventions observed on weekends are likely to be emergency procedures.

Table D3: **Sample coverage by the mother's municipality of residence**

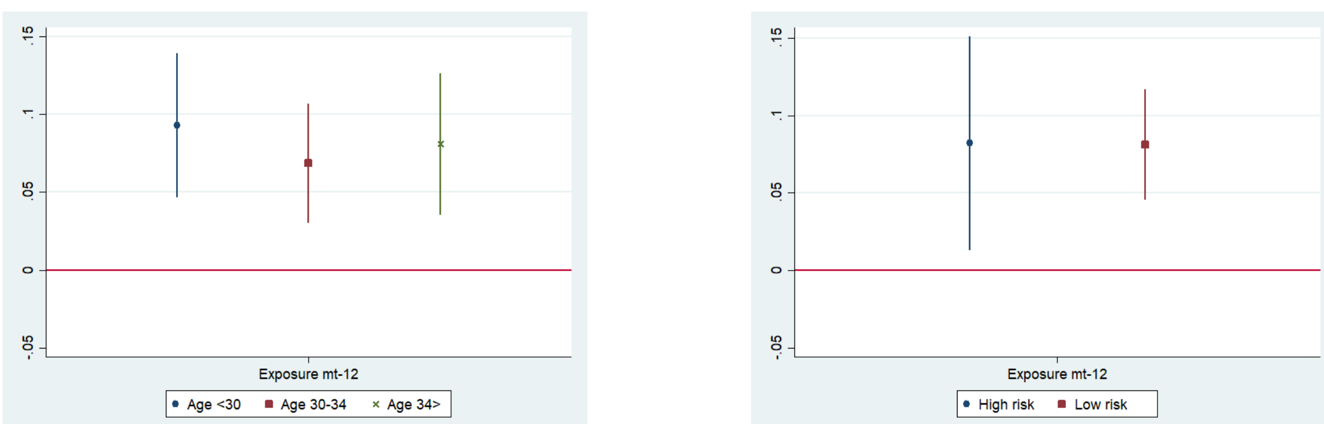
	Number of observed municipalities
Lombardy	1,543
Outside Lombardy	2,831
Overall	4,374
	Number of individual observations
Lombardy	724,695
Outside Lombardy	21,065
Overall	745,760

Notes: Number of municipalities observed at least once in the selected sample and individual observation associated. According to official statistics provided by ISTAT, the overall number of municipalities in Italy were 8,101 in 2001 and decreased to 8,057 in 2014.



Notes: Descriptive statistics on the geographic coverage of the sample selected. The whole period of analysis is taken into account (2006-2014).

Figure D2: **Effects of municipality exposure by sample**

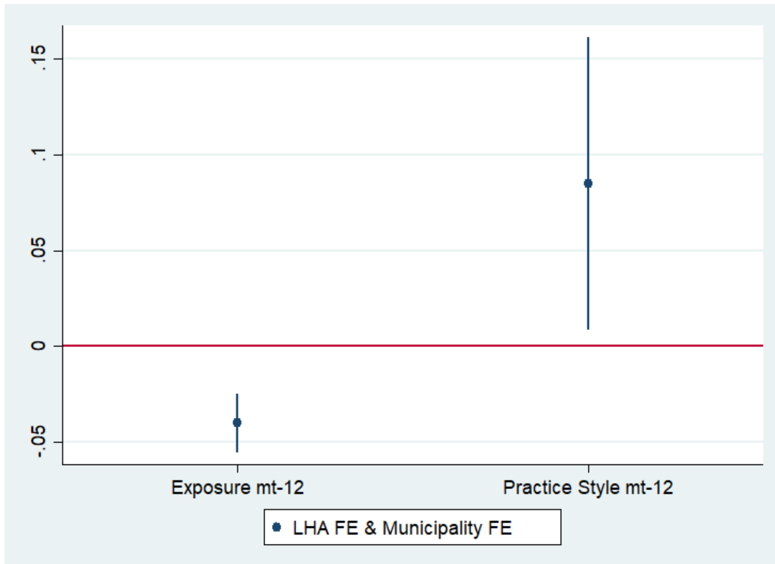


(a) *Age group*

(b) *Risk class*

Notes: Estimated effects for Equation 1, comparison by sample. Figure D2a reports separate estimates by age group of the mother at the time of delivery. Figure D2b compares samples on the basis of the estimated individual risk of undergoing a C-section (low risk: 0-0.4, high risk: 0.4-1). Confidence intervals are at 95%.

Figure D3: **Alternative specifications**



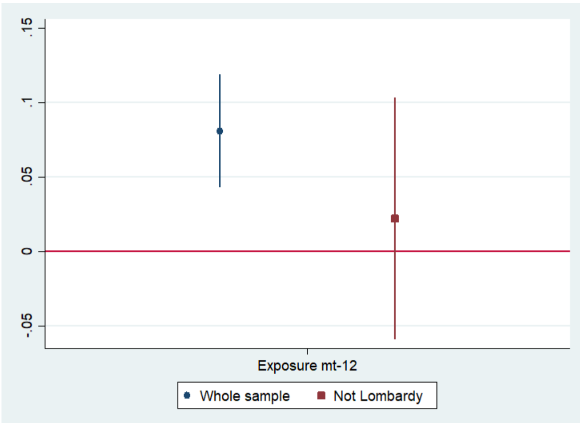
Notes: Comparison between alternative models. This specification includes both $Exposure_{mt-12}$ and $Practice\ Style_{mt-12}$, municipality fixed effects in place of hospital fixed effects. Confidence intervals are at 95%.

Table D4: **Robustness check: Municipality FE**

	(1)	(2)	(3)	(4)	(5)	(6)
Sample selection: All Observations (Baseline)						
δ	-0.036***	-0.035***	-0.052***	-0.037***	-0.055***	-0.041***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
Number of Obs	737,412	737,412	737,412	737,412	737,412	724,606
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time FE, Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
LHA FE		Yes				
LHA trend			Yes			
Hospital FE				Yes		
Hospital trend					Yes	
$Practice\ Style_{mt-12}$						Yes

Notes: *Dependent variable* is a binary variable taking a value of 1 if the patient receives a C-section. *Controls* are those specified in $X1$ and $X2$, as described in Table 1. LHA = local health authority. *LHA trend* refers to the local health authority's annual trends. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Figure D4: **Effects of municipality exposure by sample**



(a) *Equation 1*

(b) *Equation 1 - No LHA FE*

Notes: Comparison by sample: whole sample and mothers not registered in Lombardy. Figure D4b reports estimated effects for Equation 1, while Figure D4a reports estimated effects for Equation 1 when LHA fixed effects are not included in the equation. Confidence intervals are at 95%.

Table D5: $Exposure_{mt\_12m}$ **by year**

Sample	2006	2007	2008	2009	2010	2011	2012	2013	2014
Overall	0.284	0.283	0.286	0.290	0.293	0.298	0.288	0.286	0.288
	(0.084)	(0.082)	(0.080)	(0.082)	(0.081)	(0.081)	(0.077)	(0.080)	(0.081)
Lombardy	0.283	0.282	0.285	0.288	0.292	0.297	0.286	0.284	0.287
	(0.083)	(0.081)	(0.078)	(0.080)	(0.079)	(0.080)	(0.075)	(0.078)	(0.080)
Small Municipalities	0.281	0.278	0.277	0.286	0.287	0.295	0.280	0.278	0.278
	(0.132)	(0.128)	(0.126)	(0.131)	(0.127)	(0.129)	(0.125)	(0.127)	(0.132)
Medium-sized Municipalities	0.278	0.278	0.281	0.283	0.286	0.289	0.281	0.278	0.249
	(0.071)	(0.071)	(0.066)	(0.067)	(0.067)	(0.066)	(0.061)	(0.066)	(0.067)
Large Municipalities	0.301	0.299	0.305	0.307	0.316	0.321	0.310	0.311	0.314
	(0.045)	(0.044)	(0.044)	(0.045)	(0.046)	(0.042)	(0.038)	(0.040)	(0.041)

Notes: Table reporting summary statistics for $Exposure_{mt\_12m}$ by the year of observation. *Overall* includes all observations used in the analysis. *Lombardy* is restricted to mothers having residency in Lombardy, *Small Municipalities* to towns with less than 5,000 inhabitants, *Medium-sized Municipalities* to cities between 5,000 and 50,000 inhabitants, and *Large Municipalities* to cities having more than 50,000 inhabitants.

Table D6: $Practice\ Style_{mt-12}$ **- county seats, municipalities**

City	Avg Population	Obs	Mean	Std. Dev.	Min	Max
Milan	1,289,264	107,117	0.329	0.072	0.201	0.455
Bergamo	116,674.6	9,087	0.234	0.010	0.120	0.255
Brescia	190,809.3	16,526	0.305	0.029	0.239	0.401
Como	83,672.4	6,272	0.215	0.018	0.161	0.260
Cremona	71,350.7	4,909	0.269	0.012	0.246	0.298
Lecco	47,390.4	3,748	0.252	0.016	0.215	0.302
Lodi	43,603.19	3,238	0.342	0.023	0.290	0.404
Mantova	47,753.27	3,677	0.358	0.012	0.330	0.390
Monza Brianza	121,226.5	8,281	0.247	0.086	0.163	0.473
Pavia	69,995.08	5,297	0.373	0.040	0.312	0.595
Sondrio	22,012.57	1,525	0.278	0.020	0.236	0.321
Varese	81,050.89	5,920	0.318	0.019	0.281	0.355

Notes: Summary statistics for $Practice\ Style_{mt-12}$ by city. Only the 12 county seats are taken into account.

Table D7: $Exposure_{mt-12}$ **- Summary statistics**

Index Exposure	Mean	Std. Dev.	Min	Max
Overall	0.287	0.081	0	1
Italians w/o restriction	0.294	0.089	0	1
Foreigners w/o restriction	0.269	0.110	0	1
Italians w/ restriction	0.295	0.081	0	1
Foreigners w/ restriction	0.269	0.088	0	1

Notes: Summary statistics for $Exposure_{mt-12}$. Restrictions applied to obtain more homogeneous index distributions between subgroup. Restriction adopted: more than 5 Italian and 5 foreign mothers in the municipality of residence during the 12 months preceding delivery.

Table D8: **Simulated effects**

Municipality A			Municipality B			Simulation			
Municipality	C-section rate	Avg $Exposure_{mt-12}$	Municipality	C-section rate	Avg $Exposure_{mt-12}$	$Exposure_{At-12}$ - $Exposure_{Bt-12}$	Effect pp	C-section A-B pp	Explained
Mantova	0.273	0.38	Lecco	0.153	0.214	0.166	0.014	0.120	0.116
Pavia	0.273	0.378	Lecco	0.153	0.214	0.164	0.014	0.120	0.115
Mantova	0.273	0.38	Como	0.171	0.221	0.159	0.013	0.102	0.131
Pavia	0.273	0.378	Como	0.171	0.221	0.157	0.013	0.102	0.129
Mantova	0.273	0.38	Sondrio	0.191	0.25	0.130	0.011	0.082	0.133
Pavia	0.273	0.378	Sondrio	0.191	0.25	0.128	0.011	0.082	0.131
Mantova	0.273	0.38	Cremona	0.194	0.253	0.127	0.011	0.079	0.135
Pavia	0.273	0.378	Cremona	0.194	0.253	0.125	0.011	0.079	0.133
Mantova	0.273	0.38	Bergamo	0.177	0.259	0.121	0.010	0.096	0.106
Pavia	0.273	0.378	Bergamo	0.177	0.259	0.119	0.010	0.096	0.104
Lodi	0.232	0.325	Lecco	0.153	0.214	0.111	0.009	0.079	0.118
Milano	0.233	0.321	Lecco	0.153	0.214	0.107	0.009	0.080	0.112
Lodi	0.232	0.325	Como	0.171	0.221	0.104	0.009	0.061	0.143
Milano	0.233	0.321	Como	0.171	0.221	0.100	0.008	0.062	0.135
Brescia	0.216	0.311	Lecco	0.153	0.214	0.097	0.008	0.063	0.129
Mantova	0.273	0.38	Monza	0.173	0.29	0.090	0.008	0.100	0.076
Brescia	0.216	0.311	Como	0.171	0.221	0.090	0.008	0.045	0.168
Mantova	0.273	0.38	Varese	0.205	0.291	0.089	0.007	0.068	0.110
Pavia	0.273	0.378	Monza	0.173	0.29	0.088	0.007	0.100	0.074
Pavia	0.273	0.378	Varese	0.205	0.291	0.087	0.007	0.068	0.107
Varese	0.205	0.291	Lecco	0.153	0.214	0.077	0.006	0.052	0.124
Monza	0.173	0.29	Lecco	0.153	0.214	0.076	0.006	0.020	0.319
Lodi	0.232	0.325	Sondrio	0.191	0.25	0.075	0.006	0.041	0.154
Lodi	0.232	0.325	Cremona	0.194	0.253	0.072	0.006	0.038	0.159
Milano	0.233	0.321	Sondrio	0.191	0.25	0.071	0.006	0.042	0.142
Varese	0.205	0.291	Como	0.171	0.221	0.070	0.006	0.034	0.173
Mantova	0.273	0.38	Brescia	0.216	0.311	0.069	0.006	0.057	0.102
Milano	0.233	0.321	Cremona	0.194	0.253	0.068	0.006	0.039	0.146
Pavia	0.273	0.378	Brescia	0.216	0.311	0.067	0.006	0.057	0.099
Lodi	0.232	0.325	Bergamo	0.177	0.259	0.066	0.006	0.055	0.101
Milano	0.233	0.321	Bergamo	0.177	0.259	0.062	0.005	0.056	0.093
Brescia	0.216	0.311	Sondrio	0.191	0.25	0.061	0.005	0.025	0.205
Mantova	0.273	0.38	Milano	0.233	0.321	0.059	0.005	0.040	0.124
Brescia	0.216	0.311	Cremona	0.194	0.253	0.058	0.005	0.022	0.221
Pavia	0.273	0.378	Milano	0.233	0.321	0.057	0.005	0.040	0.120
Mantova	0.273	0.38	Lodi	0.232	0.325	0.055	0.005	0.041	0.113
Pavia	0.273	0.378	Lodi	0.232	0.325	0.053	0.004	0.041	0.109
Brescia	0.216	0.311	Bergamo	0.177	0.259	0.052	0.004	0.039	0.112
Bergamo	0.177	0.259	Lecco	0.153	0.214	0.045	0.004	0.024	0.158
Varese	0.205	0.291	Sondrio	0.191	0.25	0.041	0.003	0.014	0.246
Cremona	0.194	0.253	Lecco	0.153	0.214	0.039	0.003	0.041	0.080
Bergamo	0.177	0.259	Como	0.171	0.221	0.038	0.003	0.006	0.532
Varese	0.205	0.291	Cremona	0.194	0.253	0.038	0.003	0.011	0.290
Sondrio	0.191	0.25	Lecco	0.153	0.214	0.036	0.003	0.038	0.080
Lodi	0.232	0.325	Monza	0.173	0.29	0.035	0.003	0.059	0.050
Lodi	0.232	0.325	Varese	0.205	0.291	0.034	0.003	0.027	0.106
Cremona	0.194	0.253	Como	0.171	0.221	0.032	0.003	0.023	0.117
Varese	0.205	0.291	Bergamo	0.177	0.259	0.032	0.003	0.028	0.096
Milano	0.233	0.321	Monza	0.173	0.29	0.031	0.003	0.060	0.043
Milano	0.233	0.321	Varese	0.205	0.291	0.030	0.003	0.028	0.090
Sondrio	0.191	0.25	Como	0.171	0.221	0.029	0.002	0.020	0.122
Brescia	0.216	0.311	Monza	0.173	0.29	0.021	0.002	0.043	0.041
Brescia	0.216	0.311	Varese	0.205	0.291	0.020	0.002	0.011	0.153
Lodi	0.232	0.325	Brescia	0.216	0.311	0.014	0.001	0.016	0.074
Milano	0.233	0.321	Brescia	0.216	0.311	0.010	0.001	0.017	0.049
Como	0.171	0.221	Lecco	0.153	0.214	0.007	0.001	0.018	0.033
Cremona	0.194	0.253	Sondrio	0.191	0.25	0.003	0.000	0.003	0.084

Do You Need Me?

Evolution in the Supply of Healthcare Professionals in Italy

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Abstract

The current pandemic highlighted the strategic role played by the healthcare sector, with the availability of qualified professionals being a key element. This paper explores the evolution in the supply of healthcare workers following the implementation of the Italian Budget Law 2010 (*Law 191/2009*), which introduces strict restrictions on the recruitment of healthcare professionals. Applying a Difference-in-Differences estimation based on policy intensity, I observe a significant reduction in the supply of healthcare workers where the policy has been more intense, which is particularly strong in the public sector and among the professional category of physicians. Districts which experience larger reductions in the supply of public-sector physicians do not exhibit large effects on the access to care compared to the control group, while reporting significantly lower health outcomes. This effect does not seem to be related to limitations in the training capacity, which, on the contrary, increases over time during the period considered. The results raise serious redistributive and inequality issues, which still need to be addressed. After policy, the composition of physicians who are willing to migrate changes. Compared to the pre-policy period, physicians appear to be younger and more talented, with a larger prevalence of those who have not completed their specialization training yet. These evidences claim for more cautious interventions when economic resources reserved to the healthcare sector are at stake.

JEL Classification: H51, I18

Keywords: Physicians' Migration, Budget Law, Public Health

1 Introduction

The unexpected COVID-19 outbreak highlighted several weaknesses of the Italian healthcare system, ranging from the lack of qualified personnel and limited hospital capacity to a not efficient management of public health issues (Ranney et al. (2020), Balmer and Pollina (2020), Capano (2020), Corte dei Conti. Sezioni Riunite in Sede di Controllo (2020)). Besides the recent events, the shortage of skilled health professionals is a long lasting issue, involving many countries. In the US the shortage has been estimated to range between 54,100 and 139,000 clinicians by the end of the 2020s, with the worst scenario related to primary care physicians (Dall et al. (2015)); while in 2010 the European Commission estimates the gap in supply of human resources in health to be approximately of a one million workers by 2020.[1] This means that, in the current decade, almost 15% of the health needs of the EU population are expected not to be adequately covered (Sermeus and Bruyneel (2010)).

This study aims at exploring the evolution of the supply of healthcare workers in Italy, analysing how it relates with a specific policy (*i.e.,* Italian Budget Law 2010 - *Law 191/2009*) which introduces strict restrictions on the recruitment of healthcare professionals and the financing of the public health system.[2] The paper proceeds evaluating spillover effects of changes in the supply of healthcare professionals on public health and access to care and describing possible variations in the characteristics of physicians who decide to migrate. These issues are of major concern in a country where there are repeated claims for the insufficient supply of qualified professionals in the health sector (D'Arienzo et al. (2020)). It could have alternative motivations, either an overall insufficient absolute number of trained individuals (*e.g.,* insufficient personnel in the whole country) or an unbalanced distribution within the country (*e.g.,* qualified personnel disproportionally concentrated in a limited number of districts within a country). From a policy perspective, it is important to characterize the shortage and to identify the role played by main potential drivers, among others the training capacity, mobility of professionals, and bad planning that may favour specific spe-

[1] Recent updates estimate an increase in the shortage of health workers in EU to reach about 4.1 million units by 2030, distributed as 0.6 million physicians, 2.3 million nurses and 1.3 million other health care professionals (Michel and Ecarnot (2020)).

[2] Section 2 presents a detailed description of the policy and its expected effects.

cialities, age groups, or locations. While the training capacity, for the specific case of Italy, is increasing over time in the period considered, issues related to the mobility of healthcare workers seem to play a large role and they raise an intense policy debate, both nationally and internationally.[3] Healthcare workers, and physicians in particular, are indeed among the most mobile professions (Teney (2019), Becker and Teney (2020), Botezat and Ramos (2020)), and, since their training and career are strictly regulated, they may be particularly sensible to planning decisions, with a good planning possibly discouraging intense migration flows (*e.g.,* the adoption of incentive schemes could be effective in retaining professionals in rural areas as stated by McGrail et al. (2017)).[4] Moreover, migration flows of high-skilled workers raise concerns over equity and efficiency: among others, looking at the free health workforce mobility within EU, Glinos (2015) underlines how wealthier Member States may disproportionally benefit from migration flows of healthcare professionals, raising serious redistributive issues.

Theoretically, there are three dimensions that may determine changes in the local supply of health professionals: immigration from abroad, which increases the overall supply, migration to other countries, which decreases the overall supply, and relocation within the country, which may determine mixed effects at the local level.[5] From a policy perspective, we should note that while immigration would increase the overall supply, possibly generating benefits for the country, relocation or migration of professionals may have serious implication decreasing the supply, at least locally. More precisely, relocation may determine redistributive issues and inequalities within the country, while migration implies a net loss of human capital, having potential impacts on public health, access to care and, more generally, the sustainability of health services.

The literature identifies several channels affecting the propensity of healthcare workers to

[3]Figure 1 graphically presents the evolution in Italian training capacity for physicians.

[4]Looking at the flows of regulated professions within the European area (*i.e.,* EU, EEA, Switzerland), five out of the ten most mobile professions are health-related (*i.e.,* doctors, nurses, physiotherapist, dental practitioner, healthcare assistant - Figure 2), which makes the analysis of migration flows of healthcare professionals particularly relevant.

[5]It is not possible to know *a priori* if the relocation within the country causes a more homogeneous or heterogeneous distribution across geographical units.

migrate (Costigliola (2011); OECD (2019)). More precisely, looking at physicians Becker and Teney (2020) define three classes of migration patterns based on the pushing motivation.[6] *Traditional labour migrants* are those who are primarily pushed by economic and work-related factors, as the lack of job positions in the country of origin or financial motivation (*e.g.,* salary differentials between countries). Considering the specific case of the severe economic crisis faced by Greece since 2008, Ifanti et al. (2014) underline how the main causes that affect Greek physicians' brain drain were mostly work-related (*e.g.,* unemployment, job insecurity, income reduction, over-taxation). However, even in such a dramatic scenario, other factors enter the decision process, as, among others, the limited budget available for medical research. The working environment together with training and career opportunities may be indeed of particular interest for highly skilled migrants (Buch et al. (2017)).[7] This second motivation characterized the *Career seekers*, those who are mainly interested in the quality and content of their employment. They are generally young and talented, many of them moving to complete their training. Lastly, *Family settlers* are those who indicate family reasons as crucial factors in their migration decision (*e.g.,* better expected work-life balance and opportunities for the family members).

The empirical analysis proceeds following two perspectives, the internal and external dimensions.[8] First, I focus on the internal dimension, analysing the policy effects on the local supply of health professionals at the district level.[9] Since it is not possible to determine the

[6]Becker and Teney (2020) ground their study on a semi-structured survey performed between September 2015 and May 2016. They interview 1,225 physicians registered in a German State Chamber of Physicians after 2003. Physicians were required to hold citizenship of a EU28 Member State, Germany excluded.

[7]Working environment defined as the perceived quality of the relationship between colleagues, of health-care facilities, flexible working schedule. Training and career opportunities consist in specialization opportunities, professional prestige, clear career path.

[8]The magnitude of immigrant flows of foreign-trained health professionals to Italy is extremely low. Looking at medical doctors and nurses, Figure 3 reports the absolute values of the annual inflows in Italy registered by Eurostat. Moreover, data from the OECD (2019) reports that in 2016 foreign-born physicians practicing in Italy were only the 4.3% of all physicians practicing in the country. The proportion is way lower than the ones registered by other OECD European countries (Table 1). Since they are marginal in magnitude, this paper does not explore the dynamic of inflows of health professionals in Italy.

[9]Italy is organized in 110 administrative districts - *i.e., Province*. The district is an intermediate unit between municipalities and regions.

adequate level of supply in absolute terms, the analysis inspects the policy effects on relative changes in supply, additionally evaluating whether changes in supply affect secondary outcomes, like public health and the access to care. The analysis on the internal dimension uses administrative data, collected by the Italian National Institute of Statistics and the Ministry of Health and publicly available on Health-For-All-Italy. The empirical analysis consists in a Difference-in-Differences estimation performed following two steps. Since the policy affects the whole country at the same time, in the first step the variation in primary outcomes (*i.e.,* district-level supply of healthcare workers, distinguishing by sector of employment and by professional category) is estimated considering as "treated" districts where the policy has been more intense (*i.e.,* district that were under Repayment Plan at the time of policy implementation). In *high-intensity districts*, I estimate a loss in the supply of physicians by -6.04% when public and private-accredited sector are considered, while a -7.29% reduction when public sector only is considered. Overall, the decrease is driven by the public sector, which registers a reduction in healthcare personnel of about -4.57%. In the second step, I consider alternative treatments which identify district where the reduction in the supply of healthcare personnel has been larger. The results show that a larger reduction translates into worse health outcomes, with only a minor impact on the access to care. Again, results are driven by reductions in the public sector.

The analysis on the external dimensions consists in exploring whether the policy considered induced changes in the characteristics of health professionals who decide to migrate, considering that, within the European Area, Italy is a net exporter of health professionals (*i.e.,* outflows of healthcare workers from Italy are not counterbalanced by comparable inflows from abroad). To better understand the phenomenon, I focus on the case study of physicians' migration to Switzerland. Switzerland is indeed one of the main destination countries for Italian health professionals (Figure 4). In the period 2002-2019, 4,636 doctors trained in Italy left the country to permanently work in Swiss facilities.[10] Moreover, the recognition

[10]Physicians asking for the recognition of their diploma in Switzerland during the whole period considered account for about 1.2% of all physicians officially registered in Italy. Corte dei Conti. Sezioni Riunite in Sede di Controllo (2020) reports that about 9.000 physicians trained in Italy left the country during the period 2012-2020.

of medical diploma in Switzerland follows a precise scheme which is particularly suitable for the analysis. Switzerland has no predetermined quota for healthcare professionals willing to practice in the country, they are only required to ask for the recognition of their foreign title. The recognition process, managed by the MEBEKO Commission (*i.e.,* Commission in charge for the recognition of foreign medical titles), last between 3 to 4 months. Data on the successful candidates are collected by the Federal Office of Public Health (FOPH). The analysis on the external dimension focuses on a descriptive discussion of the characteristics of Italian-trained professionals asking for the recognition of their medical diploma in Switzerland. The discussion underlines the changes observed before and after policy implementation (*i.e.,* before and after 2010). Consistently with the theory of *Career seekers*, I found that after policy migrant physicians are generally younger and more talented. Moreover, I observe an increase in the number of those who move before the completion of the training (*i.e.,* physicians who do not have any specialization).

The paper is organized as follow. Section 2 presents the institutional setting, the policy and discusses its expected effects. The data, the empirical analysis and the results referred to the internal dimension are presented in Section 3. Section 4 describes the evidences over the external dimension. Section 5 concludes.

2 Institutional Setting and Policy

Italy guarantees universal healthcare coverage to all individuals. The National Healthcare System (NHS), which provides health services, is mainly funded through general taxation and official statistics reports that about 80% of the household expenses in health are covered by the public system.[11] Since 2001, the NHS is managed at the regional level (*i.e.,* 21 independent authorities). While regions are in charge of the actual management of the services, the Ministry of Health defines national standards to guarantee homogeneous opportunities in the quality and access to care throughout the country.[12] These features make the provision of health services particularly sensible to national policies.

[11]Data source: Health-For-All-Italy (2009).

[12]National standards include the definition of minimum levels in the quality of services provided (*i.e., Livelli Essenziali di Assistenza, LEA*), rules on recruitment of professionals, allowed expenses.

Due to the severe economic crisis Italy was facing in 2009, the National Government defines strict measures to contain the costs of the public sector in the Budget Law 2010 (*i.e., Law 191/2009*). For what concern the NHS, the policy operates on the labour costs, the turnover of workers and the characteristics of the expenses allowed. More precisely, the annual maximum cost for NHS personnel faced by each region has been cap to the threshold represented by the labour cost registered in 2004 reduced by 1.4% (*Law 191/2009 - comma 71*).[13] This measure imposes a strict limitation to the recruitment of new professionals, causing a contraction in the demand for health care workers. Concerning the other issues, the policy prescribes that until 31st December 2012 (*i.e.,* two years since policy implementation) the NHS personnel was not allowed to retire (*i.e., blocco del turnover*) and not-essential NHS expenses were forbidden (*Law 191/2009 - comma 76*).[14]

The primary intended effect of the policy is a contraction in the growth of the NHS spending. Looking at descriptive statistics, we can have a sense of such reduction: starting from 2010, Figure 5 shows a decrease in the growth rate of NHS spending, both in absolute values and per capita terms. While the contraction in the growth of NHS spending was one of the specific targets of the intervention, the restrictions introduced by the policy likely affects the supply of NHS personnel as well. More precisely, the policy may modify the supply of healthcare workers in terms of overall units (*e.g.,* number of health professionals per capita), characteristics (*e.g.,* specialization, age, expertise), and geographical distribution (*e.g.,* redistribution across districts according to the intensity of policy implementation). Descriptive evidences presented in Figure 6 confirms the declining trend in per capita NHS personnel. More precisely, the declining trend becomes steeper after policy implementation both for doctors and nurses, with the first category being more affected.[15] Limited availability of data prevent a proper analysis of changes in the characteristics of the healthcare workforce.[16] However, Figure 7 provides a piece of evidence of increasing imbalances between

[13]The rule defined by *Law 191/2009 - comma 71* is still active in 2020.

[14]Not-essential expenses are those not necessary to meet the quality standards yearly defined by the Ministry of Health (*i.e., Livelli Essenziali di Assistenza, LEA*).

[15]The database Health-for-all-Italy classifies healthcare workers into four professional categories: doctors, nurses, technicians and rehabilitation staff. Doctors and nurses are the two largest professional categories when this classification is considered.

[16]The Health-for-all-Italy database reports information on the composition by age-groups of health pro-

physicians' age groups in the years following the policy: by 2018 the age-group *Over 60* represents almost half of all physicians practising in Italy. Redistributive issues are discussed in Section 3.

This study aims at analysing the unintended effects of the policy on the supply of healthcare workers, and its broader consequences on public health and access to care. The paper proceeds exploring two perspectives: the dynamic of the internal supply of healthcare professionals (*internal dimension*, Section 3) and the evolution of external migration flows (*external dimension*, Section 4).[17]

3 Internal Dimension

3.1 The Data

The internal dimension is explored using Italian district-level data to inspect internal changes in the supply of health workers and to evaluate their effects on public health and access to care. The district (*i.e.,* Italian administrative districts, *Province*) is an intermediate administrative unit, keeping together a number of municipalities within the same region. Districts have an average population of approximately 550,000 individuals (median about 377,000), with a surface of about 2,800 km^2. They are grouped into regions (*i.e.,* 21 independent authorities), which are responsible for the provision and management of several services, healthcare included.

The dataset contains administrative information jointly collected by the Italian National Institute of Statistics and the Ministry of Health for the project Health-for-All-Italy.[18] The original database contains about 4,000 indexes on the healthcare system, population health and socio-economic characteristics, which follow a standardized classification defined by the

fessionals from 2011 on.

[17]Due to data limitation, the *internal dimension* evaluates changes in relative supply of health care workers, while it is not possible to adequately study internal migration flows. The analysis over the *external dimension* focuses instead over the migration flows to Switzerland, shading some lights over the individual characteristics of professionals who are willing to migrate.

[18]Data are publicly available at the following link.

World Health Organization.[19] For the scope of this analysis, the data selected are a panel where each unit (*i.e.,* district) is yearly observed during the period 2005-2014.[20]

3.2 Empirical Analysis

The empirical analysis consists in a Difference-in-Differences estimation performed over two steps. First, I analyse how the policy affects the supply of healthcare professionals at the district level. In the second place, I explore how different variations in supply affect secondary outcomes, as public health or access to care.

There are no available estimations over the appropriate level of supply in absolute values, therefore the first step of analysis is performed in relative terms (*i.e.,* evaluating whether the policy determine a variation with respect to the pre-policy supply and estimating its magnitude). From a theoretical point of view, we can expect three outcomes: increase, decrease or stability in the supply of healthcare professionals at the local level. They are determined by the combination of three types of movements: movements between districts in the country (*i.e.,* relocation), incoming from outside the country (*i.e.,* immigration), and outgoing of professionals abroad (*i.e.,* migration). The net effect of the three movements determines the variation in supply of healthcare professionals at the local level. The inflow of foreign-trained professionals is marginal in the country and period considered, then it is likely that most of the variation comes from relocation or migration. Since it is not possible to distinguish between the three types of movements, the analysis evaluates changes in the net effect produced at the district level (*i.e.,* increase, decrease or stability in the supply of health professionals).

The policy has been implemented on a national basis, however its intensity varies among districts. More precisely, the policy is assumed to be more intense in regions that were already under Repayment Plans at the time of its implementation: since they were subject to stricter rules independently from the policy, the implementation likely affects them the most.[21] The

[19] Official link: link.

[20] Due to data limitation, some indexes cannot be used in the analysis, either because they are not available for the whole period considered or because they are not representative at the district level.

[21] Repayment Plans were introduced by the Budget Law 2005 (*Law 311/2004*) to guarantee minimum standards in the provision of healthcare services in case a region would not be able to sustain its regional

econometric strategy exploits this feature, including in the "treatment group" all districts belonging to regions under Repayment Plan at the time of implementation, while considering all other districts as controls.[22] As stated by Bordignon et al. (2020), Repayment Plans *per se* do not seem to significantly affect healthcare utilization and citizens' health, while affecting the regional spending.[23] This feature makes them particularly suitable to leverage on policy intensity at the district level.

The model estimated is presented in Equation 1.

$$Outcome_{dt} = \alpha + \delta(Treated_d * Post_t) + +\beta_1 Treated_d + \beta_2 Post_t + \beta_3 X_{dt} + \omega_r + \epsilon_{dt} \quad (1)$$

The analysis is performed at the district level (d). The outcome, $Outcome_{dt}$, alternatively identifies one of the primary outcomes (*i.e.,* supply of healthcare professionals - Table 2). They consist of indexes of availability of health professionals weighted over the resident population in the district in the relevant year.[24] The variable $Treated_d$ is a dummy assuming value 1 when the district is exposed to high intensity policy implementation (*i.e.,* when the district belongs to a region that was under Repayment Plan at the time of policy implementation). To capture the role of the policy in explaining the variation in primary outcomes, the variable $Treated_d$ is interacted with $Post_t$, which identifies the period after policy implementation (*i.e.,* years 2010-2014). District-level controls (X_{dt}) include information regarding the demographic and socio-economic characteristics of the population, as well as features of the regional healthcare system and epidemiological indicators.[25] Given the

healthcare system. Repayment Plans operate on the management of the regional health services. When a Repayment Plan is necessary, the region signs an agreement with the national Government in order to receive financial and organizational support in the provision of health services. To recover the financial stability of regional health systems, Repayment Plans include restrictions in health spending.

[22] The treatment group includes all districts which belong to Lazio, Abruzzo, Molise, Campania, Calabria, Sicilia. These regions were under Repayment Plan in 2009 and continue in the years after.

[23] Other scholars like Depalo (2019) and Gigio et al. (2018) contribute to the discussion regarding the intended and unintended effects of Repayment Plans.

[24] Primary outcomes are differentiated by sector of employment (*i.e.,* public or private-accredited sectors, public sector only) and professional category (*i.e.,* overall, physicians, nurses, technicians, rehabilitation staff).

[25] Full list of controls available in Table 3.

context of economic crisis experienced during the period considered, X_{dt} includes specific covariates to control for the evolution of the economy in each district. Regional fixed effects are included (ω_r) and standard errors are clustered at the regional level. The rational is to verify the existence of a causal link between policy intensity and variation in the supply of healthcare professionals. Districts where the intensity has been stronger are expected to show a larger reduction in the supply of healthcare workers.

The absence of pre-trends is verified by means of an event-study analysis. It guarantees the comparability of the treatment and control group, which do no exhibit significant anticipatory effects possibly driven by other interventions (*e.g.,* Repayment Plans). The model estimated is modified as presented in Equation 2, where $Year_t$ are dummies assuming value 1 in each relevant year t.

$$Outcome_{dt} = \alpha + \sum_{t=2005}^{2014} \delta_t (Treated_d * Year_t) + +\beta_1 Treated_d + \sum_{t=2005}^{2014} \beta_t Year_t + \beta_3 X_{dt} + \omega_r + \epsilon_{dt} \tag{2}$$

In the second place, the analysis proceeds by evaluating whether secondary outcomes (*e.g.,* access to care, public health) are affected by variations in the supply of healthcare personnel. The model estimated is presented in Equation 1, where $Outcome_{dt}$ assumes the values of secondary outcomes (*i.e.,* public health, access to care - Table 4). The variable $Treated_d$ identifies now the districts where the reduction in the supply of healthcare workers has been stronger. Such reduction could be identified in alternative ways, either based on the sector of employment (*i.e.,* public sector or public; private-accredited sector) or the professional category (*i.e.,* overall personnel; physicians). In each estimation, the index $Treated_d$ is a dummy equal to 1 when the reduction in the supply of healthcare workers between 2009 and 2013 in the sectors considered is above the median value.[26] Table 5 describes the correlations among the indexes alternatively considered as treatments.

The analysis is performed over the period 2005-2014. The results are presented both considering changes in the public sector only or public and public-accredited sectors together. Since the policy primary affects the public sector, one could expect reductions in the public

[26]The variation is computed as the percentage change in the supply of healthcare workers in the district between 2009 and 2013.

sector being partially compensated by complementary increases in the private-accredited sector.

3.3 Results

Table 6 describes the results of the first set of estimations on primary outcomes. In districts subject to a stricter policy implementation we observe a reduction in the supply of healthcare professionals, in particular for what concern physicians. Overall, districts exposed to a higher policy intensity register a reduction in the healthcare personnel of about -4.57% in the public sector compared to the control group. The reduction is in place, but not significant, when both public and private-accredited sectors are considered. Looking at physicians, the estimated effects account for a -6.04% reduction when public and private-accredited are considered, while a -7.29% reduction when public sector only is considered. Nurses exhibit a negative but not statistically significant evolution of the supply in district treated, while the other professional categories (*i.e.,* technicians and rehabilitation staff) do not appear to be affected.

The absence of pre-trend is verified by means of an event-study presented in Figure 8. Additionally, Figure 8 allows for a better description of the dynamic in the supply of professionals. Starting from 2010, the reduction increases up to the year 2013, when it reaches the largest negative value. Similar dynamics could be observed in the *Overall* category and the professional groups of *Physicians* and *Nurses*. The results suggest that the hypothesis of reductions in supply of healthcare workers in the public sector being partially compensated by a complementary increase in the private-accredited sector is verified. Still, the compensation is not sufficient to perfectly counterbalance the reduction registered in the public sector, in particular for the professional group of physicians. Physicians are indeed among the most mobile professions and are more likely to react to external events by moving to more appealing locations (Ifanti et al. (2014)).

Tables 7 and 8 present the results for the second step of analysis, when secondary outcomes are considered. Looking at outcomes on public health (Table 7), we can observe that districts with a larger reduction in healthcare workers present negative outcomes on public health, proxied by alternative indexes of death rate. More precisely, the reduction of physicians in the public sector determines the largest increases in death rates, compare to not-treated districts. Looking at that specific treatment (*i.e.,* Treatment D), the overall death rate in treated districts increases by 1.83% compared to the control group, with females reporting the largest increase (+2.07% female death rate, +1.57% male death rate). Chronic conditions, like circulatory diseases and diabetes, are among the main responsible for the increase (+4.18% circulatory diseases, +3.88% diabetes). Serious conditions that are likely related to a lack in prevention, female breast cancer and male prostate cancer, exhibit large increases as well (+5.33% female breast cancer, +4.28% male prostate cancer).

Table 8 presents the estimated effects on the access to care. No significant difference is in place for what concern the behaviour of patients (*i.e.,* patients' mobility, Emergency Room access). If any, a reduction in the supply of healthcare professionals increases the likelihood of moving to districts different from the patient residence in order to be hospitalized (Table 8 - Column (1)), while it reduces the number of access at the Emergency Room (Table 8 - Column (2)). When considering hospitalizations in both public and private-accredited institutions, treatments do not produce any statistically different estimations (Table 8 - Column (3) (4) (5)). However, a larger reduction in healthcare personnel in the public sector significantly affects the average days of hospitalization in public hospitals: overall the average duration of hospitalizations in public hospitals increases by 5.98% (Table 8 - Column (6) - Treatment D), mainly driven by the hospitalizations in acute care which increases by 5.83% (Table 8 - Column (7) - Treatment D). We discuss alternative possible explanations. Either patients require a longer hospitalization to properly recover or healthcare workers change their behaviour by increasing the hospitalization without specific medical indication. Looking at the first explanation, it may be driven by two alternative channels. On the one hand, when there is scarcity of healthcare workers patients may have more severe conditions at the time of hospitalizations for instance because they have less opportunity to have preventive care, follow-up or specialists visits before the event or because, once a hospital treatment is required, they have to wait a longer time prior to the hospitalization (*e.g.,* longer waiting lists). On the other hand, when the availability of healthcare workers is more scarce, once a patient is hospitalized the medical team may need a longer time period to perform all specific treatments and exams required.

4 External Dimension

4.1 The Data

The analysis on the external dimension focuses on the case study of migration to Switzerland. Due to data limitation, the analysis is restricted to physicians only. However, it has the positive drawback of focusing the attention on the professional group most affected by the policy (See Table 6). Switzerland is one of the main destination countries for Italian health professionals, with about 4,500 doctors leaving Italy in the period 1997-2019 to permanently work in Swiss facilities (Figure 4). It has no predetermined quota for healthcare professionals willing to practice in the country, who are only required to ask for the recognition of their foreign title. The recognition process, managed by the MEBEKO Commission (*i.e.,* Commission in charge for the recognition of foreign medical titles), last between 3 to 4 months. Moreover, Switzerland has the rare feature of having three official languages (*i.e.,* Italian, German, French), which are the official languages of each of the countries it shares the border with. It reduces linguistic barriers, while limiting positions of competitive advantage between physicians from any of the bordering countries. I analyse microdata collected by the Federal Office of Public Health (*i.e.,* FOPH), which describes the demographics and educational attainments of physicians asking for the recognition of their diploma or specialization in Switzerland. It consists of micro-level information on the demographics (*e.g.,* gender, date of birth, citizenship), the professional training (*e.g.,* date and country of graduation, date and country of each specialization acquired), and the possibility to practice in Switzerland (*e.g.,* date of recognition of the professional diploma in Switzerland). The dataset contains 4,636 records of individuals obtaining their professional diploma in Italy and asking for its recognition in Switzerland. They are observed during the period 2002-2019 and account for the 12% of all Swiss recognitions observed during the selected period.

4.2 Descriptive Analysis

The analysis of the external migration consists in exploring the characteristics of physicians who decide to migrate from Italy, verifying whether they vary over time. The analysis aims at identifying whether the policy has induced changes in the characteristics of professionals who migrate. Given the descriptive approach, further analysis is needed to verify the causal link between policy implementation and change in characteristics. However, this anecdotal evidence could provide interesting preliminary insights.

Figure 9 shows the absolute numbers of physicians gaining their degree in Italy and asking for the recognition to practice in Switzerland. Before policy, about 100 physicians a year leave the country, with similar trends if we consider separately the two groups of those having or not at least one specialization. Immediately after policy, starting from 2010, we can observe a steep increase in the number of physicians who decide to migrate to Switzerland. The yearly number of migrants reaches the highest peak in 2013, when 521 professionals ask for the recognition in Switzerland. Interestingly, physicians with specialization show a short-term dynamic, with a steep increase up to 320 units in 2013 and a subsequent fast reduction up to 99 units in 2019. Physicians without specialization present a completely different dynamics: the increase in the number of migrants takes a longer period, reaching the peak of 287 units in 2015. However, this increase seems to be long-lasting, with stable outflows in the following years.

After policy (*i.e.,* from 2010 on), we observe a variation in the demographic characteristics of physicians who migrate to Switzerland (Figure 10). Before policy, only about a 75% of physicians were Italian, with the largest group of foreigners having Swiss citizenship (Figure 10a). This last group probably already have a higher propensity to move, regardless the external conditions. After policy the share of physicians having Italian citizenship increases up to the 90% of those who decide to migrate. Looking at the gender composition, after policy we observe a reduction in the gender gap: the share of males over the migrant doctors decreases from 68% to 59% (Figure 10b).

Moving to the professional characteristics of movers, we observe a reduction in the share of those having at least a medical specialization at the time of recognition (Figure 11a). It means that proportionally an increasing number of trained but not specialized individuals leave Italy in the years following the policy. It is consistent with the yearly trends presented in Figure 9. We do not observe statistically significant differences in the average number of specializations gained before the move by each specialized physician (Figure 11b). Notice that during the period considered, physicians without specialization cannot be hired in the Italian NHS. Together with the restrictions introduced by the policy, this specific feature probably affects younger physicians the most. They are indeed the most penalized even when the restrictions are less strict. It is confirmed by Figure 12 where we observe a reduction in the age at the time of recognition after policy implementation. Overall, the average age at recognition decreases from about 43 years old to 39 years old (Figure 12a). Even if the changes are in the same direction, Figure 12b underlines large gender differences. The average age at recognition decreases from 38 to 36 for females, while from 45 to 41 for males. If we distinguish by specialization, we observe no variation in the average age at recognition for specialized physicians (about 44 years old before and after policy), while a large drop among not specialized physicians, from 40 to 34 years old (Figure 12c). This information reinforces the hypothesis that younger professional, in particular those not specialized, are the most affected by the policy with a subsequent increase of their propensity to migrate.

Figure 13 provides information on the quality of professionals who decide to migrate. The quality is proxied by the age at the time of graduation. Regarding the access to Medical Schools, the Italian academic system requires potential students to follow a strict selection before starting the first year of university, while allowing students who do not succeed in the selection process to try again in the following years. Once a student is enrolled in the academic training, the shortest possible duration of the degree in Medicine is 6 years.[27] Before graduation, students have to succeed in all exams required, complete the hours of practical training and write their dissertation. No limit in duration is applied, therefore students may be enrolled more than 6 years to meet all requirements for graduation. Given these rules, a higher age at graduation means that the student does not enter the academic training immediately after the end of the high school, or it takes more than 6 years for him to meet the requirements for graduation. I consider both these events as a proxy for less talented individuals. Under this interpretation, a lower age at graduation signals better quality of the individual. Figure 13a shows a large reduction in the age at graduation before

[27] Given the Italian educational system, the standard age at which students complete high school is about 19 years hold. It means that the most brilliant students are expected to complete the degree in Medicine by the age of 25.

and after policy, with no gender differences (Figure 13b). Overall, it decreases from 31 to 27 years old (from 30 to 27 for females, from about 32 to 27 for males). It means that at the time of policy implementation, there is a change in physicians' preferences toward migration to Switzerland, with an increase in the quality of those who decide to migrate.

These elements provide anecdotal support to the hypothesis that there is an increasing prevalence of *Career seekers* among physicians who are willing to migrate. This category of migrants increases in concurrence of the implementation of a policy which reduces working prospectives of younger physicians in particular.

I last provide a focus on the type of specializations among migrant specialists. Figure 14 presents descriptive statistics on medical specializations for which there are largest shortages in Italy (D'Arienzo et al. (2020)): anestesits, cardiology, orthopedics, general surgery, internal medicine, obstetric-gynaecologist, pediatrics, radiologist, oncology. With the exception of obstetric-gynaecologist, all selected specialities show an increasing prevalence after policy. The increase is particularly significant among radiologists. Moreover, we have to underline that the Figure 14 presents trends in relative terms: it presents the changes in the prevalence of each speciality among specialists who decide to move. Since we register an increase in the absolute number of specialists who migrate, the real increase in outflows is even larger.[28]

5 Conclusions

The current pandemic situation highlighted the strategic role played by the healthcare sector, with health workers being a key element. Malfunctioning and losses in efficiency may have serious implication both on the healthcare workers (Barili et al. (2020)) and population as a whole (Capano (2020)). This paper explore the evolution in the supply of healthcare workers following the implementation of the Italian Budget Law 2010 (*Law 191/2009*), which introduces strict restrictions on the recruitment of healthcare professionals and the financing of the NHS. I find a significant reduction in the supply of healthcare workers after policy

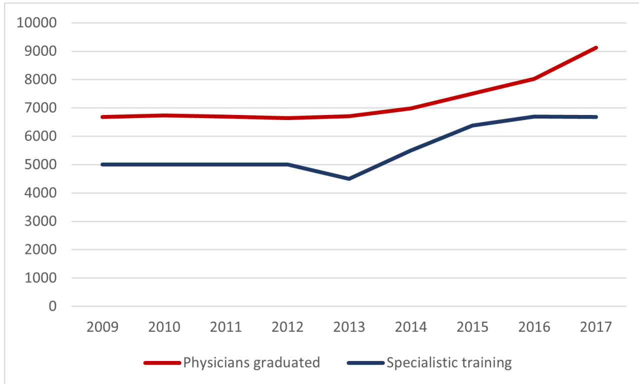
[28] To obtain the absolute values of specialized physicians by speciality, the prevalences must be multiplied by the absolute number of specialized physicians asking for recognition before and after policy (*i.e.,* 533 before policy, 1659 after policy).

implementation, which is particularly strong in the public sector and among the professional category of physicians. Districts which experience a larger reduction in public-sector physicians are subject to worse health outcomes, while they do not exhibit large effects in the measures of access to care considered. After policy, the composition of physicians who are willing to migrate changes. Compared to the pre-policy period, physicians appears to be younger and more talented, with a larger prevalence of those who have not completed their specialization training yet. It seems to suggest that the policy actually affects the supply of healthcare professionals, physicians in particular who are among the most mobile category of high-skilled workers. A reduction in the local supply of physicians has negative effects on public health. Interestingly, the reduction observed in the public sector is not perfectly counterbalanced by an increasing role of the private-accredited sector, which only partially compensate for the reduction. The changes observed in the characteristics of those who decide to migrate point at an increasing prevalence of *Career seekers* among migrant physicians, who decide to leave the country looking for improvements in working environment and better defined career paths. It translates into a net loss for the Italian community, which partially loses investments in Medical Schools, mainly financed by the Ministry of Education. Moreover, after policy those who decide to migrate appear to be with higher frequency specialized in scarce speciality-groups, increasing the negative effect for the community.

From a policy perspective, this analysis suggests the necessity of improvements in workforce planning in the healthcare sector. In particular, physicians appear to be the most sensible to changes in the working conditions and their shortages in the public-sector are among the main causes of bad outcomes in terms of public health. During the life course of a physician, the first years after graduation appear to be the most relevant in the decision to migrate (*i.e.,* reduction in the age at recognition of foreign title). Interventions should carefully consider this point, better defining the possible career paths. Particular attention should be given to the training and retention of specialists in the medical areas for which regions register the largest shortages. A better planning should also consider and implement actions to reduce geographic imbalances in the distribution of healthcare workers within the country, since there is a link between local shortages and adverse health outcomes. This tasks could benefit from a more transparent and comprehensive system of collecting information relative to the healthcare workforce, both within Italy and at the European level. These observations sustain the evidences reported by Barriball et al. (2015), where they encourage the European Commission and Member States to take effective actions to recruit and retain health workers. They observe that the measures of cost-containment adopted to counterbalance the economic crisis have worsen the situation in terms of equality in the access to care. Moreover, they stress the point that financial incentives (*e.g.,* interventions on salary) do play a role, but they are not enough to reach the goal of having an adequate health workforce that could guarantee high quality care. Alternative considerations, linked to the working environment, good management, access to professional development and career opportunities are among the main drivers influencing mobility of such a strategic professional category.

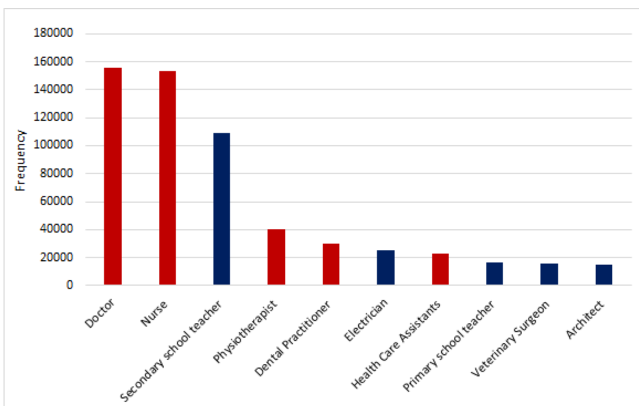
6 Tables and Figures

Figure 1: **Italian training capacity and planning**



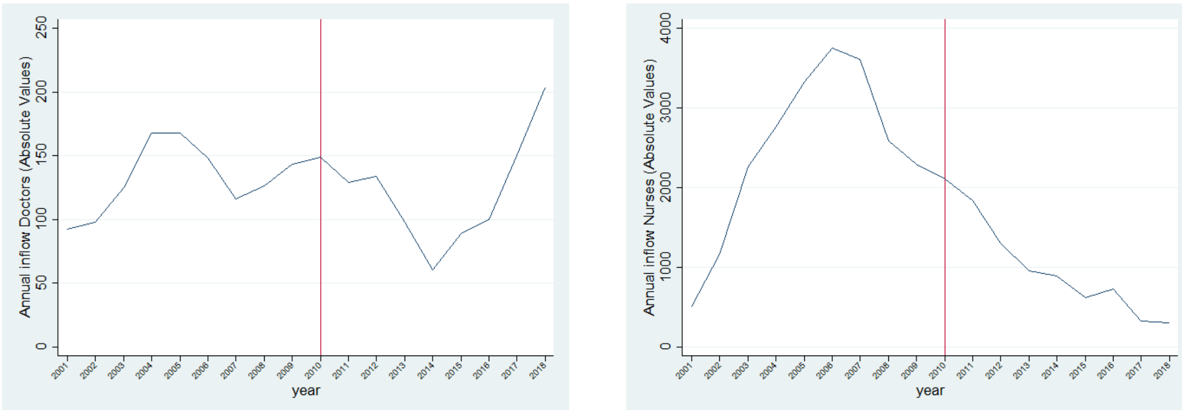
Notes: The Figure presents the trends in the number of graduates and specialistic training capacity in Italy. Data source: Health-for-all-Italy, Ministry of Education (MIUR)

Figure 2: **Mobility of regulated professions in the European Area (2001-2019)**



Notes: The Figure presents the absolute values of migration flows for the 10 most mobile regulated professions. Data refers to registered movements within the European Area (*i.e.,* EU, EEA, Switzerland) during the period 2001-2019. Red bars highlight health-related professions. Data source: European Commission - Regulated Professions Database

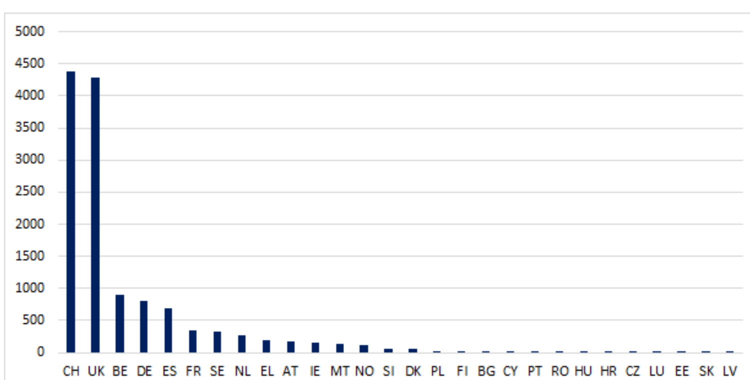
Figure 3: **Inflow of Foreign-trained health professionals in Italy**



(a) Doctors (b) Nurses

Notes: Annual inflow of foreign-trained health professionals in Italy during the period 2001-2018. Only the professional categories of medical doctors and nurses are considered. Data source: Eurostat.

Figure 4: **Main destination countries for Italian-trained doctors (1997-2019)**



Notes: Absolute numbers in the outflows of Italian-trained doctors to the European Area during the period 1997-2019. The five main destinations are Switzerland, United Kingdom, Belgium, Germany, Spain. Data source: European Commission - Regulated Professions Database

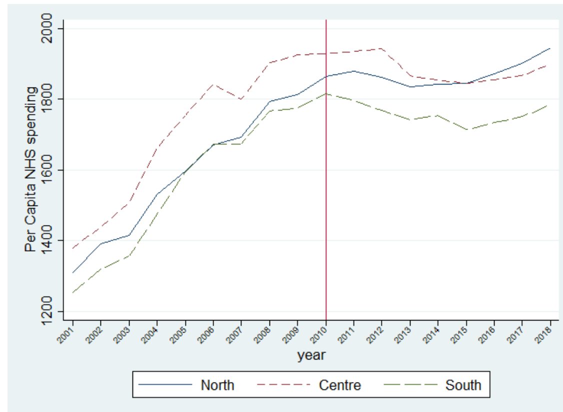
Table 1: **Prevalence of Foreign-Born Physicians in Europe**

Country of residence	Total	Foreign-born physicians absolute values	Foreign-born physicians percentage
Austria	36,782	5,225	14.2
Belgium	39,265	6,174	15.7
Czech Republic	42,363	4,110	9.7
Denmark	18,593	3,904	21.0
Estonia	5,299	742	14.0
Finland	20,121	1,917	9.5
France*	224,998	43,955	19.5
Germany	390,039	78,907	20.2
Greece	49,922	2,103	4.2
Hungary	33,532	3,761	11.2
Ireland	13,538	5,565	41.1
Italy	234,704	10,163	4.3
Latvia	6,868	1,197	17.4
Luxembourg	2,006	1,103	55.0
Netherlands	65,744	11.247	17.1
Norway	22,348	5,082	22.7
Poland*	109,652	2,935	2.7
Portugal	35,592	3,508	9.9
Slovak Republic	13,127	153	1.2
Slovenia*	5,556	1,006	18.1
Spain	189,396	25,875	13.7
Sweden	50,437	15,372	30.5
Switzerland	49,760	23,436	47.1
United Kingdom	262,465	86,866	33.1

Notes: Prevalence of foreign-born doctors by country of residence. Data referred to the years 2015/2016, with the exception of countries marked with * (for them, data referred to 2010/2011 since more recent data are not available). Data source: OECD (2019)

Figure 5: **NHS Spending**

(a) Absolute values



(b) Per capita

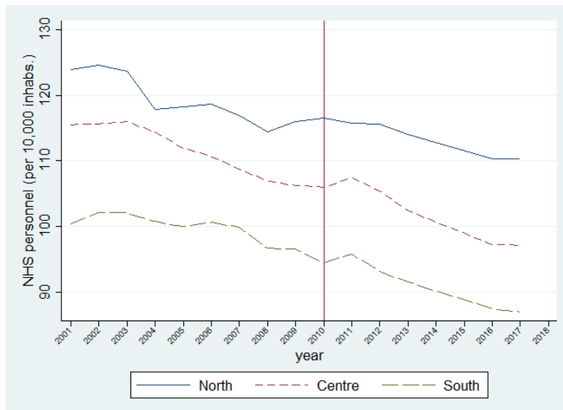
Notes: The Figures present the evolution in the NHS spending over the years 2001-2018 comparing the three Italian macroareas (*i.e.,* North, Centre, South). Figure 5a reports the values in absolute terms (million euros), while Figure 5b show the trends in per capita terms (euros/person). Data source: Health-for-all-Italy.

Table 2: **Primary Outcomes - Supply of Health Professionals**

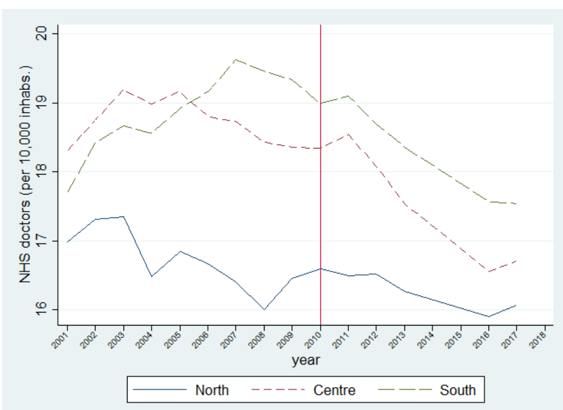
Variable	Mean	Std. Dev.
Public / Private accredited sectors		
Overall personnel over 10,000 inhabitants	99.915	(28.906)
Physicians over 10,000 inhabitants	19.409	(5.310)
Nurses over 10,000 inhabitants	43.708	(11.031)
Technicians over 10,000 inhabitants	6.261	(2.425)
Rehabilitation over 10,000 inhabitants	2.819	(1.773)
Public sector		
Overall personnel over 10,000 inhabitants	88.664	(28.432)
Physicians over 10,000 inhabitants	16.613	(4.876)
Nurses over 10,000 inhabitants	40.346	(11.181)
Technicians over 10,000 inhabitants	5.844	(2.388)
Rehabilitation over 10,000 inhabitants	2.149	(1.618)

Notes: Full set of secondary outcomes considered in the analysis. The indexes are standardized over the resident population in the district in the relevant year. Data source: Health-for-All- Italy

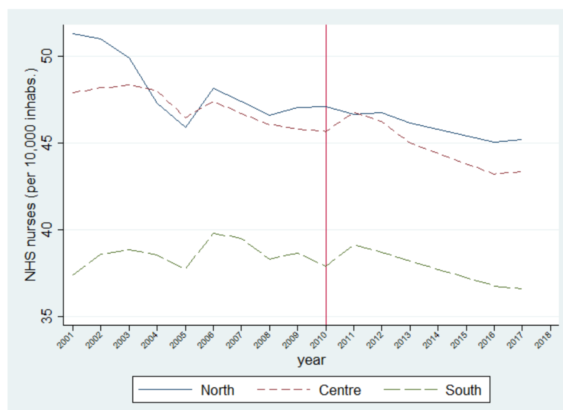
Figure 6: **NHS Personnel**



(a) Overall



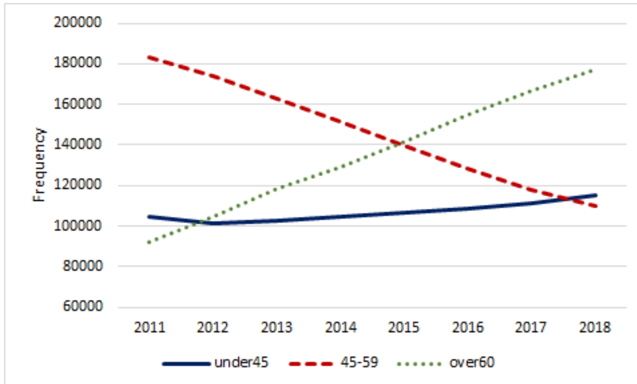
(b) Doctors



(c) Nurses

Notes: The Figures present the evolution in the NHS personnel over the years 2001-2018 comparing the three Italian macroareas (*i.e.,* North, Centre, South). All indexes are weighted over the resident population (10,000 inhabitants). Figure 6a reports the values for NHS personnel overall, while Figure 6b and Figure 6c distinguish by the two largest professional categories (*i.e.,* physicians and nurses). Data source: Health-for-all-Italy.

Figure 7: **Italian Physicians by age-group**



Notes: The Figure presents the trends in the weight of age-group within the professional category of physicians. Data source: Health-for-all-Italy

Table 3: **Controls**

Variable	Mean	Std. Dev.
Demographics		
population over65 (rate)	0.212	(0.028)
female population (rate)	0.479	(0.018)
Socio-Economic indicators		
employment rate	0.574	(0.096)
gender gap (difference in employment)	0.212	(0.063)
average income (in terms of 2017 euros)	19,819.45	(3,187.549)
high school rate	0.255	(0.034)
rate of growth (1991-2001)	-0.085	(0.058)
rate of growth (2001-2011)	-0.226	(0.182)
Health care system		
hospital beds rate (over 10,000 inhabs.)	33.708	(9.537)
prevalence of private-accredited hospitals	17.678	(13.732)
ambulance rate (over 100,000 inhabs.)	2.232	(3.914)
Epidemics: hospital discharge rates (over 10,000 inhabitants)		
circulatory diseases	249.049	(49.353)
respiratory diseases	118.871	(21.152)
brain diseases	47.382	(12.055)
diabetes	15.171	(11.137)

Notes: Full set of controls included in Equation 1. Data source: Health-for-all-Italy

Table 4: **Secondary Outcomes - Public Health and Access to Care**

Public Health		
Death rate over 10,000 inhabitants	102.490	(15.271)
Death rate over 10,000 female inhabitants - females	101.931	(16.862)
Death rate over 10,000 male inhabitants - males	103.064	(14.329)
Death rate over 10,000 inhabitants - circulatory diseases	39.776	(7.102)
Death rate over 10,000 inhabitants - diabetes	3.504	(1.062)
Death rate over 10,000 inhabitants - respiratory diseases	6.959	(1.563)
Death rate over 10,000 female inhabitants - breast cancer (females)	3.881	(0.900)
Death rate over 10,000 male inhabitants- prostate cancer (males)	2.667	(0.582)
Access to Care		
Patients' mobility	0.080	(0.051)
Emergency Room access over 10,000 inhabitants	3584.833	(861.807)
Average days of hospitalization (overall)	7.840	(1.433)
Average days of hospitalization for acute care	6.845	(1.002)
Average days of hospitalization for rehabilitation	24.766	(10.946)
Average days of hospitalization (overall) in the public sector	7.624	(1.314)
Average days of hospitalization for acute care in the public sector	6.995	(0.982)
Average days of hospitalization for rehabilitation in the public sector	23.836	(13.289)

Notes: Full set of secondary outcomes considered in the analysis. *Death rates* are standardized over the resident population in the district in the relevant year. *Patients' mobility* is defined as the share patients having residence in district A hospitalized in a district different from their residence (i.e., district A). Data source: Health-for-All- Italy

Table 5: **Secondary Outcomes - Correlations among treatments**

Treatment	A	B	C	D
A	1.000			
B	0.695	1.000		
C	0.702	0.583	1.000	
D	0.601	0.577	0.857	1.000

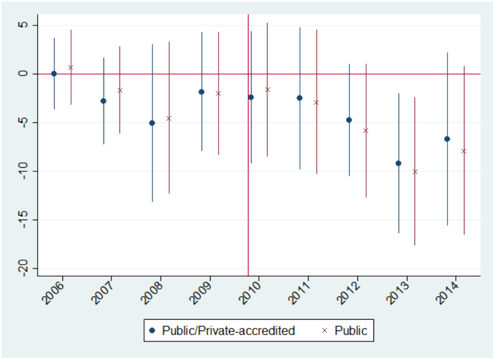
Notes: Table of correlations among treatments when secondary outcomes are considered. *Treatment A* is a dummy assuming value 1 when the reduction in supply of healthcare professionals between 2009 and 2013 considering public and private accredited sectors is above the median. *Treatment B* is a dummy assuming value 1 when the reduction in supply of physicians between 2009 and 2013 considering public and private accredited sectors is above the median. *Treatment C* is a dummy assuming value 1 when the reduction in supply of healthcare professionals between 2009 and 2013 considering public sector is above the median. *Treatment D* is a dummy assuming value 1 when the reduction in supply of physicians between 2009 and 2013 considering public sector is above the median.

Table 6: **Primary Outcomes - Supply of Health Professionals**

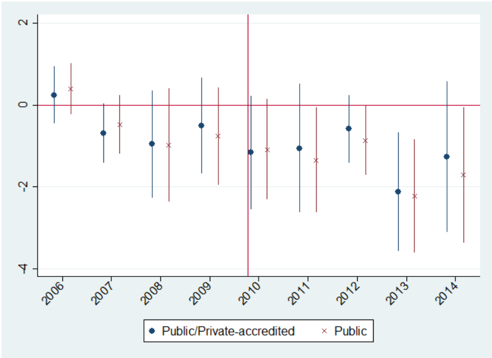
	(1)	(2)	(3)	(4)	(5)
	Overall	Doctors	Nurses	Technicians	Rehab
Outcome: Public / Private-accredited Sectors					
δ	-3.633	-1.172**	-0.456	-0.029	0.031
	(2.425)	(0.488)	(1.016)	(0.176)	(0.198)
Mean Dep.Var.	99.915	19.409	43.708	6.261	2.819
Outcome: Public Sector					
δ	-4.049*	-1.211***	-0.891	0.015	0.044
	(2.130)	(0.410)	(1.019)	(0.173)	(0.159)
Mean Dep.Var.	88.664	16.613	40.346	5.844	2.149
Obs	1058	1058	1058	1058	1058

Notes: Estimated effects for Equation 1 when primary outcomes are considered. Each specification include region fixed effects and standard errors clustered at the regional level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

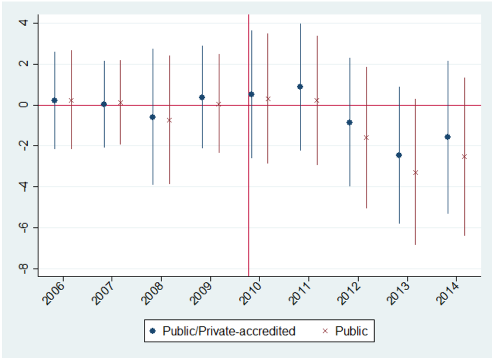
Figure 8: **Supply of Health Professionals: Event-Study Analysis**



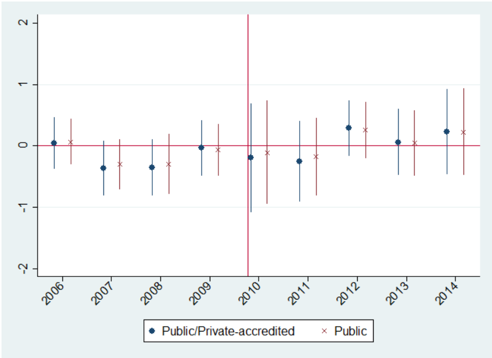
(a) Overall



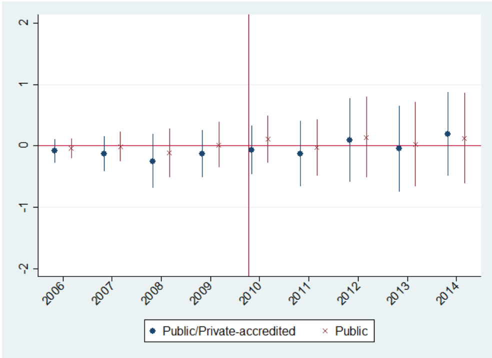
(b) Physicians



(c) Nurses



(d) Technicians



(e) Rehabilitation Staff

Notes: *Notes*: Event-study analysis when primary outcomes are considered. Equation 1 is modified substitution $Post_t$ with yearly dummies. Each specification include region fixed effects and standard errors clustered at the regional level. 90% confidence intervals.

Table 7: **Secondary Outcomes - Public Health**

Death rate:	(1) Overall	(2) Females	(3) Males	(4) Circulatory Diseases	(5) Diabetes	(6) Respiratory Diseases	(7) Breast Cancer (F)	(8) Prostate Cancer (M)
Treatment A: Reduction in Public / Private-accredited Sectors - Overall personnel								
δ	0.976	1.202	0.715	0.829*	0.094*	0.015	0.170**	0.092
	(0.660)	(0.790)	(0.655)	(0.460)	(0.054)	(0.104)	(0.062)	(0.055)
Treatment B: Reduction in Public / Private-accredited Sectors - Physicians								
δ	0.920	1.282	0.524	0.908**	0.105*	0.035	0.115*	0.032
	(0.695)	(0.758)	(0.700)	(0.403)	(0.055)	(0.123)	(0.061)	(0.054)
Treatment C: Reduction in Public Sector - Overall personnel								
δ	0.878	1.066	0.658	0.919**	0.121**	-0.024	0.195**	0.147**
	(0.629)	(0.759)	(0.626)	(0.374)	(0.047)	(0.094)	(0.073)	(0.053)
Treatment D: Reduction in Public Sector - Physicians								
δ	1.879***	2.114***	1.615***	1.662***	0.136**	0.151	0.207***	0.114**
	(0.569)	(0.691)	(0.556)	(0.338)	(0.064)	(0.118)	(0.062)	(0.053)
Mean Dep.Var.	102.490	101.931	103.064	39.776	3.504	6.959	3.881	2.667
Obs	1058	1058	1058	1058	1058	1058	1058	1058

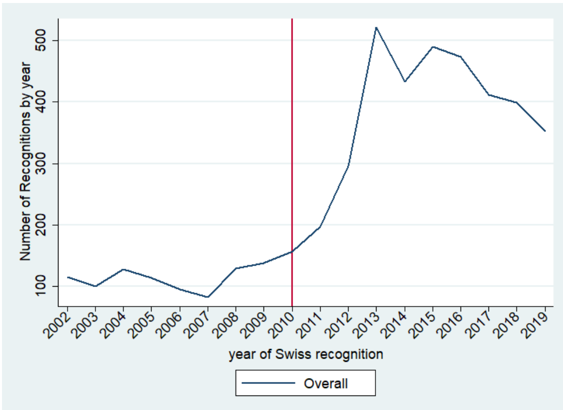
Notes: Estimated effects for Equation 1 when secondary outcomes (public health) are considered. Each specification include region fixed effects and standard errors clustered at the regional level. Significance levels: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 8: **Secondary Outcomes - Access to Care**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			Average days of hospitalization					
	Patients' mobility	ER access	Overall	Acute care	Rehab	Overall public	Acute care public	Rehab public
Treatment A: Reduction in Public / Private-accredited Sectors - Overall personnel								
δ	0.002	-11.932	0.165	0.291	-1.681	0.352*	0.365*	0.051
	(0.003)	(112.036)	(0.194)	(0.204)	(1.436)	(0.170)	(0.191)	(1.283)
Treatment B: Reduction in Public / Private-accredited Sectors - Physicians								
δ	0.004	-45.765	0.049	0.115	-1.195	0.181	0.173	0.508
	(0.002)	(97.450)	(0.165)	(0.181)	(1.707)	(0.157)	(0.173)	(1.747)
Treatment C: Reduction in Public Sector - Overall personnel								
δ	0.001	-53.442	0.233	0.377	-1.669	0.437**	0.472**	-0.081
	(0.003)	(127.285)	(0.211)	(0.218)	(1.405)	(0.185)	(0.207)	(1.305)
Treatment D: Reduction in Public Sector - Physicians								
δ	0.002	-133.583	0.205	0.284	-0.765	0.456**	0.408**	-0.223
	(0.002)	(150.148)	(0.188)	(0.196)	(1.467)	(0.172)	(0.192)	(1.688)
Mean Dep.Var.	0.080	3584.833	7.840	6.845	24.766	7.624	6.995	23.836
Obs	1058	1058	1058	1058	1058	1058	1058	1058

Notes: Estimated effects for Equation 1 when secondary outcomes (access to care) are considered. Each specification include region fixed effects and standard errors clustered at the regional level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Figure 9: **External Migration from Italy to Switzerland**

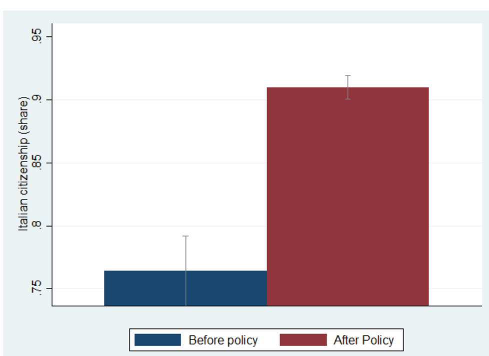


(a) Overall

(b) By Specialization

Notes: Evolution in the request for recognition of medical diploma by year. Only physicians who obtained their diploma in italy are considered. Data source: Swiss Federal Office of Public Health - FOPH

Figure 10: **Descriptives - Demographics**

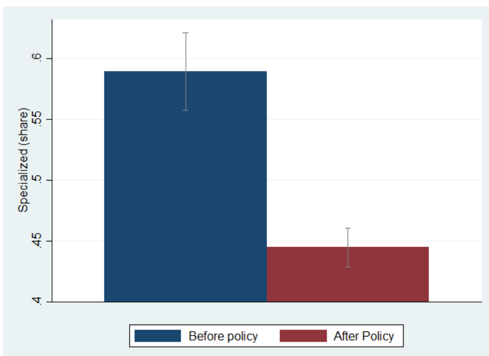


(a) Citizenship

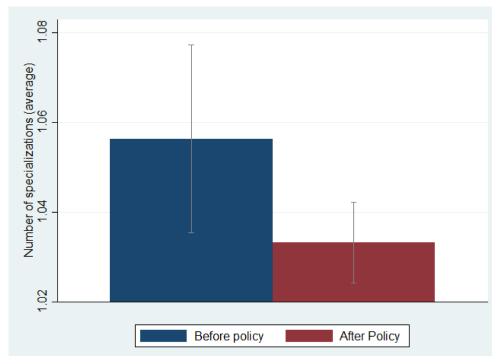
(b) Male

Notes: Descriptives over the demographic characteristics of physicians asking for recognition of their Italian diploma in Switzerland. *Before Policy* identifies the years 2002-2009, *Post Policy* identifies the years 2010-2019. Confidence intervals at 95%. Data source: Swiss Federal Office of Public Health - FOPH

Figure 11: **Descriptives - Specializations**



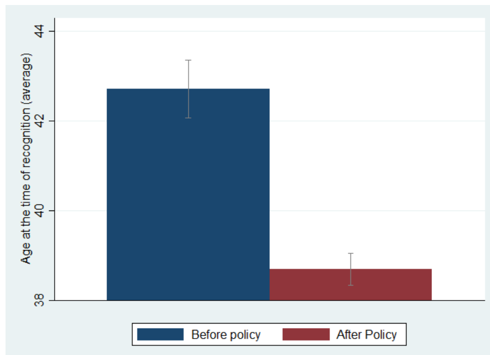
(a) Specialization



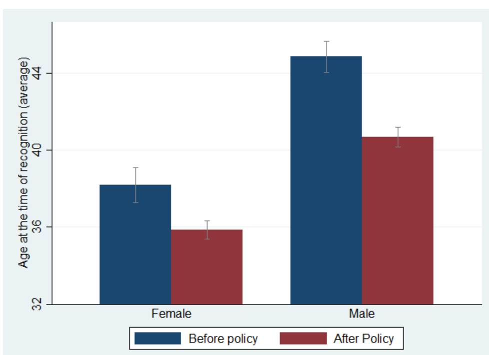
(b) Number of Specializations

Notes: Descriptives over the professional characteristics of physicians asking for recognition of their Italian diploma in Switzerland. *Before Policy* identifies the years 2002-2009, *Post Policy* identifies the years 2010-2019. *Specialization* consist in a dummy assuming value 1 when the physician has at least one specialization. The Figure 11b show the average number of specializations considering only those individuals who have at least 1 specialization. Confidence intervals at 95%. Data source: Swiss Federal Office of Public Health - FOPH

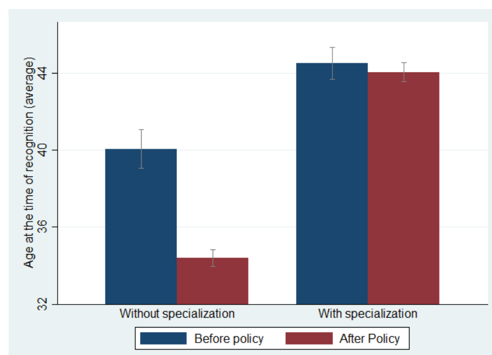
Figure 12: **Descriptives - Age at Recognition**



(a) Age at recognition



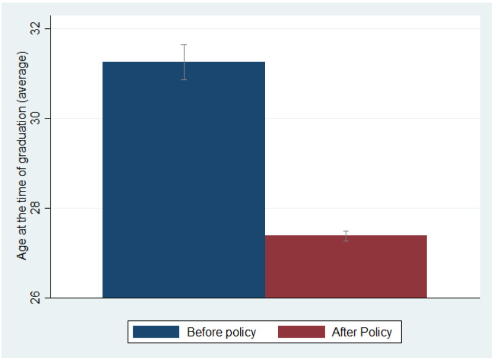
(b) Age at recognition by gender



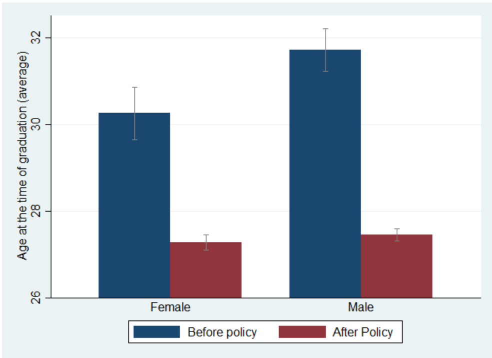
(c) Age at recognition by specialization

Notes: Descriptives over the demographic characteristics at the time of recognition of physicians asking for recognition of their Italian diploma in Switzerland. *Before Policy* identifies the years 2002-2009, *Post Policy* identifies the years 2010-2019. Confidence intervals at 95%. Data source: Swiss Federal Office of Public Health - FOPH

Figure 13: **Descriptives - Quality**



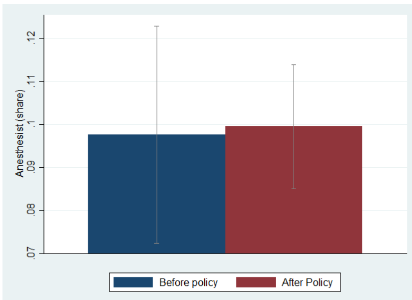
(a) Age at graduation



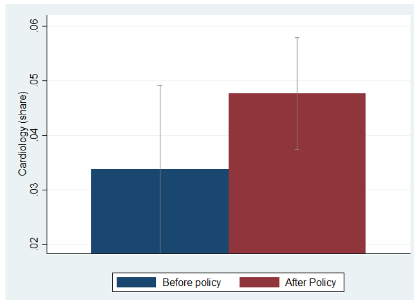
(b) Age at graduation by gender

Notes: Descriptives over the training characteristics of physicians asking for recognition of their Italian diploma in Switzerland. *Before Policy* identifies the years 2002-2009, *Post Policy* identifies the years 2010-2019. Confidence intervals at 95%. Data source: Swiss Federal Office of Public Health - FOPH

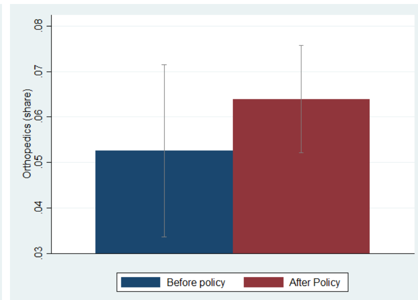
Figure 14: **Descriptives - Specialization type**



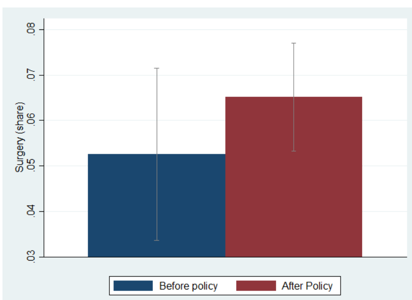
(a) Anesthesist



(b) Cardiology

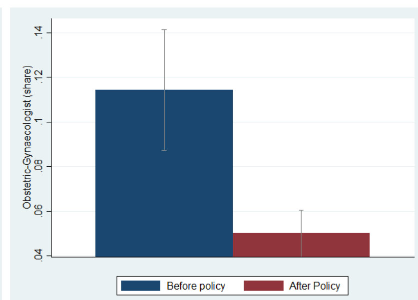


(c) Orthopedics



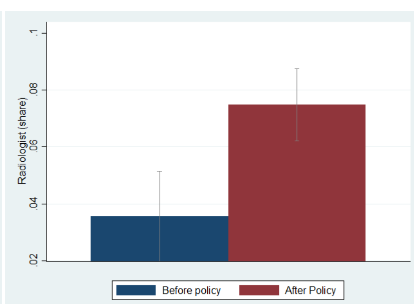
(d) Surgery

(e) Internal Medicine



(f) Obstetric-Gynaecologist

(g) Pediatrics



(h) Radiologist

(i) Oncology

Notes: Descriptives over the prevalence by type of specialization of physicians asking for recognition of their Italian diploma in Switzerland. *Before Policy* identifies the years 2002-2009, *Post Policy* identifies the years 2010-2019. Only physicians who have at least 1 specialization are included. Confidence intervals at 95%. Data source: Swiss Federal Office of Public Health - FOPH

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