THE DARK SIDE OF FISCAL FEDERALISM:
EVIDENCE FROM HOSPITAL CARE IN ITALY

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Keywords: Hospital competition, patients mobility, mixed market, fiscal federalism
The dark side of fiscal federalism: evidence from hospital care in Italy

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Abstract

We use 2009-14 data from patients hospital discharges to assess the effects of fiscal federalism on the quality of care provided to regional and extraregional patients in Lombardy. Empirical results suggest that even after controlling for hospital fixed effects, patients demographic and health characteristics, extraregional patients wait less compared to regional ones, stay longer in hospital and are associated with higher reimbursement costs. However, private and public hospitals with higher proportion of extraregional patients show a lower mortality and lower reimbursement costs. This result suggest that competition works because of the spillovers effects that the market for extraregional patients produces.

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1 Introduction

The diffusion of the welfare state has produced a widespread involvement of the public sector in financing the production of health care for paternalistic and equity reasons (Schnellenbach, 2012). The parallel process of decentralization has meant that decisions on expenditure and service organisation have been devolved to local Governments tiers. Decentralisation is a key feature of several European countries such as Austria, Denmark, Germany, Sweden and Spain (Adolph et al. (2012)). Compared to other European countries, decentralization of financial, administrative and political powers in the health care market in Italy allows for significant regional discretion in the architecture of the market for hospital care (France et al. (2005); Levaggi (2008); Nuti et al. (2016)). Another important feature of the Italian hospital care market is that patients are “voting with their feet” namely they are free to seek hospital care without geographical constraints but their cost of care is always reimbursed by the region of residence (quote Brenna Spadonaro). Within the European context, Italy provides a unique opportunity to explore the effects of competition and decentralization on the quality of care provided at regional level in a setting characterized by large jurisdictional differences in hospital capacity, technology endowment, income and financing ability.

In general, the increase in elasticity of demand combined with fixed price regime has been shown to improve the quality of health care services and to enhance cost containment (Oliver and Mossialos, 2005; Gaynor and Town, 2011; Gravelle et al., 2014).

The welfare effects of decentralization combined with the high volume of patients’ mobility (and associated financial flows) across Italian regions are less clear. In a context where regions differ in their skills, Brekke et al. (2014) show that patients choice may be beneficial for high and low skill regions. In the long run, voluntary mobility should disappear: competition should provide a strong incentive to stimulate quality improvements in the less efficient jurisdictions (Brekke et al. (2012a)). However, patients mobility may have countervailing effects on welfare in the presence of regional differences in income and financial decentralization/fiscal federalism (Brekke et al. (2016)). In Italy patient flows across regions have not exhibited any tendency to decrease. Central–northern regions are net exporters of hospital treatments as their hospitals admit a larger number of patients coming from the south, suggesting that quality differences have been persistent over time. The payment of extra-regional hospital admission has generated additional amounts of financial flows in favour of central–northern regions, exacerbating the north–south gradient in the Italian NHS\(^4\). In addition, hospitals admitting extraregional patients are less constrained by the regional budget cap because they benefit from the revenues of their exported services (Brenna and Spandonaro, 2015).

The objective of the present paper it to investigate the consequences of fiscal federalism together with hospital competition on the quality of care provided to extraregional and regional patients. In particular it aims to answer to the following unexplored research questions:

• What are the driving forces of extra regional patients’ inflows?
• Are the strategies used to attract extraregional patients hospital specific?
• Which are the consequences for local residents: do they benefit from extraregional competition or are they somehow discriminated?

To answer these questions we study the effects of fiscal federalism at the hospital level, through the analysis of patient mobility and by comparing quality offered to patients living in Lombardy with what offered to patients living in other Italian regions (excluding border regions). We use longitudinal data on 4,902,225 hospital discharges in the period 2010-2014 in private, public and not-for-profit hospitals in Lombardy (Italy).

To our knowledge, no other study investigates whether hospitals engage in strategic incentives to attract patient from other regions nor the question of whether, besides the economic benefits for hospital and regional budget, cross border mobility is also a quality driver for regional patients through the higher competition of private and public providers to attract extra regional patients.

2 Related Literature

Internal markets have been created to improve value for money in health care. Patients freedom to choose their health care supplier, within a context of fixed prices, creates incentives to increase quality; this process may be enhanced by devolution of functions to lower tiers. Devolution allows jurisdictions to choose their preferred market form to organise hospital care; if they are efficient may attract patients from other regions thus enhancing the effects of competition. (Gaynor and Town (2011); Jones and Cullis (1996)). In the long run, competition is expected to increase quality and reduce the regional quality gap. In Italy, devolution does not seem to have produced these positive, balancing, effects: the flow of patients moving from poorer/less inefficient regions to richer/more efficient ones is increasing and the quality gap is on the rise. The pattern of patients mobility may be partly explained by sharp difference in disposable income. People living in wealthier regions (i.e. where higher is the GDP per capita) that in principle would be more willing to move for a better quality of care are also those where public health expenditure is higher and the outflow mobility is low (Levaggi and Zanola (2004)). This may create a perverse incentive to quality improvement: the poor regions may find it less expensive to pay an higher quality treatment to few patients (the rich moving outside the regional boundaries) than to improve local quality.

These results are also confirmed by Fabbri and Robone (2010). Using gravity models, their analysis shows that patients flows move from poorer (south) to richer (northern) regions especially for the most severe cases. Their results also suggest that larger local health authorities have a better ability to contain patients outflows and to export hospital services. Balia et al. (2017) investigated the drivers of patients mobility in Italy using data on hospital admission from all the Italian regions. The authors found that regional income, hospital capacity, organizational structure, performance and technology were the main determinants of patients cross border mobility. The strategic game that regions can play using patients mobility has been analysed by Levaggi and Menoncin
The authors suggest that in the Italian context, due to a regulatory failure, there is a strong incentive for efficient and less efficient regions to play strategically. Efficient regions want to control expenditure, less efficient ones, given the lack of incentives to raise quality export patients to other regions in exchange for a soft budget. A number of studies investigated hospital choices of extra-regional patients moving to richer/more efficient regions. According to Berta et al. (2013), public hospitals in Italy perform as well as the private ones and are more efficient. Following these analyses one should expect to find the same attraction index of cross border patients for public and private hospitals (or a higher attraction index for public hospital). In contrast with these findings, Brenna and Spandonaro (2015) found that cross border patients are more likely to prefer private care. Confirming their hypothesis, the study results suggest that the attraction index - measuring the ability of a selected region to attract patients from another region - is systematically higher for accredited private hospitals than for public hospitals. A similar result is also found for a specific health procedure, aortic valve replacement (Fattore et al., 2014). Given that no differences in quality were found between private and public providers, this finding suggests the presence of a proactive behaviour of private hospitals that influences patients choice and attracts more workload.

2.1 The Italian Health Care System

The WHO rated the Italian Health Care system as one of the best in the world. Italy’s life expectancy is the 4th highest among OECD countries with a per capita health care spending well below the average of other high income countries (OECD (2017)). Despite this success, there are significant regional differences in the quality of health care and, as consequence, in the health status of the Italian citizens. Average life expectancy is 82.3 years, but this value ranges from 83.5 years (81.2 for men and 85.8 for women) in Trento (North of Italy) to 80.5 years in Campania (78.3 for men and 82.8 for women) (South of Italy). A similar trend is observed for the reduction in mortality over the last 15 years: 27% in the North; 22% in the Centre and only 20% in the South (Osservasalute (2016)). Arguably, the differences can be associated with the unequal quality of the health care delivered. The average number of acute hospital beds, for instance, ranges from 2.6 per 1000 inhabitants in Calabria (South) to 3.8 in Friuli Venezia Giulia (North). A similar pattern is observed for waiting times (Osservasalute (2016)). Waiting times for a cardiological visits range from 51 days in the North-East to 68 days in the South of Italy (Cittadinanzattiva (2017)).

Lombardy is one of the largest regions both in terms of population (10 millions) and GDP per capita (34,640 euro). Lombardy has approximately 150 hospitals, treating about 1.7 million patients per year and has a health expenditure of 18 billion Euro, which amounts to 75% of total regional public spending. The region is also the major exporter of health care services to extraregional patients. In 2016 only, Lombardy attracted 115,000 patients (10.6 percent of the overall number of extraregional patients), 6,000 more than the previous

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5 The introduction of hard budget constraints with the so-called “Piani di rientro” has sensibly reduced this incentive.

years. In 1997 Lombardy has adopted a quasi-market model for hospital care which is unique example in the Italian experience of fiscal federalism: providers compete on quality under a prospective payment system based on Diagnosis Related Groups (DRGs). NHS patients can receive treatment from public, private non-profit and private for-profit hospitals, though hospitals need to be accredited. Hospitals in Lombardy are reimbursed using a prospective budget that is assigned based on the historical cost at the beginning of the year. Although in principle the Lombardy case is a quasi-market model in practice competition between public and private providers is highly regulated (Berta et al. (2016)). The Region may supply with ex-post funding only to public hospitals that override their budget; private hospitals face instead a hard budget constraint and must comply with a tariff cap. This system creates distortions in the free competition between providers and produces incentives to cross border mobility. Extra regional patients are paid extra budget (outside the tariff caps) using a national tariff as a reference (Fabbri and Robone (2010)) at the end of the year and this provides a strong incentive for private providers looking for additional source of revenues (Brenna (2011); Levaggi and Menoncin (2013); Neri (2015)).

3 The model

We model the decision process of hospitals that choose the level of services to be produced in order to maximise their objective function. Potential providers are profit-maximizing firms ($P$) and public providers with intrinsic motivation ($A$) (Brekke et al., 2011, 2012b; Levaggi and Levaggi, 2017; Galizzi et al., 2015). Public providers have altruistic preferences and cannot retain any surplus. Although they face a binding budget constraint, the Regulator may allow for some slack due to their status (Brekke et al. (2015)). Private hospitals are assumed to be surplus maximisers, have a fixed capacity and face a budget constraint in terms of services they can offer to residents. The latter is assumed to lower than their capacity, i.e. they have an excess of hospital beds that have to filled with patients from other regions. They are assumed to compete for patients on two level: on the market for treating resident patients ($D$) and on the national market to attract patients from other Regions ($E$). In this respect our model is similar to Bisceglia et al. (2017), but with some interesting differences since we assume asymmetry in the competition setting as in Levaggi and Levaggi (2017). The analytical description of the model and the derivation of the quality levels for both hospital are presented in Appendix A. in what follows we highlight the essential features of the model and the hypotheses that we are going to test.

Public providers do not discriminate among patients (they offer the same quality level independently of the residence of the patients) and do not actively try to attract extra regional output. In the empirical estimation they will be used as a benchmark on which to evaluate how private hospitals respond to competition.

Competition is made on quality levels $q$ and private hospitals may choose to supply the same level to resident and non resident or they may discriminate among the two. In this setting it is possible to show (see Appendix A) that the optimal level of $q_D$ and $q_E$ chosen by private hospitals can be written as:
\[ q_E = \bar{q}_E + m_E \frac{2(F - D) - \sigma}{2\sigma \varphi_E} \]
\[ q_D = \bar{q}_D + m_D \frac{2D - \delta}{2\delta \varphi_D} \]

where \( \delta \) and \( \sigma \) are two parameters that relates to the intensity of competition (locally and externally respectively), \( \varphi_D \) and \( \varphi_E \) to patients evaluation of quality; \( m_D \) and \( m_E \) are cost parameters related to the distance (physical or in terms of preferences) patients experience in choosing their preferred providers. The quality for extraregional patients depends on the level of quality in the other Region. The second element \( 2(F - D) \) shows a positive correlation between quality and the number of extraregional cases: the higher is the need for the hospital to attract patients, the higher the quality. For domestic patients, it is interesting to note that \( 2D - \delta \) is a measure of matching between the Regional budget and local demand and for this reason it may well be even negative.

If hospitals do not discriminate on quality, the level is set in order to get on the market for extraregional patients the minimum number of patients to break even, i.e.

\[ q_D = q_E = \frac{2(F - D) - \sigma}{2\sigma \varphi_E} \]

In this case the quality is driven by the competition in the market for extraregional patients. In our empirical estimation we will test whether the more the hospital need to attract patients the less it discriminate on quality levels because of possible reputation effects.

The Regional output can be written as:

\[ S = D_D + D_E = D_P^D + D_A^D + D_P^E + D_A^E \] (1)

We expect extraregional admissions to be higher the higher the number of private hospital, which also means that it is more likely that a non resident is admitted to a private hospital. As per the quality, we expect the market for non resident to be more competitive, i.e. we expect the quality for these patients to be higher than for residents, given that these patients have more alternatives than the domestic ones. Quality discrimination may not however be the best policy for a hospital that wants to attract patients; for this reason we will test for the hypothesis that hospitals do not discriminate patients, i.e. the quality level is the same for all the patients. If our hypothesis is true (the non domestic market is more competitive) we should however still observe a positive relationship between quality and the attraction index of each hospital.

As quality measures we propose to use waiting times (W), patient length of stay (LOS), reimbursement and mortality. Waiting times for elective surgery, measured as the number of days elapsing between the time the patient was added to the waiting list and the day of hospital admission, are a major political issue in many OECD countries. In the absence of price rationing waiting times may
have a countervailing effect: they may constitute a way of rationing health care services, but they may also increase supply of care if workers are intrinsically motivated (Riganti et al. (2017)). This variable will be considered only surgical DRG, the target for which it may inform patients choices. Patient’s length of stay is a typical indicator of efficiency (shorter stays are associated with higher hospital efficiency), but it is also an indicator of intensity of treatment. The third outcome measure is reimbursement which allows to identify whether the extra-regional patients are concentrated in DRGs where the reimbursement is higher compared to the patients living in Lombardy. Finally we will also use hospital readmission and 30 days mortality to control for quality discrimination between residents and non residents.

In order to identify for possible differences in patients motivation for travelling to Lombardy, we will split the sample of incoming patients into the subgroups presented in Figure 1.

“Border” comprises patients coming from Italian regions sharing a border with Lombardy (the area in blue on the top left diagram of 1). These patients may move to avoid waiting for treatment (because of activity thresholds) in their region of residence, while the difference in quality as concerns other indicators is expected to be rather minimal. In general we expect these patients to be healthier than residents. “South” comprises patients coming from the South of Italy (the area in blue in the top left of 1); these patients are more likely to move to receive a better service than in their resident region, given the north/south divide as concerns quality shown about. “Non border non south” is the residual category which is represented by the area in blue on the top right diagram of 1. It comprises an heterogeneous group of Regions with different levels of quality (as well as income) which are however residual since only about

4 Data and Variables

4.1 Data Source

We use longitudinal data on hospital discharges (SDO) over the period 2010-2014 in private, public and no-profit hospitals in Lombardy (data from 150 hospitals for 5 years). The control variables include patient’s age and gender, Diagnostic Related Group (DRG), USA weight, co-existing co-morbidities as captured by the Elixhauser index (e.g. coagulopathy, obesity, weight loss etc.) (Elixhauser et al. (1998)) and the transit in Intensive Care Unit (ICU). We further include different fixed effects: a set of dummy variables that identify the month the patient was treated to capture seasonal effects, a set of dummy variables were also included to control for major disease categories (MDCs). In the overall model, we also include an effect controlling for the different types of admission: Medical and Surgical Admissions. Information on ownership status of the hospital (public, private for-profit, private non-profit) and other hospital characteristics were linked with patient-level administrative data and included in the second set of model (for Lombardy patients), to control for different behaviour among different ownerships.
5 Descriptive statistics

Table 1 reports some descriptive statistics for the variable in analysis. On average, 10 percent of all patients admitted to Lombardy hospitals come from other regions however this proportion changes significantly between private (18% of patients admitted are extraregional) vs. public hospitals and no profit hospitals. Overall, about 10% of the hospital activity derives from extraregional patients and is almost equally distributed between “border” and “south” patient. Non border non south Italy represents in fact about 1.2% of total admissions and they seem to prefer to be admitted to non-profit hospitals.

[Table 1 about here]

6 Results

To answer the first policy question (which are the driving forces behind patients inflows) we have performed a standard logistic model using being extra-regional patient as binary dependent variable. The independent variables are the characteristics of extraregional patients admitted to Lombardy hospitals (in terms of demographics, health condition, diagnosis, type and time of admission, comorbidites) and other variables aimed at capturing ownership characteristics and the effect of the regional budget constraint. The regression has been performed on the overall sample and for the two sub samples “border” and “south” patients. Table 2 summarises the results.

[Table 2 about here]

The estimation is adjusted for hospital fixed effects, years fixed effects and co-morbidity through the 30 morbidity indicators that enter into the Elixhauer index. Instead of including an index which summarises the number of comorbidities according to the Elixhauser algorithm, we included in the model one dummy for each of the 30 comorbidity. In this way we adjust for each specific co-morbidity affecting the patient’s severity and not only by an overall generic measure of comorbidities.

Compared to residents, extraregional patients are more likely to be younger. Surgical patients tend to be admitted for DRG with a higher weight than residents, while the contrary is true for medical DRGs. In general, the gap between the average patients characteristics is higher for patients from the south than for those travelling from border regions. Interestingly, there is a seasonal effect for surgical care. Compared to January the probability increases in the following months, it decreases in August to raise again in September October, November and December. The intake of patients from border regions and the south is quite similar, the only difference is perhaps that the size of the monthly change is less pronounced for border patients: this may be interpreted as a possible evidence that border patients are admitted for a push effect (they shop around in order to avoid queuing in their region of residence). On the contrary for patient admitted from the south a pull effect may prevail: as the end of the year approaches, the number of resident patients that are likely to be reimbursed decreases (because of the threshold on reimbursed activity level) and hospital
increases inflows in order to increase their level of activity by actively seeking out to attract more patients.\textsuperscript{7}

To answer the second question (which are the strategies used by hospitals to attract extraregional patients) standard Ordinary Least Squares (OLS) estimations have been performed to assess the effect of being extraregional on (the log of) waiting times, (log of) LOS and (log of) reimbursement cost.

All the models control for patients demographic, health characteristics (30 comorbidities Elixhauer) and for hospital fixed effect. The complete results are presented in table 4 in Appendix B while the most significant parameters are summarised in Table 3

\[\text{Table 3 about here}\]

Estimation results consistently suggests that extra regional patients from non-border south regions wait less compared to regional ones, stay longer in hospitals and, other thing being equal, some form of upcoding exists since hospitals ask for a higher reimbursement. The first two indicators suggest that hospitals, in their quest to attract patients, try to offer to extraregional patients a more attractive service. The strategy is quite consistent across hospitals, with private and not for profit hospitals showing a more striking difference in the treatment as compared to residents. Border patients follow a rather different pattern: for them the length of stay is lower, they wait less but also the reimbursement is lower than for residents. This result reinforces the conclusions presented above: these patients are probably healthier and less complicated than average, they may not to wait for treatment in their resident region and find it more convenient to travel and be treated more quickly. The difference in the three quality indicators presented above does not allow to conclude that resident are discriminated. The difference in waiting times may depend on the presence of the budget constraint while differences in LOS may be simply determined by the fact that extraregional patients have either to travel longer to reach their residence, or they may be healthier patients than residents. The third element suggests instead that the absence of an overall budget constraint may create incentive to hospital to increase their revenue by creating a sort of price discrimination among patients. For this reason, we have run another set of regressions where we have studied the quality determinants for resident patients. This analysis is run on the quality measures presented above and other two indicators, namely patients hospital re-admissions and 30 days-mortality. The results are presented in Table 5 in Appendix B. In what follows we present the graphical representation of the relationship between the proportion of extraregional patients and the five measures of quality of care considered for Lombardy patients: mortality, readmissions, length of stay, waiting time and reimbursement. Figures report the marginal effects of the five outcomes considered for regional patients on the dependent variable (percentage of extraregional patients admitted to the hospital) by hospital ownership\textsuperscript{8}. In all the five figures, the red, blue and green lines represent private, no profit and public hospitals respectively. As seen in Figure 2 there are no differences in mortality rates and readmissions between private vs. public hospitals; however, for hospitals admitting a high percentage of extraregional patients public hospitals have lower mortality and compared to not

\textsuperscript{7}It should be kept in mind non resident patients are treated extra budget.

\textsuperscript{8}The coefficients estimates are reported in Table 5 in the Appendix
for profit. The opposite is true for hospitals having a percentage of extraregional patients close to zero. Overall, Figure 2 suggests that low mortality hospitals are able to attract a higher proportion of extraregional patients, but it may also suggest that to attract patients beyond the borders hospitals have to reduce their mortality rate. The same effect is also observed for hospital readmission with no difference between private and public hospitals. LOS for Lombardy patients (Figure 2) is significantly higher for public hospitals admitting a low volume of extraregional patients but as the proportion of extraregional patients increases public hospitals become more efficient and no difference is found for between public and private hospitals for those admitting 25 percent or more of extraregional patients. Waiting times are similar across hospital ownership for low volumes of extraregional patients. However, they are significantly longer in public hospitals when the volume of extraregional patients increases. The effect of having a higher proportion of extraregional patients is very interesting on the reimbursement outcome. The results suggest that higher proportion of extraregional patients decreases the reimbursement cost for regional ones independently form the ownership type. This effect is however stronger for private vs. public hospitals suggesting that for private hospitals facing a hard budget constraint being able to generate extra revenues by exporting hospital services reduces their opportunistic behaviours such as cream skimming and upcoding on regional patients. Overall these results seem to point out to the conclusion that competition to get patients from other regions may improve the quality of care for residents. In some ways this is an interesting result since it suggest that better quality of care is achieved because of patients mobility rather than competition on the internal market.

7 Conclusions and Policy Implications

The objective of this paper is to explore whether fiscal federalism together with hospital competition is beneficial or detrimental for the quality of the hospital care provided to regional and (exported) to extraregional patients. Our results suggest that, in a context like Italy with a wide north-south divide, there is not a straightforward answer to our research question. Given the heterogeneity of the care provided in different regions in Italy, citizens from less efficient regions do not choose their hospital according to distance, following a standard Hotelling framework. Instead they are willing to travel long distances from their home (and regional healthcare system) even for standard medical and surgical procedures to seek a (perceived) better and faster cure. In addition to this element of quality heterogeneity between the different Italian regions (and in particular Southern vs. Northern) that push patients demand for extraregional care, Italian fiscal federalism seems to be designed to promote inter-regional mobility also on the supply side. Using their tax revenues, regions, and as consequence hospitals, have to pay only for the care provided to their residents, while extraregional patients constitute an uncapped source of revenue for regional hospitals. In a prospective payment system this difference in budget constraints between regional and extraregional patients might promote or exacerbate existing opportunistic behaviours and even potentially create discriminatory actions...
against regional (capped) patients. A qualitative survey conducted among patients travelling for care in Lombardy found that long waiting times were a main pull factor for extraregional patients in Italy\(^9\). This result is confirmed in our analysis. Independently from the patient characteristics and hospital ownership extraregional patients wait less compared to regional ones for elective surgery in Lombardy hospitals. This result suggest that in context like Italy where extraregional patients constitute an uncapped source of revenue for all the types of hospitals fiscal federalism creates a strong incentive for regional patients willing to wait less to migrate in other regions to reduce their waiting times. As pointed out by Balia et al. (2017), for extraregional patients travelling long distances for care a longer length of stays are perceived "as an insurance against bad health at home after hospital discharge". Consistently with this findings we found that extra-regional-non-border patients LOS is longer compared to regional patients even once we control for patients co-morbidity and hospital fixed effects. The same result is not observed for medical patients, for those there are no differences between regional and extraregional patients. Extraregional patients are for Lombardy hospitals an uncapped source of revenues and are not subject to regional authorities control for opportunistic behaviours. Our results suggest that these two elements might promote the adoption of opportunistic behaviours for exporting hospitals. Compared to regional patients indeed extraregional ones are always assigned to a higher cost DRG. This result is in line with the study by Fattore et al. (2014) in which the authors found that independently from the ownership, extraregional patients were more likely to be assigned to the DRG with a higher reimbursement for aortic valve replacement. The analysis of the consequences of fiscal federalism on the quality of care provided to regional patients shed further interesting results. According to Berta et al. (2013) ownership does not significantly affect the risk of dying for Lombardy patients. Consistently with these results our analysis suggest that between hospitals with the same level of extraregional patients there are no difference in mortality, however, between low vs. high exporting hospitals there is an significant decrease in mortality and readmissions suggesting two possible (and potential complementary reasons): better hospitals attract more extraregional patients, independently from the ownership. Secondly, because of financial incentives hospitals that want to attract extraregional patients improve their quality by reducing mortality and readmissions even for regional patients. This results is more relevant for public hospitals as there is a significant difference in mortality between hospitals attracting extraregional patients vs. hospitals with low volume of export. If confirmed by future studies, this result is extremely relevant for policy makers as it suggests that it is external (measured by the volume of export) rather than internal competition the main driver of quality improvements for public hospitals. Similar beneficial effects of fiscal federalism on the quality of care provided are observed for LOS and reimbursement. Public hospitals admitting more extraregional patients are more efficient in reducing the LOS of regional ones. For reimbursement cost per patient, private hospitals admitting more extraregional patients assign regional patients to lower DRG costs. This result is very interesting and deserve further analyses. According to Berta et al. (2016) the prospective payment system

induce hospitals, and in particular private hospitals that face a hard budget constraint to engage more in cream skimming compared to public and not for profit. Our results suggest that in private hospitals with a high proportion of extraregional patients the effect of fiscal federalism decreases their incentive to opportunistic behaviours toward resident patients.
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### Tables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Public Hospitals</th>
<th>Private Hospitals</th>
<th>No Profit Hospitals</th>
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<td>60.49 18.55 109 18.00</td>
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<tr>
<td>Southern extraregional</td>
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</table>

| Overall                         | 0.535 0.499 1.00 0.000 | 0.507 0.507 1.00 0.000 | 0.515 0.515 1.00 0.000 |
| Age                             | 59.747 19.557 109.000 18.000 | 60.76 17.93 108.00 18.000 | 60.49 18.55 109 18.000 |
| DRG weight                      | 1.210 0.910 12.227 0.182 | 1.37 1.00 12.23 0.18 | 1.24 1.03 12.23 0.18 |
| Extraregional (All)             | 0.097 0.296 1.00 0.000 | 0.045 0.207 1.00 0.000 | 0.040 0.195 1.00 0.000 |
| Border extraregional            | 0.065 0.297 1.00 0.000 | 0.045 0.207 1.00 0.000 | 0.040 0.195 1.00 0.000 |
| Southern extraregional          | 0.06 0.26 1.00 0.000 | 0.065 0.297 1.00 0.000 | 0.06 0.26 1.00 0.000 |

Table 1: Descriptive statistics
Table 2: Determinants of patients inflow

Note: The coefficients and standard errors (in brackets) are reported. *** represents significance at the 1% level. ** represents significance at the 5% level, and * represents significance at the 10% level.

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Overall

Border Only

Medical

Surgical

USA weight

Age

Variables and *represents significance at the 10% level.
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Note: ***: significant at 0.01%

Table 3: Quality to Lombard patients vs extra regional
Figure 1: Definition of export areas
Figure 2: Quality in Lombardy as function of extraregional patients by hospital ownership
A The theoretical model

Let us consider two communities both consisting of a unit mass of patients needing hospital care. Health care is supplied for free, but users incur linear distance costs to acquire it. Individuals are allowed to choose the preferred provider and in doing so they evaluate hospital quality and travel costs. The unit cost to produce care with a minimum verifiable level of quality \((q = 0)\) is equal to \(k\). Quality can be enhanced, but its cost is hospital-specific. As in Levaggi and Levaggi (2017) the staff of public hospitals is intrinsically motivated to supply quality of care because they derive utility from its enhancement. For them, the cost to produce quality is non monetary and simply depends on the difference between the utility derived from quality enhancement and the disutility of such effort. Workers in private hospitals lose their intrinsic motivation and to increase quality the management has to pay higher salaries, which we measure through a linear cost in quality \(k\). We also assume the presence of a fixed cost \(F\) which depends on the bed capacity of the hospital itself. With these assumptions, the cost function for a generic hospital can be written as:

\[
C = \beta + (1 - \rho)kqD + \rho\frac{\theta}{2}q^2 + F
\]

where \(D\) is the hospital demand. For \(\rho = 0\) the hospital is a private organisation while \(\rho = 1\) represents a public provider.

Private hospitals are surplus maximisers and are entitled to retain the full difference between revenue and costs; public hospitals have a more complex function that depends on their surplus (of which they can retain only a fraction \(1 - \rho\)) and quality. For each patient treated the provider in each Region foresees a reimbursement \(T_i\). Let us define \(S_i = T_i - \beta\); the objective function of the providers can be written as:

\[
V = (1 - \rho)\Pi + \rho q = (1 - \rho)(TD - kqD) + \rho\phi q - \frac{\theta}{2}q^2 - F
\]

where \(\Pi\) is the surplus, and \(0 \leq \rho \leq 1\) measure the degree to which the hospital is profit-constrained.

The demand \(D\) is derived from the choices of patients that choose the provider that maximise their net utility. In what follows we assume that the demand may derive from two different sources: patients resident in the Region where the hospitals are located, \(D_D\), and patients coming from other Region, \(D_E\). In choosing their quality level, hospital can discriminate over patients according to their geographical location by offering a different level of quality. We denote \(q_D\) the quality offered to residents and \(q_E\) the level for non resident. The resident demand for each hospital is derived from a spatial model with oligopolistic competition which can be considered a modified (to a line city) version of the oligopolistic model presented in Levaggi and Levaggi (2017) where hospital care is provided by a public hospital at located in 0 and a private hospital located in 1\(^{10}\). The location of the indifferent consumer \((x_D)\) determines the demand for each hospital:

\[\text{See also Levaggi and Levaggi (2018)}\]
\[ x_D = \frac{\varphi (q_R - \bar{q}_R)}{m_D} + \frac{1}{2} \]  

(4)

where \( q_D \) is the quality of the hospital and \( \bar{q}_D \) is the quality of the other competitors.

In this setting we can introduce more private hospitals by considering that the demand for private and public hospital is split equally among private hospitals from one side and public providers from the other side, so that the demand can be written as

\[ D_D = \delta \left( \frac{1}{2} + \frac{\varphi_D (q_D - \bar{q}_D)}{m_D} \right) \]

For the external demand demand, we can imagine a similar process, but in this case the hospital located outside the regional boundaries provides a service that corresponds to the quality of the average hospital in the other region, in this case the indifferent consumer is located at

\[ x_E = \left( \frac{\varphi (q_E - \bar{q}_E)}{m_E} + \frac{1}{2} \right) b \]  

(5)

and the demand for treatment for patients can be written as:

\[ D_E = \sigma \left( \frac{1}{2} + \frac{\varphi_E (q_D - \bar{q}_E)}{m_E} \right) \]

where \( \delta \) are two parameters that relates to the intensity of competition (locally and externally respectively), \( \varphi_D \) and \( \varphi_E \) to patients evaluation of quality; \( m_D \) and \( m_E \) are cost parameters related to the distance (physical or in terms of preferences) patients experience in choosing either of the types of providers.

A.1 Public hospitals

Public hospitals do not set quality in order to attract patients: in spatial competition model quality is in fact used as an instrument to increase surplus. However, the hospital staff is intrinsically motivated because it derives utility from quality enhancement through the parameter \( \phi \) which reflects the altruistic aspect of intrinsic motivation, i.e. the common concern that the staff and patients have for quality. In other words, also public hospital care for quality, but in a different way from private hospitals. Their objective function can be written as:

\[ V^A = \phi \left( q_D^A + q_E^A \right) - \frac{\theta}{2} \left( q_D^A + q_E^A \right)^2 - \bar{H} \]

The F.O.C. for the problem can be written as:

\[ \frac{\partial V^A}{\partial q_D^A} = \frac{\partial V^A}{\partial q_E^A} = \phi - \theta \left( q_D^A + q_E^A \right) \]

Several solutions are compatible with this condition; the more likely case is that the patients receive the same level of care, i.e. \( q_D^A = q_E^A = \frac{\phi}{2\theta} \) which becomes the benchmark for the private hospital, i.e. \( \bar{q}_D^A = \bar{q}_D = \frac{\phi}{2\theta} \).
A.2 Private hospitals

Private hospitals maximise the surplus that they can fully retain. Let us consider the strategy of an hospital that want to maximise its profit by taking into account the demand of resident and non resident patients. They face a fixed cost $F$ and a bed capacity that can be translated into a maximum number $F$ of patients that can be admitted. The Regional Health care system set the maximum number of resident patients that the hospital will be reimbursed, $D$, hence the hospital management also estimates that a minimum number of non-resident patients $E - D$ has to be admitted in order to break even.

A.2.1 Quality discrimination is possible

Let us first assume that hospitals can provide a different level of quality to domestic and non domestic patients. The problem they face can be written as:

$$\max_{q_L,q_E} \Pi = (S_D-kq_D)\delta \left( \frac{\varphi_D(q_D - \bar{q}_D)}{m_D} + \frac{1}{2} \right) + (S_E-kq_E)\sigma \left( \frac{\varphi_E(q_E - \bar{q}_E)}{m_E} + \frac{1}{2} \right)$$

s.t.

$$\delta \left( \frac{\varphi_D(q_D - \bar{q}_D)}{m_D} + \frac{1}{2} \right) \leq D$$

$$E \leq \delta \left( \frac{\varphi_D(q_D - \bar{q}_D)}{m_D} + \frac{1}{2} \right) + \sigma \left( \frac{\varphi_E(q_E - \bar{q}_E)}{m_E} + \frac{1}{2} \right) - H \leq F$$

Let us observe the second constraint. The two constraints are clearly antagonistic, i.e. if the first is binding the second is not binding and vice versa. We can have three different cases:

- a) internal solution i.e. both constraints are not binding
- b) $D + \delta \left( \frac{\varphi_D(q_D - \bar{q}_D)}{m_D} + \frac{1}{2} \right) \geq E$ binding as an equality
- c) $D + \delta \left( \frac{\varphi_D(q_D - \bar{q}_D)}{m_D} + \frac{1}{2} \right) \leq E$ binding as an equality

From a mathematical point of view, case b) and c) are solved in the same way, the conditions on the parameters determine which conditions is binding. In what follows we will then write the solution for a generic constraint $D + \delta \left( \frac{\varphi_D(q_D - \bar{q}_D)}{m_D} + \frac{1}{2} \right) = F$ The Lagrangian for the problem can be written as:

$$L = (S_D-kq_D)\delta \left( \frac{\varphi_D(q_D - \bar{q}_D)}{m_D} + \frac{1}{2} \right) + (S_E-kq_E)\sigma \left( \frac{\varphi_E(q_E - \bar{q}_E)}{m_E} + \frac{1}{2} \right) - \lambda_1 \left( \delta \left( \frac{\varphi_D(q_D - \bar{q}_D)}{m_D} + \frac{1}{2} \right) - D \right) - \lambda_2 \left( \delta \left( \frac{\varphi_D(q_D - \bar{q}_D)}{m_D} + \frac{1}{2} \right) + \sigma \left( \frac{\varphi_E(q_E - \bar{q}_E)}{m_E} + \frac{1}{2} \right) - F \right)$$

The F.O.C. can be written as:

$$\frac{\partial L}{\partial q_D} = \frac{1}{2} \delta - \frac{2k_D\varphi_D q_D - \delta \varphi_D D - km_D + 2\varphi_D S_D - 2\lambda_1 \varphi_D - 2\lambda_2 \varphi_D}{m_D} = 0$$

$$\frac{\partial L}{\partial q_E} = \frac{1}{2} \sigma - \frac{2k_E\varphi_E q_E + 2k_D\varphi_D q_D - \delta \varphi_D D + km_E + 2\varphi_E S_E - 2\lambda_1 \varphi_E - 2\lambda_2 \varphi_E}{m_E} = 0$$

$$\frac{\partial L}{\partial \lambda_1} = \delta \left( \frac{\varphi_D(q_D - \bar{q}_D)}{m_D} + \frac{1}{2} \right) - D = 0$$

$$\frac{\partial L}{\partial \lambda_2} = \delta \left( \frac{\varphi_D(q_D - \bar{q}_D)}{m_D} + \frac{1}{2} \right) + \sigma \left( \frac{\varphi_E(q_E - \bar{q}_E)}{m_E} + \frac{1}{2} \right) - F = 0$$

and the solution can be written as:
\[ q_D = q_D + m_D^2(F - D) - \delta \]
\[ q_E = q_E + m_E^2(F - D) - \delta \]

If the second constraint is not binding, it is sufficient to solve the problem using the first three FOC’s. The optimal quality will be equal to:

\[ q_D = a_D + m_D^2(F - D) - \delta \]
\[ q_E = \frac{1}{4} q_E \]

The problem admits an internal solution if \( F < D < \bar{F} \). Let us then define the demand for the internal solution. The indifferent patient will be located at

\[ x^*_E = \left( \frac{1}{4} + \frac{w (S_E - kq_E)}{m_E} \right) \]

Since \( D_E = x^*_E \sigma \), the unconstrained demand from non-resident patients is equal to

\[ D_E = \sigma \left( \frac{1}{4} + \frac{w (S_E - kq_E)}{m_E} \right) \]

The solution is compatible with the constraints if \( F \leq D_E \leq \bar{F} \) otherwise one of the other two constraints is binding. The complete solution for the problem can be written as:

\[ \begin{align*}
\text{if} & \quad \sigma \left( \frac{1}{4} + \frac{w (S_E - kq_E)}{m_E} \right) < F - D & q_E = q_E + m_E \frac{2(F - D) - \sigma}{2\sigma \phi_E} \\
\text{if} & \quad \sigma \left( \frac{1}{4} + \frac{w (S_E - kq_E)}{m_E} \right) > F - D & q_E = q_E + m_E \frac{2(F - D) - \sigma}{2\sigma \phi_E} \\
\text{if} & \quad F - D \leq \sigma \left( \frac{1}{4} + \frac{w (S_E - kq_E)}{m_E} \right) \leq F - D & q_E = \frac{q_E}{2} + \frac{S_E}{2k} - \frac{m_E}{4\phi_E} \\
& & q_D = q_D + m_D \frac{2(D - \delta \sigma)}{2\delta \phi_D}
\end{align*} \]

A.2.2 Quality discrimination is not possible

In this case we assume that the quality of hospital care for domestic patients should be the same from that offered to non resident. The problem can be written as:

\[ \max_{q_D, q_E} \Pi = (S_D - kq_D) \delta \left( \frac{q_D(q_D - q_D)}{m_D} + \frac{1}{2} \right) + (S_E - kq_E) \sigma \left( \frac{q_E(q_E - q_D)}{m_E} + \frac{1}{2} \right) \]

s.t.

\[ \delta \left( \frac{q_D(q_D - q_D)}{m_D} + \frac{1}{2} \right) \leq D \]
\[ q_D = q_E \]
\[ F \leq \delta \left( \frac{q_D(q_D - q_D)}{m} + \frac{1}{2} \right) + \sigma \left( \frac{q_E(q_E - q_D)}{t} + \frac{1}{2} \right) - H \leq \bar{F} \]
As before all these constraints cannot be binding. In our model, given the nature of the constraint on the internal demand, we assume that the competitive market on which the demand is set is the non domestic one, i.e. we assume that the quality is set on the market for non resident. We also assume that since quality is higher than what would allow to get $D$ patients, the hospital always if this is the case, the first constraint is not binding in quality setting while the second one can be substituted back into the objective function. The problem can be written as:

$$
\max_{q_E} \Pi = (S_D - kq_E)\delta \left( \frac{\varphi_D(q_E - \bar{q}_D)}{m_D} + \frac{1}{2} \right) + (S_E - kq_E)\sigma \left( \frac{\varphi_E(q_E - \bar{q}_E)}{m_E} + \frac{1}{2} \right)
$$

s.t.

$$
\bar{F} \leq D + \sigma \left( \frac{\varphi(q_E - \bar{q}_D)}{m_E} + \frac{1}{2} \right) - H \leq F
$$

Let us observe the constraint. The two constraints are clearly antagonist, i.e. if the first is binding the second is non binding and vice versa We can have three different cases

a) internal solution i.e. both constraints are not binding

b) $D + \sigma \left( \frac{\varphi(q_E - \bar{q}_D)}{m_E} + \frac{1}{2} \right) \geq \bar{F}$ binding as an equality

c) $D + \sigma \left( \frac{\varphi(q_E - \bar{q}_D)}{m_E} + \frac{1}{2} \right) \leq F$ binding as an equality

From a mathematical point of view, case b) and c) are solved in the same way, the conditions on the parameters determine which conditions is binding. In what follows we will then write the solution for a generic constraint $D + \sigma \left( \frac{\varphi(q_E - \bar{q}_D)}{m_E} + \frac{1}{2} \right) = F$. The Lagrangian for the problem can be written as:

$$
\mathcal{L} = (S_D - kq_E)\delta \left( \frac{\varphi_D(q_E - \bar{q}_D)}{m_D} + \frac{1}{2} \right) + (S_E - kq_E)\sigma \left( \frac{\varphi_E(q_E - \bar{q}_E)}{m_E} + \frac{1}{2} \right) - \lambda \left( D + \sigma \left( \frac{\varphi(q_E - \bar{q}_D)}{m_E} + \frac{1}{2} \right) - F \right)
$$

The F.O.C. can be written as:

$$
\frac{\partial}{\partial q_E} : - \frac{1}{2} \frac{\delta D}{S_D} \frac{\delta q_E - 2\varphi_E q_E \delta + \varphi_E q_E \delta + k \sigma m_D}{m_E} - \sigma \frac{2 \delta q_E - \varphi_E q_E - \varphi_E g_E + \lambda}{m_E} = 0
$$

$$
\frac{\partial}{\partial \lambda} : D + \sigma \left( \frac{\varphi(q_E - \bar{q}_D)}{m_E} + \frac{1}{2} \right) - F = 0
$$

and the solution can be written as:

$$
q_D = \bar{q}_E + m_E \frac{2(F-D) - \sigma}{2(\delta \varphi_D - \delta \varphi_E)}
$$

$$
q_E = \bar{q}_E + m_E \frac{2(F-D) - \sigma}{2(\delta \varphi_D - \delta \varphi_E)}
$$

If the constraint is not binding, it is sufficient to solve the problem using the first FOC's. The optimal quality will be equal to:

$$
q_E = \bar{q}_E + \frac{\sigma m_D \varphi_E}{2 \delta m_E \varphi_D + \sigma m_D \varphi_E} + \frac{\delta m_E \varphi_D}{2 \delta m_E \varphi_D + \sigma m_D \varphi_E} \left( \frac{1}{4} \frac{2(\sigma m_D w S_E + \delta m_E \varphi_D S_D) - k \delta m_D \varphi_D + \sigma m_D \varphi_E}{k (\delta m_E \varphi_D + \sigma m_D \varphi_E)} \right)
$$
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<td>-0.007***</td>
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<td>0.050***</td>
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<td>0.014</td>
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<td>0.032***</td>
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| Note: all regressions are adjusted for hospital fixed effects and comorbidity; *** stands for significant at 0.01%
Table 5: Change in quality due to extraregional patients by ownership
Note: all the regression are adjusted for year fixed effects and co-morbidity