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Hospital budget constraint(s) and patients' mobility: Evidence from Lombardy

Paolo Berta[1,2], Carla Guerriero[1,3], Rosella Levaggi[1,4]

Abstract

This paper investigates the consequences of fiscal federalism and patients' mobility on hospital competition using data for the Lombardy Region, which in Italy has adopted a competition model for hospital care: public and private hospitals coexist, and patients can choose their preferred provider. 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 extra-regional patients admitted to hospitals in Lombardy. We use waiting times, length of stay and reimbursement cost as proxies for quality. For regional patients, we also consider 30-days mortality and hospital readmissions.

The empirical results suggest that even after controlling for hospital fixed effects, patients' demographic and health characteristics, extra-regional patients wait less compared to regional ones, stay longer in hospital and are associated with higher reimbursement costs. In spite of this, exporting hospital services to other regions seems to benefit the quality of care provided to regional patients. Private and public hospitals with a high proportion of extra-regional patients show a lower mortality and are associated with lower reimbursement costs. These results suggest that competition in the market for hospital care works because of the spillover effects that the market for extra-regional patients produces.

Keywords: Health care expenditure, equalisation grants

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Introduction

The diffusion of the welfare state has produced a widespread involvement of the public sector in financing the supply of private goods for paternalistic reasons (Schnellenbach 2012). One of the most relevant examples is health care, the public provision of which is advocated on equity grounds. The parallel process of devolution has meant that decisions on expenditure and service organisation have often been assigned to local Governments tiers. Devolution is a feature of several European countries such as Austria, Denmark, Germany, Sweden and Spain (Adolph et al 2012). Compared to other European countries, regions in Italy can make different choices in regard to the role of private health care providers and patients' freedom to choose their preferred provider. Through time, this process has produced 21 separate health care systems responsible for funding, organizing and delivering health care services. Within the European context, the Italian framework provides a unique opportunity to explore the effects of competition and decentralization on the quality of care provided at regional and hospital level in a setting characterized by large jurisdictional differences in hospital capacity, technology endowment, income and financing ability. Previous studies suggest that the patients' free choice between types (public vs. private), and across providers in different regional jurisdictions has not a clear effect on the quality and the efficiency of health care. Gravelle et al. (2014) show that hospital quality, measured using medical and patient reported indicators, positively reacts to the quality provided by other hospitals in the same market. This finding is in line with other literature showing that patients' choice enhances competition, improves the quality of health care services, and allows cost containment (Oliver & Mossialos 2005; Gaynor & Town 2011). The welfare effects of patients' mobility across regions are less clear. Brekke et al. (2014) consider an environment where patients' needs are similar while efficiency in health care delivery differs across region; in this context they study the effect of patients' mobility. They show that patient choice may be beneficial for high and low skill regions. Patients from high skill regions receive benefits from high skill hospitals while, with free mobility, low skill regional patients receive high quality care elsewhere. In the long-run, voluntary mobility should disappear: competition should provide a strong incentive to stimulate quality improvements in the less efficient jurisdictions. However, patients' mobility may have opposite effects on welfare when regions differ in their income level (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 (their hospitals admit a larger number of patients coming from the South) suggesting that quality differences have been persistent over the observed period. The payment of extra-regional hospital admissions has generated additional amounts of financial flows towards Central/Northern regions, exacerbating the North/South divide in the Italian NHS[1]. Regional health authorities that are efficient in attracting patients have significant benefits. The ability to attract patients from other regions is a signal of hospital and regional health care quality. In addition,

[1] See for example the article recently published in http://espresso.repubblica.it/attualita/2018/01/18/news/paradosso-sanita-il-sud-paga-piu-tasse-perche-le-persone-devono-andare-al-nord-per-curarsi-1.317263

hospitals exporting their services to extra-regional patients are able to generate revenues on top of the funds provided by their regional authority. Therefore, they are less dependent on their assigned regional budget (Brenna & Spandonaro 2015). The purpose of the present paper it to investigate the consequences of fiscal federalism in hospital competition by answering three unexplored research questions:

- What are the driving forces of patients' inflows?
- Which are the strategies used by hospitals to attract patients from other regions?
- Do public and private hospitals use different strategies to attract patients?
- Are there opportunistic behaviours adopted towards extra-regional patients?
- Does the inflow of extra-regional patients affect the quality offered to resident patients?

To answer these questions, we use longitudinal data on 4,902,225 hospital discharges in the period 2010-2014 in private and public hospitals in Lombardy (Italy). We study the effects of decentralization at the hospital level by analysing patient mobility and by comparing the quality offered to patients living in Lombardy with that offered to patients living in other Italian regions (excluding border regions). To our knowledge, no other study investigates whether hospitals engage in strategic incentives to attract patients 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.

Related Literature

Internal markets for hospital care have been created in order 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. Hospitals that increase their quality should also be able to attract patients from other regions (Gaynor & Town 2011). In the long-run, competition is expected to rise overall quality because the regions where quality is lower are expected to improve efficiency to reduce patients' migration. However, decentralization does not seem to have produced these positive effects in Italy: 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 South to North pattern of patients' mobility may derive from the sharp difference in disposable income. People living in wealthier regions (i.e., with higher GDP per capita) that in principle would be more willing to move for a better quality of care are also living in the regions where public health expenditure is higher and the outflow mobility is low (Levaggi & Zanola 2004). This may create a perverse incentive for low income regions to quality improvements. For these regions it may in fact be less expensive to pay for higher quality for few patients (the rich moving to other regions) than to improve the level of quality provided locally. These results are confirmed by Fabbri & Robone (2010). Using gravity models, their analysis shows that patients flows have a clear South to North direction, 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 & Menoncin (2013). In their study, a game is developed between poor/inefficient regions and rich/efficient ones. 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[2]. 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 are able to attract patients as the private ones but are more efficient. In contrast with these findings, Brenna & Spandonaro (2015) found that cross border patients are more likely to prefer private care. Their results show that the attraction index - measuring the ability of a selected region to attract patients from another region- is systematically higher for private hospitals than for public ones. A similar result is also found for aortic valve replacement (Fattore et al.2014). Since no differences in quality were found between private and public providers, this finding suggests the presence of strategic incentives from the supply side, which affect patients' preferences in the choice of the hospital type (private vs. public).

The Italian Health Care System

The WHO has 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 2015). Despite this success, there are significant regional differences in the quality of health care and, as a consequence, in the health status of the Italian citizens. In Italy, average life expectancy is 82.3 years. 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 (78.3 for men and 82.8 for women) in Campania (South of Italy). A similar pattern is observed for the reduction in mortality over the last 15 years: 27% in the North; 22% in the Center and only 20% in the South (Osservasalute, 2016). Arguably, these differences may be associated with the unequal quality of 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 visit range from 51 days in the North-East to 68 days in the South of Italy (Cittadinanzattiva 2017).

[2] The introduction of hard budget constraints with the so-called "Piani di rientro" has significantly reduced this incentive.

Lombardy is one of the largest regions both in terms of population (10 millions) and GDP per capita (34,640 euro)[3]. 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 extra-regional patients. In 2016, Lombardy attracted 115,000 patients (10.6 percent of the overall number of extra-regional patients), 6,000 more than the previous years.

In 1997, Lombardy has adopted a quasi-market model for hospital care which is a unique example in the Italian experience of fiscal federalism (France et al. 2005, Brenna 2011, Berta et al. 2013, Nuti et al. 2016). In Lombardy, 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. Competition between public and private providers is highly regulated (Berta et al. 2016). Each hospital in Lombardy has prospective budget defined on the historical cost at the beginning of the year. Private hospitals face a hard budget constraint and must comply with a tariff cap while the budget for public hospitals is softer. The region may in fact supply the latter with ex-post funding. This system creates distortions to competition between providers, and it 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 & Robone 2010). This payment system provides a strong incentive for private providers looking for additional sources of revenues to attract patients from other regions (Brenna 2011; Levaggi & Menoncin 2013; Neri 2015).

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. The level of quality is measured through aspects of care such as waiting times, length of stay, mortality. Potential providers are profit-maximizing firms (P) and public providers with altruistic preferences (A) (Brekke et al. 2012b; Levaggi & 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). On the other hand, private providers are surplus maximisers and compete for patients on two level: on the local 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 & Levaggi (2017). The analytical description of the model and the derivation of the quality levels for both hospitals are presented in the Appendix. In what follows we highlight the essential features of the model and the hypotheses that we are going to test. Public

[3] Source: http://www.asr-lombardia.it/RSY/economic-accounts/estimates-of-gdp-and-value-added-(istituto-tagliacarne)/lombardia-and-provinces/tables/14343

providers do not discriminate among patients (they offer the same quality level independently of the residence of the patients) and they do not actively try to attract extra regional output. In the empirical estimation they will be used as a benchmark with respect to which we evaluate how private hospitals respond to competition. Private hospitals on the other hand, are assumed to be surplus maximisers, have a fixed capacity and face a budget constraint in terms of services they can offer to residents. Private hospitals have an excess capacity that must be filled with patients from other regions. In doing so they face the competition of local providers and of other hospitals that want to attract patients. Competition is made on quality levels *q*, and hospitals may choose to supply the same level to residents and non-residents or they may discriminate among the two. In this setting, it is possible to show (see the Appendix) that the optimal level of $q_D$and q_E can be written as:

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

where δ and σ are two parameters that relate to the intensity of competition (locally and externally respectively), φ_D and φ_E relate to the patients' evaluation of quality; m_D and m_E are travel cost parameters and $\underline{F}$ is the hospital capacity (e.g. number of beds). The quality for extra-regional patients depends on the level of quality in the other Region, which in Italy is lower than q_D. The second element $\underline{F}$-D shows a positive correlation between quality and the number of extra-regional 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-δ* is a measure of the difference between the Regional budget and local demand. In general, it is reasonable to expect that the quality for extra-regional patients is higher than for domestic ones in this setting. For some quality indicators, the assumption of quality discrimination may not be reasonable[4], and it may happen that the hospital has no interest in setting a different level of quality to increase its reputation and its standard of care. In this case, the quality for both categories of patients will be set on the market for extra-regional patients, i.e.

$$q_D \quad = \quad q_E = \bar{q_E} + m_E \frac{2(\underline{F} - D) - \sigma}{2\sigma\varphi_E}$$

In our empirical estimation, we will test whether the more the hospital need to attract patients, the less they discriminate on quality levels because of possible reputational effects.

Regional output can be written as:

[4] For example, hospital mortality.

$$
\begin{aligned}
S &= D_D + D_E \\
&= D_D^P + D_D^A + D_E^P + D_E^A
\end{aligned}
$$

We expect extra-regional admissions to increase with the number of private hospital. As per the quality, we expect the market for non-residents 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. However, quality discrimination may not 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. that the quality level is the same for all patients. Yet, even if our hypothesis is true (the non-domestic market is more competitive), we should still observe a positive relationship between quality and the attraction index of each hospital.

Data and Variables

Data Source

To study the effects of fiscal federalism at the hospital level, we use longitudinal data on hospital discharges (SDO) over the period 2010-2014 in private, public and no-profit hospitals in Lombardy. The empirical approach is designed to study the differences between patients living in Lombardy vs. patients living in non-border regions. Mobility from border regions was not considered because there are bilateral agreements between Lombardy and its border regions that limit the volume and the price of reimbursement. The control variables include the 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.) and the transit in Intensive Care Unit (ICU). We further include different fixed effects: a set of dummy variables for the month the patient was treated to capture seasonal effects. A set of dummy variables was also included to control for major disease categories (MDCs) and for different types of admission: Medical or Surgical. Information on the 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 models (for Lombardy patients), to control for different behaviour among different ownerships.

Descriptive statistics

We use data from 150 hospitals for 5 years (2010-2014). Tables 1 and Table 2 report 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 percent of all patients admitted are extra-regional) vs. public hospitals and no profit hospitals (6 percent of all patients admitted are extra-regional).

Results

To answer the first policy question, namely which are the driving forces behind patients' inflows, we have performed a standard logistic model using extra-regional patient as binary dependent variable. The independent variables are the characteristics of extra-regional patients admitted to Lombardy hospitals (in terms of demographics, health condition, diagnosis, type and time of admission) 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 a sub-sample that does not include border regions.

Compared to residents, extra-regional patients are more likely to be younger and with more severe conditions (as measured by the USA weight system). Interestingly, there is a seasonal effect for surgical care. Compared to January the probability for an extra-regional patient to be admitted increases in the following months, it decreases in August, and raises again in September, October and November.

This effect is likely to be driven by the budget on resident patients: as the end of the year approaches, the probability of hitting the budget target increases and hospitals increase inflows of extra-regional patients. To answer the second question (which strategies are used by hospitals to attract extra-regional patients?) standard Ordinary Least Squares (OLS) and Instrumental Variables (IV) estimations have been performed to assess the effect of being extra-regional on (the log of) waiting times, (log of) LOS and (log of) reimbursement cost. Waiting times for elective surgery are a major political issue in many OECD countries such as the UK, Spain and Italy. In the absence of price mechanisms, waiting times constitute a way of rationing health care services. Long waiting times are expected to reduce the demand for elective surgery in the public sector because wealthier patients decide to go private paying a fee (Riganti 2017). They may also increase supply of care if doctors are altruistic and willing to work harder to treat more patients. We measure waiting times as the number of days elapsed between the time the patient was added to a hospital waiting list and the day of hospital admission. In the analysis we have considered only surgical DRG, the target for which waiting times are a variable that may inform patients choices. The second dependent variable we consider is patients' length of stay (LOS). LOS 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 considered to investigate potential opportunistic behaviours is reimbursement cost. This measure allows to identify whether the extra-regional patients are classified with DRGs for which reimbursement is higher compared to Lombardy patients. All the models control for patients demographic and health characteristics and for hospitals fixed effect. However, there might be other factors, such as personal social network, education and income, that may affect the dependent variable of interests. In the absence of a randomized trial[5], instrumental variable estimation may help to control for unobservable heterogeneity (fixed or variable) and for measurement error bias. Instruments must be related to the

[5] Ideally, we should have a randomized controlled trial with which we randomize the patients (regional and extra-regional) receiving care in Lombardy hospitals. We could then observe whether hospitals adopt towards extra-regional patients' opportunistic behaviours.

probability of being extra-regional patients to receive hospital care in Lombardy, but should have no effect on the dependent variables in analysis. The instrument we use in the present study is the mean rainfall on the month of hospitalization in each region-year. The identification assumption is that the meteorological conditions affect the probability of moving to another region to seek care but not the outcome of interests (hospital length of stay, reimbursement, waiting time). Standard linear models were used to investigate the effects of extra-regional patients on the quality of care received by Lombardy patients by type of hospital (private vs. public). The independent variable used is the percentage of extra-regional patients admitted in the hospitals. As in Stock et al. (2002), we conclude that the instrument is valid if the F-statistic is larger than 10, which in our case is true for all the three outcomes considered. Durbin score and Wu-Hausman test reveal evidence of endogeneity and confirm our a priori hypothesis to adopt a IV approach. First Stage results are reported in Table 5 in the Appendix. In Table 4 we report the results the analysis. In the third, fifth and seventh column we report the results of the instrumental variable models. Estimation results from OLS and IV analyses consistently suggest that extra regional patients from non-border regions wait less compared to regional ones, stay longer in the hospitals and are assigned to DRG with higher reimbursements. The first two indicators suggest that hospitals, in their quest to attract patients, try to offer to extra-regional patients a more attractive service.

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 a longer LOS may be simply determined by the fact that extra-regional patients have to travel longer to reach their residence, hence they need to be fitter to be discharged. 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 on other two indicators, namely patients' hospital re-admissions and 30 days-mortality. The results are presented in Table 6 to Table 10 in the Appendix. In what follows we present the graphical representation of the relationship between the proportion of extra-regional patients and the five measures of quality of care considered for Lombardy patients: mortality, readmissions, length of stay, waiting time and reimbursement. Figures 1-5 report the marginal effects of the five outcomes considered for regional patients on the dependent variable (percentage of extra-regional patients admitted to the hospital) by hospital ownership[6]. In all the five figures, the red, blue and green lines represent private, no profit and public hospitals respectively. Figure 1 and Figure 2 show that there are no differences in mortality rates and readmissions between private vs. public hospitals; however, for hospitals admitting a high percentage of extra-regional patients, public hospitals have lower mortality and compared to not for profit. The opposite is true for hospitals having a percentage of extra-regional patients close to zero. Overall, Figure 1 suggests that hospitals where mortality is comparatively low are able to attract a higher proportion of extra-regional

[6] The coefficients estimates are reported in Table from \ref{tab:tab6} to \ref{tab:tab9} in the Appendix

patients, but it may also suggest that in order 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 3) is significantly higher for public hospitals admitting a low volume of extra-regional patients; however, as the proportion of extra-regional patients increases, public hospitals become more efficient and the difference disappears for hospitals admitting 25 percent or more of extra-regional patients. Figure 4 suggests that waiting times are similar in all types of hospitals for low volume of extra-regional patients; as hospital attract patients across the borders a gap emerges and public hospitals waiting times become significantly higher. The effect of having a higher proportion of extra-regional patients is very interesting on the reimbursement outcome. The results, reported in Figure 5, suggest that having a higher proportion of extra-regional patients decreases the reimbursement cost for regional ones independently form the ownership type. This effect is however stronger for private vs. pubic 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 suggests that better quality of care is achieved because of patients' mobility rather than competition on the internal market.

Conclusions and Policy Implications

The objective of this paper is to explore whether decentralisation is beneficial or detrimental to the quality of the hospital care provided to regional and (exported) to extra-regional patients. Our results suggest that 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, the Italian decentralisation model seems 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 extra-regional patients constitute an uncapped source of revenue for regional hospitals. In a prospective payment system, the difference in the budget constraints applying to regional and extra-regional patients might promote or exacerbate existing opportunistic behaviours and possibly 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 extra-regional patients in Italy[7]. This result is confirmed in our analysis. Independently of patients' characteristics and hospital ownership, extra-regional patients wait less compared to regional ones for elective surgery in Lombardy hospitals. This result suggests that in context like Italy

[7] Survey: http://docplayer.it/4121520-A-casa-lontani-da-casa-progetto-a-casa-lontani-da-casa-indagine-e-valutazioni-sul-fenomeno-della-mobilita-sanitaria-verso-la-regione-lombardia.html

where extra-regional patients constitute an uncapped source of revenue, fiscal federalism creates a strong incentive for regional patients willing to wait less to migrate in other regions. As pointed out by Balia et al. (2017), for extra-regional patients travelling long distances for care a longer stay is perceived "as an insurance against bad health at home after hospital discharge". Consistent with this finding, we found that extra-regional-non-border patients LOS is longer compared to regional patients even after controlling 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 extra-regional patients. Extra-regional 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 extra-regional ones are always assigned to a higher DRG cost. This result is in line with the study by Fattore et al. (2014) in which the authors found that independently of ownership, extra-regional 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. Consistent with these results our analysis suggests that between hospitals with the same level of extra-regional patients there are no difference in mortality, however, between low vs. high exporting hospitals there is a significant decrease in mortality and readmissions suggesting two possible (and potential complementary reasons): better hospitals attract more extra-regional patients, regardless of the ownership. Secondly, because of financial incentives, hospitals that want to attract extra-regional patients improve their quality by reducing mortality and readmissions even for regional patients. These results are more relevant for public hospitals as there is a significant difference in mortality between hospitals attracting extra-regional 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 extra-regional patients are more efficient in reducing the LOS of regional ones. For reimbursement cost per patient, private hospitals admitting more extra-regional patients assign regional patients to lower DRG costs. This result is very interesting and deserves further analyses. According to Berta et al. (2016), the prospective payment system induces 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 extra-regional patients the effect of Fiscal Federalism decreases their incentive to opportunistic behaviours toward resident patients.

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Table 1: Descriptive Statistics complete sample

Variable	Mean	SD	Maximum	Minimum
Gender(1=Male)	0,535	0,499	1,000	0,000
Age	59,747	19,557	123,000	18,000
DRG weight	1,210	0,910	12,227	0,182
Extra-regional patients	0,097	0,296	1,000	0,000
Border exrta-regional	0,045	0,207	1,000	0,000
Southern extra-regional	0,040	0,195	1,000	0,000

Table 2: Descriptive statistics by hospital ownership

Variable	***Mean***	***SD***	***Maximum***	***Minimum***
	Public Hospitals			
Gender(1=Male)	*0,55*	*0,50*	*1,000*	*0,000*
Age	*59,30*	*20,20*	*123,000*	*18,000*
DRG weight	*1,15*	*0,85*	*12,227*	*0,182*
Extra-regional patients	*0,06*	*0,24*	*1,000*	*0,000*
Border extra-regional	*0,03*	*0,17*	*1,000*	*0,000*
Southern extra-regional	*0,03*	*0,16*	*1,000*	*0,000*
	Private Hospitals			
Gender(1=Male)	*0,50*	*0,50*	*1,00*	*0,00*
Age	*60,76*	*17,93*	*108,00*	*18,00*
DRG weight	*1,37*	*1,00*	*12,23*	*0,18*
Extra-regional patients	*0,18*	*0,38*	*1,00*	*0,00*
Border extra-regional	*0,09*	*0,28*	*1,00*	*0,00*
Southern extra-regional	*0,07*	*0,26*	*1,00*	*0,00*
	No Profit Hospitals			
Gender(1=Male)	*0,51*	*0,500*	*1*	*0,00*
Age	*60,49*	*18,552*	*112*	*18,00*
DRG weight	*1,24*	*1,025*	*12,2268*	*0,18*
Extra-regional patients	*0,15*	*0,357*	*1*	*0,00*
Border extra-regional	*0,06*	*0,244*	*1*	*0,00*
Southern extra-regional	*0,06*	*0,246*	*1*	*0,00*

Table 3: Determinants of patients' inflow

	All Italy				***Sud Only***		
Variables	**Overall**	**Medical**	**Surgical**	**Variables**	**Overall**	**Medical**	**Surgical**
Gender (Male=1)	0.027***	-0.051***	0.063***	Gender (Male=1)	-0.013**	-0.093***	0.028***
	0.004	0.006	0.005		0.005	0.008	0.007
Age	-0.020***	-0.024***	-0.017***	Age	-0.022***	-0.026***	-0.020***
	0.000	0.000	0.000		0.000	0.000	0.000
USA weight	0.139***	-0.035***	0.162***	USA weight	0.163***	-0.007	0.198***
	0.002	0.008	0.002		0.003	0.011	0.004
Constant	-1.275***	-1.234***	-1.542***	Constant	-2.503***	-2.313***	-2.805***
	0.095	0.045	0.098		0.135	0.106	0.142
Febr vs. Jan	0.056***	0.013	0.078***	Febr vs. Jan	0.071***	-0.000	0.113***
	0.008	0.014	0.010		0.012	0.020	0.016
March vs. Jan	0.058***	0.032**	0.069***	March vs. Jan	0.065***	0.023	0.090***
	0.008	0.013	0.010		0.012	0.019	0.015
April vs. Jan	0.056***	0.020	0.070***	April vs. Jan	0.056***	-0.005	0.089***
	0.008	0.013	0.011		0.012	0.020	0.016
May vs. Jan	0.080***	0.042***	0.097***	May vs. Jan	0.091***	0.025	0.129***
	0.008	0.013	0.010		0.012	0.019	0.015
June vs. Jan	0.061***	0.000	0.089***	June vs. Jan	0.067***	-0.018	0.114***
	0.008	0.013	0.010		0.012	0.019	0.016
July vs. Jan	0.038***	-0.002	0.053***	July vs. Jan	0.002	-0.077***	0.046***
	0.008	0.013	0.011		0.012	0.020	0.016
Agust vs. Jan	-0.150***	-0.166***	-0.138***	Agust vs. Jan	-0.265***	-0.330***	-0.222***
	0.010	0.015	0.013		0.015	0.022	0.020
Sept. vs. Jan	0.048***	0.005	0.065***	Sept. vs. Jan	0.040***	-0.049**	0.089***
	0.008	0.014	0.011		0.012	0.020	0.016
Oct. vs. Jan	0.126***	0.057***	0.159***	Oct. vs. Jan	0.153***	0.062***	0.205***
	0.008	0.013	0.010		0.012	0.019	0.015
Nov. vs. Jan	0.130***	0.057***	0.164***	Nov. vs. Jan	0.146***	0.052***	0.197***
	0.008	0.013	0.010		0.012	0.019	0.015
Dic. Vs. Jan	0.052***	-0.011	0.084***	Dic. Vs. Jan	0.023*	-0.063***	0.071***
	0.008	0.014	0.011		0.013	0.020	0.016
MDC Fixed Effect						-0.079	0.520***
30 Comorbidity based on Elixhauser						0.060	0.124
Hospital Fixed Effects						-0.116***	-0.243**
Year Fixed Effects						0.030	0.123
Observations	4,902,225	2,494,224	2,407,976	Observations	4,620,893	2,400,108	2,220,520
Pseudo R-squared	0.185	0.188	0.172	Pseudo R-squared	0.186	0.192	0.176

Table 4: Quality outcomes

	Lenght of Stay		Waiting Time		Reimbursment	
Variables	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**
Extra-regional	0.077***	0.068***	-0.083***	-0.112***	0.167***	0.257***
	0.002	(0.003)	0.004	(0.006)	0.003	(0.005)
Gender==F	0.060***	0.060***	0.042***	0.042***	0.071***	0.071***
	0.001	(0.001)	0.002	(0.002)	0.001	(0.001)
Age	0.008***	0.008***	0.001***	0.001***	0.005***	0.005***
	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
Usa Weight	0.314***	0.314***	-0.022***	-0.022***	0.541***	0.540***
	0.000	(0.000)	0.001	(0.001)	0.001	(0.001)
TIPCM = 2, M	0.287***	0.287***			-0.503***	-0.503***
	0.001	(0.001)			0.002	(0.002)
Constant	0.361***	0.362***	3.137***	3.140***	6.012***	6.002***
	0.025	(0.025)	0.060	(0.060)	0.043	(0.043)
Hospital Fixed Effects	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
Month Fixed Effects	✓	✓	✓	✓	✓	✓
MDC Fixed Effects	✓	✓	✓	✓	✓	✓
30 Comorbidity based on Elixhauser	✓	✓	✓	✓	✓	✓
Observations	4,682,948	4,682,948	1,622,585	1,622,585	4,682,948	4,682,948
R-squared	0.326	0.326	0.207	0.207	0.270	0.270
Adjusted R-squared	0.326	0.326	0.207	0.207	0.270	0.270

Standard errors in parentheses; iv=Istrumental Variable, OLS= ordinary least square. *** p<0.01, ** p<0.05, * p<0.1

Figure 1: Waiting Times by ownership and proportion of extra-regional patients

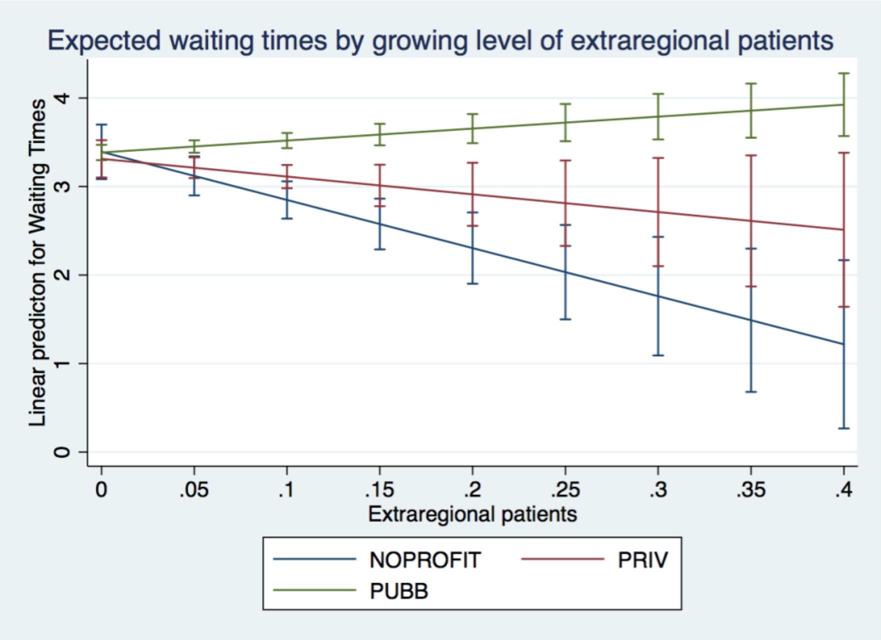


Figure 2: Reimbursements by ownership and proportion of extra-regional patients

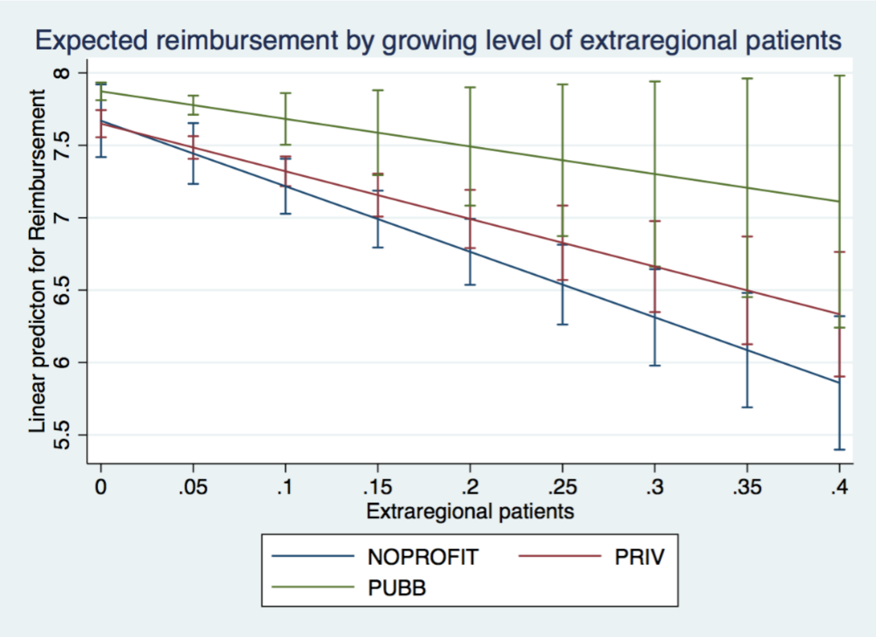


Figure 3: Length of stay by ownership and proportion of extra-regional patients

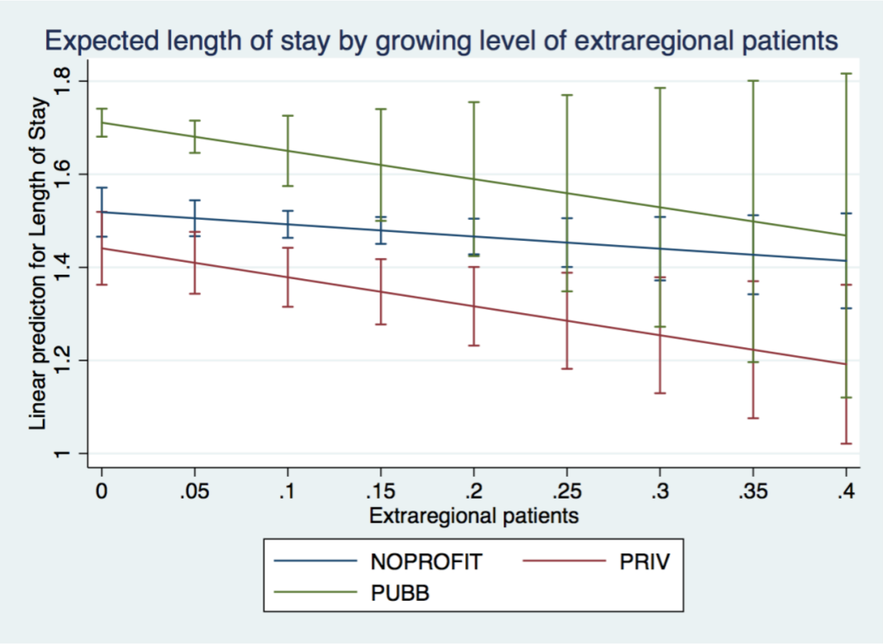


Figure 4: Readmissions by ownership and proportion of extra-regional patients

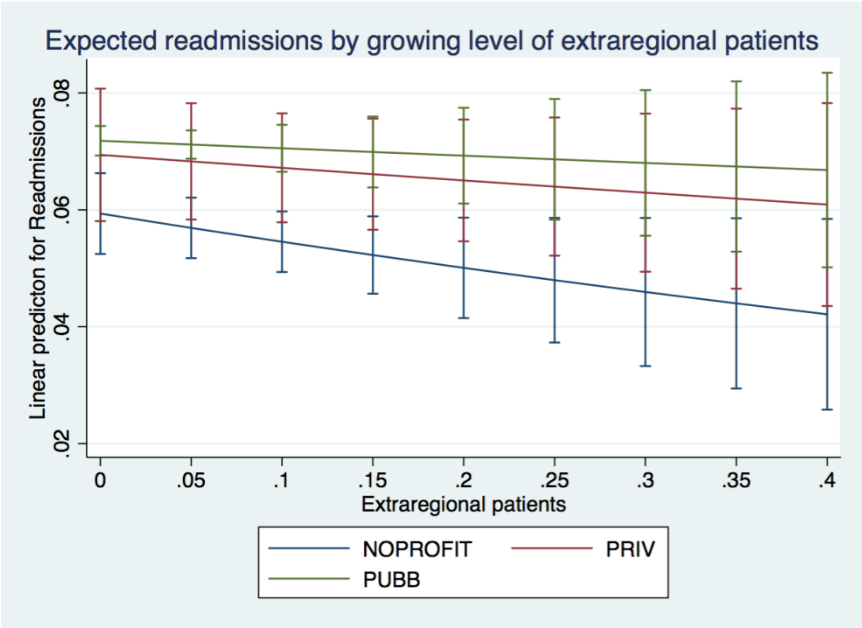
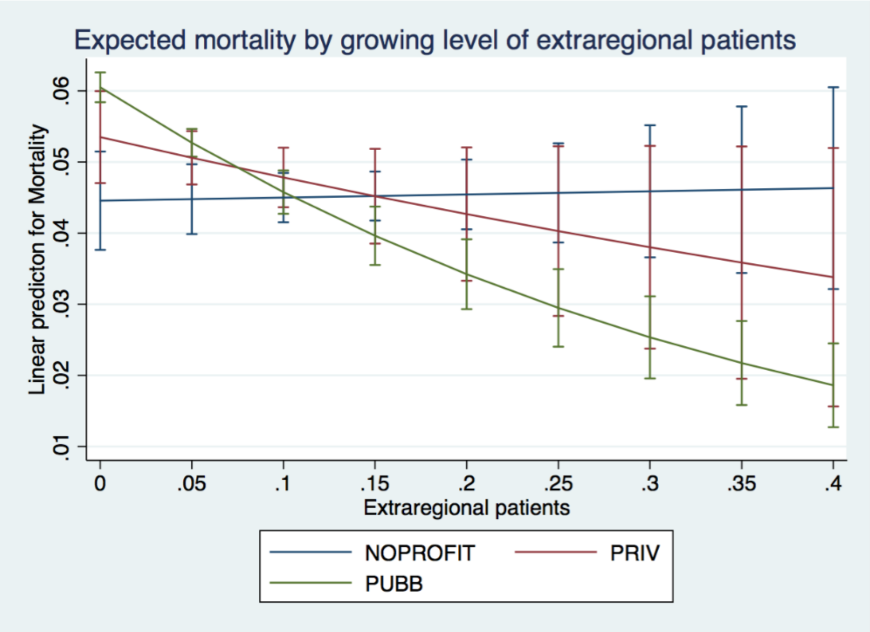


Figure 5:30-day Mortality by ownership and proportion of extra-regional patients



A.

Appendix

A. Derivation of the quality for hospital care for private hospital

Let us consider the following setting which can be considered a modified (to a line city) version of the oligopolistic model presented in Levaggi & Levaggi (2017). A community consisting of a mass of patients (normalized to 1 for simplicity) is uniformly distributed on a line of unit length. Hospital care is provided by a public hospital at located in 0 and a private hospital located in 1. The location of the indifferent consumer (x_D) determines the demand for each hospital:

$$x_D = \frac{\varphi\left(q_R - \bar{q_R}\right)}{m_D} + \frac{1}{2}$$

where q_R is the quality of the hospital and the quality of the other competitors.

In this setting we can introduce more private hospital 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:

$$x_D = \left(\frac{\varphi\left(q_R - \bar{q_R}\right)}{m_E} + \frac{1}{2}\right) a$$

For the external 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:

$$x_E = \left(\frac{\varphi\left(q_E - \bar{q_E}\right)}{m_E} + \frac{1}{2}\right) b$$

A.1 Quality Discrimination is not possible

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

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

$$s.t.$$

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

$$\underline{F} \le \delta\left(\frac{\varphi_D\left(q_D - \bar{q_D}\right)}{m_D} + \frac{1}{2}\right) + \sigma\left(\frac{\varphi_E(q_E - \bar{q_E})}{m_E} + \frac{1}{2}\right) - H \le \overline{F}$$

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:

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

$$s.t.$$

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

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

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

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

c) $D + \sigma\left(\frac{\varphi_E(q_E - \bar{q_E})}{m_E} + \frac{1}{2}\right) \leq \underline{F}$ 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+ $\delta\left(\frac{\varphi_E(q_E - \bar{q_E})}{m_E} + \frac{1}{2}\right) = F.$ The Problem can be written as:

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

$$s.t.$$

$$D + \sigma\left(\frac{\varphi_E(q_E - \bar{q_E})}{m_E} + \frac{1}{2}\right) - F = 0$$

The Lagrangean for the problem can be written as:

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

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

$$\frac{\partial}{\partial q_E} : -\frac{1}{2}\frac{4k\delta\varphi_D q_E - 2k\varphi_D \bar{q_D}\delta + km_D\delta - 2\varphi S_D\delta + k\sigma m_D}{m_D} - \sigma w\frac{2kq_E - k\bar{q_E} - S_E + \lambda}{m_E} = 0$$

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

and the solution can be written as:

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

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

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:

$$q_E = \frac{\bar{q}_E}{2}\frac{\sigma m_D\varphi_E}{\delta m_E\varphi_D + \sigma m_D\varphi_E} + \frac{\bar{q}_D}{2}\frac{\delta m_E\varphi_D}{\delta m_E\varphi_D + \sigma m_D\varphi_E} + \frac{1}{4}\frac{2(\sigma m_D w S_E + \delta m_E\varphi_D S_D) - km_D m_E(\sigma+\delta)}{k(\delta m_E\varphi_D + \sigma m_D\varphi_E)}$$

The problem admits an internal solution if $\underline{F} < D_E < \overline{F}$. Let us define the demand for an internal solution. The indifferent patient will be located at:

$$x_E^* = \left(\frac{\varphi_E \left(\frac{\bar{q}_E}{2} \frac{\sigma m_D \varphi_E}{\delta m_E \varphi_D + \sigma m_D \varphi_E} + \frac{\bar{q}_D}{2} \frac{\delta m_E \varphi_D}{\delta m_E \varphi_D + \sigma m_D \varphi_E} + \frac{1}{4} \frac{2(\sigma m_D w S_E + \delta m_E \varphi_D S_D) - k m_D m_E (\sigma + \delta)}{k(\delta m_E \varphi_D + \sigma m_D \varphi_E)} - \bar{q}_E \right)}{m_E} + \frac{1}{2} \right)$$

Since $D_E = x_E^* \sigma$ the indifferent patient will be located at:

$$D_E = \sigma \left(2\varphi_E \left(\sigma m_D w \left(S_E - a_E \right) + \delta m_E \varphi_D \left(S_D + a_D k - 2a_E k \right) \right) + \varphi_E k m_D m_E \left(\sigma - \delta \right) + 2k m_E^2 \delta \varphi_D \right)$$

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

$$\begin{aligned}
&if \quad D + D_E < \underline{F} \quad && q_E = \bar{q}_E + m_E \frac{1}{2} \frac{2(\underline{F} - D) - \sigma}{\sigma \varphi_E} \\
&if \quad D + D_E > \overline{F} \quad && q_E = \bar{q}_E + m_E \frac{1}{2} \frac{2(\overline{F} - D) - \sigma}{\sigma \varphi_E} \\
&if \quad \underline{F} \leq D + D_E \leq \overline{F} \quad && q_E = q_E = \frac{\bar{q}_E}{2} \frac{\sigma m_D \varphi_E}{\delta m_E \varphi_D + \sigma m_D \varphi_E} + \frac{\bar{q}_D}{2} \frac{\delta m_E \varphi_D}{\delta m_E \varphi_D + \sigma m_D \varphi_E} + \\
& && \frac{2\left(\sigma m_D w S_E + \delta m_E \varphi_D S_D \right) - k m_D m_E \left(\sigma + \delta \right)}{4k \left(\delta m_E \varphi_D + \sigma m_D \varphi_E \right)}
\end{aligned}$$

A.2 Quality Discrimination is possible

In this first case we assume that the quality of hospital care for domestic patients may be different from that offered to non-residents. The problem can be written as:

$$\max_{q_L, H} \Pi = (S_D - k q_D) \delta \left(\frac{\varphi_D \left(q_D - \bar{q}_D \right)}{m_D} + \frac{1}{2} \right) + (S_E - k q_E) \sigma \left(\frac{\varphi_E (q_E - \bar{q}_E)}{m_E} + \frac{1}{2} \right)$$
$$s.t.$$
$$\delta \left(\frac{\varphi_D \left(q_D - \bar{q}_D \right)}{m_D} + \frac{1}{2} \right) \leq D$$
$$\underline{F} \leq \delta \left(\frac{\varphi \left(q_D - \bar{q}_D \right)}{m_D} + \frac{1}{2} \right) + \sigma \left(\frac{\varphi (q_E - \bar{q}_E)}{m_E} + \frac{1}{2} \right) - H \leq \overline{F}$$

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

a) internal solution i.e. both constraints are not binding
b) $D + \delta \left(\frac{\varphi(q_D - \bar{q}_D)}{m_D} + \frac{1}{2} \right) \geq \underline{F}$ binding as an equality
c) $D + \delta \left(\frac{\varphi(q_D - \bar{q}_D)}{m_D} + \frac{1}{2} \right) \leq \underline{F}$ 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 constrain D+ $\delta\left(\frac{\varphi(q_D - \bar{q_D})}{m_D} + \frac{1}{2}\right) = F$ The problem can be written as:

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

$$s.t.$$

$$\delta\left(\frac{\varphi_D\,(q_D - \bar{q_D})}{m_D} + \frac{1}{2}\right) \le D$$

$$\underline{F} \le \delta\left(\frac{\varphi_D\,(q_D - \bar{q_D})}{m_D} + \frac{1}{2}\right) + \sigma\left(\frac{\varphi_E(q_E - \bar{q_E})}{m_E} + \frac{1}{2}\right) - H \le \overline{F}$$

The Lagrangean for the problem can be written as:

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

$$\frac{\partial L}{\partial q_D} : \frac{1}{2}\delta\frac{-4k\varphi_D q_D + 2k\varphi_D a_D - km_D + 2\varphi_D S_D - 2\lambda_1\varphi_D - 2\lambda_2\varphi_D}{m_D} = 0$$

$$\frac{\partial}{\partial q_E} : \frac{1}{2}\sigma\frac{-4k\varphi_E q_E + 2k\varphi_E a_E - km_E + 2\varphi_E S_E - 2\lambda_2\varphi_E}{m_E} = 0$$

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

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

and the solution can be written as:

$$q_D = \bar{q_D} + m_D\frac{2D - \delta}{2\delta\varphi_D}$$

$$q_E = a_E + m_E\frac{2(F - D) - \sigma}{2\sigma\varphi_E}$$

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:

$$q_D = a_D + m_D\frac{2D - \delta}{2\delta\varphi}$$

$$q_E = \frac{1}{4}\frac{2k\bar{q_E} - km_E + 2\varphi_E S_E}{k\varphi_E}$$

The problem admits an internal solution if $\underline{F} < D_E < \overline{F}$. Let us then define the demand for the internal solution. The indifferent patient will be located at

$$x_E^* = \left(\frac{\varphi\left(\frac{1}{4}\frac{2k\varphi_E\bar{q_E} - km_E + 2\varphi_E S_E}{k\varphi_E} - \bar{q_E}\right)}{m_E} + \frac{1}{2}\right)$$

Since $D_E = x_E^*\sigma$ the unconstrained demand from non-resident patients is equal to:

$$D_E = \sigma\left(\frac{1}{4} + \frac{1}{2}\frac{w\,(S_E - k\bar{q_E})}{km_E}\right)$$

The solution is compatible with the constraints if $\underline{F} \le D_E \le \overline{F}$ otherwise one of the other two constraints is binding. The complete solution for the problem can be written as:

$$\begin{array}{lll}
if & \sigma\left(\frac{1}{4}+\frac{1}{2}\frac{\varphi_E(S_E-k\bar{q_E})}{km_E}\right)<\underline{F}-D & q_E=\bar{q_E}+m_E\dfrac{2(\underline{F}-D)-\sigma}{2\sigma\varphi_E} \\
if & \sigma\left(\frac{1}{4}+\frac{1}{2}\frac{\varphi_E(S_E-k\bar{q_E})}{km_E}\right)>\overline{F}-D & q_E=\bar{q_E}+m_E\dfrac{2(\overline{F}-D)-\sigma}{2\sigma\varphi_E} \\
if & \underline{F}-D\leq\sigma\left(\frac{1}{4}+\frac{1}{2}\frac{\varphi_E(S_E-k\bar{q_E})}{km_E}\right)\leq\overline{F}-D & q_E=\dfrac{\bar{q_E}}{2}+\dfrac{S_E}{2k}-\dfrac{m_E}{4\varphi_E} \\
 & & q_D=\bar{q_D}+m_D\dfrac{2D-\delta a}{2\delta\varphi_D}
\end{array}$$