Does Virtual Integration Improve Care Coordination? Assessing the Impact of the 2016 Public Hospitals Reform in France

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Abstract

The 2016 healthcare reform in France mandated territorial groupings for public hospitals to achieve integration without legal personality, termed "virtual integration," aiming to improve coordination of segmented care within the public sector. However, this policy encountered two primary challenges: the risk of non-cooperative behaviors from managers facing agency problems, as constraints were not overly binding and compensation schemes were absent; and the risk of market monopolization by the public sector, potentially reducing healthcare provision in the territory by excluding the private sector. Using a synthetic difference-in-differences approach with comprehensive hospital-level data spanning 2013-2021, our results suggest that without the reform, efforts in care coordination, measured by the rate of patient transfers between public hospitals, would have stagnated. The GHT reform specifically strengthened the integration of local hospitals with other public healthcare facilities in the region. Despite initial concerns, we argue that public and private hospitals operate in segmented markets, making it unlikely that the reform would have caused adverse general equilibrium effects. Overall, the reform complemented rather than disrupted the ongoing integration of public hospital services, a process initiated as early as 2009.

JEL Codes: D04, I11, M11

Keywords: Healthcare integration, Patients transfer, Executive behavior, Agency theory

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Highlights

This manuscript:

- Presents the objectives and challenges of a major hospital reform in France, combining integration principles and agency theory.
- Provides the first causal inference analysis of this reform based on comprehensive data for all hospital stays in France between 2013 and 2021.
- Uses of a synthetic difference-in-differences (SDID) approach and explore heterogeneous effects among the treated.
- Shows that the reform increased patient transfer, especially with local hospitals.
- Discusses partial and general equilibria effects of the reform considering market dynamics.

1 Introduction

Inter-organizational collaboration (IOC) of healthcare providers is widely advocated to keep up with innovations, cost cutting policies, and increasingly complex patient cases (Schors et al. 2021). Integrated regional healthcare networks, a specific form of service provision touted as a promoter of IOC, have recently gained popularity in the literature, although their economic merits are still debated. On the one hand, such networks can achieve economies of scale and scope through asset and staff pooling, and improve collaboration to share best practices, standardize care protocols, and coordination to provide efficient and high-quality care across the region (Weert, Burzynska, and Knoben 2022; Gaynor 2006; Post, Buchmueller, and Ryan 2018). On the other hand, integration raises concerns on potential for monopolization of local healthcare markets. Hart et al. 1990 theoretical framework posits that *market foreclosure* is one potentially undesired consequence of (vertical) integration, leading to excessive market power, rent-seeking behaviors and negative outcomes such as, in our case, increased healthcare expenditures. Despite these concerns, French health authorities have initiated since 2009 a public policy aimed at promoting the integration of public hospitals at the territorial level. These legal innovations based on contractual networks diverge from usual forms of integration in that partners maintain their legal identity and autonomy, resulting in a form of "virtual integration" (Huckfeldt et al. 2021; Cafaggi 2008; Robinson and Casalino 1996) or "hybrid integration" (Ménard 2004).

1.1 The context: from voluntary to mandatory partnerships

In practice, the French health authorities introduced in 2009 the CHT[1] (Territorial Hospital Community), a voluntary contract-based partnership to foster inter-hospital cooperation in a given area, and to reduce competition in the public sector. Despite the incentives voluntary IOC provide for hospitals, only 11% of public sector entities engaged in a CHT between 2009 and 2014 (Hubert and Martineau 2016). Why so little enthusiasm?

One possible reason for the relative failure of the CHTs could be that hospital managers, already hesitant to endorse integration due to various agency-related reasons. Managers could perceive the cost of integrating as out weighting the benefits, for them and the pre-existing structure. A main cost for manager can be the fear of experiencing heightened internal competitive pressures in newly formed horizontal structures (Lee, Mauer, and Xu 2018), where overlapping services could lead to increased conflict over patients and funding.[2] Non-cooperative behaviors may prevail when hospital managers exploit asymmetric information situations to increase their divisional power and their independence. In the detail, managers may be prone to excessive inertia ("quiet life") when faced with tough decision (Koetter, Kolari, and Spierdijk 2012; Stein 2003; Bertrand and Mullainathan 2003). Career concerns can also encourage over-investment and information retention from managers wishing to defend their role in the organization or improve their career (Holmstrom and Costa 1986). Furthermore, managers could be inclined to build a diversified and independent division ("empire building"), sometimes at the expense of others inside the organization, leading to over-investment in unprofitable lines of business

[1] CHT (Communauté Hospitalière de Territoire) or territorial hospital community, created by the HPST Act in 2009. A non-mandatory procedure aimed at facilitating cooperation without integration of the hospitals involved.

[2] In a horizontal network, hospitals at the same level of care are more likely to compete for the same patient base and resources between duplicated services, which can intensify rivalry among managers, as they fear losing autonomy or market share to their peers in other hospitals, unlike in a vertical network where different care levels complement each other.

(Jensen 1993, Jensen 1986). Fourth, the justification for maintaining the existing system and organizational structures becomes a crucial factor in understanding how managers, medical professionals, and care providers place value on the *status quo* and their affiliation with an independent institution. This attachment not only reinforces the legitimacy of the current system but also amplifies the personal and social costs associated with organizational change (Jost, Banaji, and Nosek 2004).

These four types of behaviors raise barriers to the implementation of any IOC requiring resource rationalization, specialization of divisions, unified strategy and coordinated governance. From a public regulator perspective, public hospitals are divisions of the overall public healthcare system, such that hospital executives are akin to division managers and subjected to similar non-cooperative behaviors. These challenges can be mitigated by reducing perceived costs through the severing of previous cooperation, the definition of group competitors and establishing new collective language, goods, reach, goals and outsiders[3,4]; and by enhancing the perceived benefits for the group, in our case, through the imposition of penalties by the regulatory body.

The 2016 reform for public hospitals was a public policy attempt to mitigate such potential non-cooperative behaviors. The rationale stems from the agency theory advocating for the use of a whole set of constraints, including contractual obligations, sanctions for non-compliance, and disclosure requirements. First, health authorities made the participation to a CHT mandatory for all public hospitals, rebranding the legal entity as GHT[5] (Territorial Hospital Groupings). Second, regional health authorities could impose non-cooperative hospitals severe financial penalties and the reduction in the amounts of discretionary subsidies allocated for general interest tasks[6]. Regional authorities have large powers over hospitals, such as the ability to authorize care activities, and could withhold discretionary financing until implementation. Third, each hospital in the GHT was requested to contribute to and ratify a detailed operational strategic document (PMP[7], shared medical project) describing the roles of each partners in the combined healthcare provision. The production of the PMP compelled managers to enumerate and articulate comprehensive medical strategies within the GHT, and with respect to its geographical boundaries, striving to ensure seamless care continuity when services across different levels of care are required between hospitals. The implementation of the mandatory PMP was specifically designed to encourage hospitals to develop care pathways by integrating fragmented activities across multiple sites. Although some level of horizontal integration is inevitable, the PMP promotes a more comprehensive approach that goes beyond mere horizontal cooperation to enhances vertical relationships. Fourth, the competitive environment, driven by the DRG payment system and the lim-

[3] While no study directly addresses this specific issue within our context, existing literature establishes connections between group behaviors, organizational change, environmental pressures, and collective action problems(De Dreu, Gross, and A. Romano 2024)

[4] An analytic examination of PMPs uncover such mechanisms, including the establishment of collective goods (e.g., human resources, patients, medico-technical platforms), the delineation of territorial reach (e.g., defined through geographic mapping), and the articulation of common goals (e.g., integrated care, accessibility, quality of care, centralization). Additionally, PMPs identify outsiders such as potential competitors for resources, or individuals who exploit the system without contributing, often referred to as free riders (e.g. "medical mercenaries").

[5] GHT (Groupement Hospitalier de Territoire) or territorial hospital groups, created by the Modernisation de notre système de santé Act of 2016. The evolution of the CHT, the procedure is now mendatory and for all hospitals. https://sante.gouv.fr/IMG/pdf/ght_vademecum-2.pdf

[6] Migac: "Missions d'Intérêt Général et d'Aide à la Contractualisation"
https://sante.gouv.fr/professionnels/gerer-un-etablissement-de-sante-medico-social/financement/missions-d-interet-general-et-d-aides-a-la-contractualisation-migac

[7] PMP (Projet Médical Partagé) or shared medical project is a document enumerating all medical strategies of the GHT.

ited resources of the healthcare sector, supports the development of a new group identity, formalized through the PMP and the strategic frameworks of the GHT.

However, these constraints are not overly binding. The mandatory inclusion in a GHT imposes a relatively non-stringent constraint, merely necessitating the institution's endorsement of a participation contract with the network of public hospitals in its region. The absence of legal personality for the GHT does not guarantee full integration, and providers had a degree of freedom to determine their own prerogatives. This is especially problematic in the case of the PMP since health authorities did not disclose any specific objectives to the reform with regard to the delegation of clinical activities between public hospitals. Furthermore, agents are neither rewarded on their performance relative to others, nor on their collective performance. There are simply no compensation schemes to incentive managers' cooperative behavior outside of implied compliance and career concerns.

1.2 Research question and contribution to the literature

Did the mandatory virtual integration of French public hospitals improve care coordination among them? Specifically, did the implementation of the PMP facilitate the development of relationships between public hospitals in their respective territories? In the industrial organization literature, integration arises as a means to minimize transaction costs when the market fails to do so due to coordination problems (Williamson 1981). In the case of the GHT, by mitigating uncooperative behaviors among agents, it should have reduced transaction costs within the group. In this context, patient transfers can be understood as input-output flows between hospitals. The reduction in transaction costs can lead to two potential outcomes. First, it may improve vertical coordination, integrating complementary care segments to create more streamlined and rationalized care pathways. In this scenario, the literature on vertical integration offers a theoretical framework for analyzing these relationships, revealing not only the potential benefits for the integrating organization but also broader market effects, such as the *foreclosure* of competitors (see Hart et al. 1990). Alternatively, the reduction in transaction costs may also encourage more "opportunistic" transfers. This could manifest through patient selection, where non-profitable patients are transferred to other hospitals within the group, or through efforts to alleviate congestion during supply or demand shocks[8]. In both cases, the reduction in transaction costs resulting from reorganization is likely to lead to an increase in patient transfers. Therefore, tracking the proportion of patients transferred between hospitals before and after the 2016 reform can provide valuable empirical evidence to address this research question. The Inter-Facility Patient Transfer Rate (IFTR), calculated as the annual average of the proportion of patients received from and sent to other facilities, serves as an appropriate outcome measure (see 3.2). If the GHT reform has been effective in decreasing transaction costs, we would expect the IFTR to increase following its implementation. **Thus, the null hypothesis of this study posits that the GHT reform did not significantly affect the IFTR trend.**

Empirical evidence on this topic is rather limited. To the best of our knowledge, only one academic publication addressed the impact of GHT on IOC. Chrusciel et al. 2023 found that the increase in patients' transfers after the reform followed a pre-existing trend, suggesting that the reform did not lead to major changes. However, their approach did not rely on a differences-in-differences setting

[8] The literature on bed management more directly addresses these issues (see Marquinez et al. 2021; B. M. Hill 2005; Nezamoddini and Khasawneh 2016)

but rather on a simple comparison between transfer rates before and after the reform. The absence of a control group could conceal the possibility that, without the reform of the Territorial Hospital Groups (GHT), public institutions may have reached a ceiling in their level of care integration. The counterfactual situation could resemble a status quo established after the previous reform of Territorial Hospital Communities (CHT). In essence, it is entirely possible that GHTs have brought continuity in the integration of public institutions, which would be impossible to detect without estimating a counterfactual.

Our main contribution to the existing literature is to provide a causal inference approach to the evaluation of the GHT reform. The identification strategy rests on a quasi-experimental design where public hospitals undergo a massive integration reform in 2016 to estimate the causal effect of the policy in a difference-in-differences setting. The constitution of a pool of potential hospital candidates for a control group is based on the analysis of the healthcare system in France, particularly the market structure between public and private sectors. Estimating the causal effect using the synthetic difference-in-differences method allows us to overcome the parallel trends assumption. The heterogeneity of the treatment among different types of hospitals is also examined, as it is possible that not all public institutions reacted in the same way to the reform based on their status, roles, missions, and resources within the territory.

The second contribution of this work is the development of a theoretical framework at the intersection of agency theory and the vertical integration literature, which conceptualizes Territorial Hospital Groups (GHT) as a form of virtual integration of public hospitals. This framework offers a retrospective understanding of the evolution of the French healthcare system. It also allows us to interpret our main hypothesis as an attempt to test whether the introduction of constraints alone, without compensation schemes for managers, can serve as a sufficient shock to alter hospital managers' non-cooperative behaviors. This contributes to agency theory by exploring how non-monetary constraints can influence agent behavior, potentially challenging the conventional reliance on financial incentives as the primary mechanism of control. Moreover, given that hospital managers, particularly in the public sector, may not respond to financial incentives in the same way as those in private firms, this approach aligns agency theory more closely with non-profit and government contexts, where non-monetary incentives play a larger role.

The manuscript is organised as follows. The definition of the treatment and control groups and the associated refined hypothesis are presented in the following section, together with the econometric options retained. Section three presents the dataset at hand, made of hospital discharges and other activity-based data from the PMSI (Program of Medicalized Information System), for all hospitals performing MSO activities (Medicine, Surgery, Obstetrics and odontology) in France between 2013 and 2019, and the additional hospital-level databases used to produce the variables. The results displayed in section four with a wide array of robustness checks in section five. We find that, in the absence of the reform, the IFTR between public hospitals would have plateaued, suggesting that the reform achieved its objective to improve integration of care within the public sector. In the detail, it appears that local hospitals (LH) are the ones for which the reform had the strongest impact. We also did not find any evidence of reaction to a potential market foreclosure, probably because the healthcare market is segmented between public and private hospitals. This last result suggests that general equilibrium effects, which could have influenced the analysis's conclusions, did not materialize. The conclusion is drawn in section six where avenues for further research and policy implications are discussed.

2 Identification strategy

2.1 Control group

The definition of a reliable pool of hospitals to form the control group needs to comply with the Stable Unit Treatment Value Assumption (SUTVA). Namely, the control group should not have been impacted, even indirectly, by the treatment to prevent contamination bias and adverse general equilibrium effects. However, the potential for monopolization of local healthcare markets by regionally integrated networks of public hospitals may produce adverse consequences for other hospitals operating in the territory. Vertical integration by a particular firm can come at the expense of other actors in the market, depending on input constraints and market concentration. Faced with the risk of foreclosure (Hart et al. 1990), non-integrated firms may choose to respond similarly (Bolton and Whinston 1993). This can lead to the coexistence of vertically integrated firms, increasing exchanges within those firms. Alternatively, market foreclosure could reduce healthcare provision in the area by excluding private sector hospitals. In both scenarios, the reform could lead to unanticipated general equilibrium effects, potentially violating the SUTVA and rendering our causal inference approach unsuitable (Heckman 2001, Heckman, Lochner, and Taber 1998; Heckman and Pinto 2024). Although testing for SUTVA can be challenging in this context, we shall argue hereafter that the french healthcare system is characterized by strategic independence between public and private hospitals and strong market segmentation between the two sectors (see 2.1), so that it seems reasonable to assume the absence of adverse general equilibrium effects of the reform.

A first pool of candidates for the control group consists of public hospitals in the three largest French cities (Paris, Lyon, and Marseille). They are historical multi-site hospitals that have been cooperating for care provision since the 19$^{\text{th}}$ century, predating the GHT with a legally defined brokered form of governance that exempted them to comply with the 2016 reform. It seems thus reasonable to assume that the GHT reform did not modify patient transfers between hospitals that have been vertically integrated for a long time. These historic IOC form the baseline control group.

A second group of candidates allows for extending the control group at the cost of an additional assumption of strategic independence between public and private sectors. Evidence from the French healthcare system supports the assumption that hospitals operating in market segments different from public hospitals had little incentive to react to their vertical integration since market foreclosure was unlikely. For instance, Choné and Wilner 2022 found that the magnitude of the strategic interactions between non-profit (public and non-profit private) and for-profit hospitals is weak, which aligns with a parallel integration business model (Bolton and Whinston 1993), where providers compete at the point of entry but not along the entire pathway of care. Furthermore, Herrera-Araujo and Rochaix 2020 provided evidence of strong, pre-existing market segmentation between public and private for-profit sectors for maternity units, where user choice is central. They found that (i) the number of public maternity units is likely to be much larger in less populated territories than in more populated ones;

(ii) as the number of public maternity units decreases, the profitability constraint should allow more private players into the market; and, (iii) private units are closer substitutes to other private units than to public units. These hospitals together with the historic IOC form the extended control group.

The case for not-for-profit private hospitals is ambiguous. They are typically fringe firms that could experience market foreclosure (Loertscher and Reisinger 2014; Riordan 1998), they have long-lasting cooperative relationships with the public sector, and they perform public service missions. Choné and Wilner 2022 show that intra-sector competition is fiercer than between sectors, and argue that non-profit are similar to public hospitals. In this context, the assumption of absence of general equilibrium effect is harder to entertain. Due to concerns with SUTVA, we will not use the non-profit private sector as a control group. Although this procedure would potentially raise issues with the external validity of our analysis, the generalization of the reform to all hospitals would be irrelevant in the present case as of a public sector policy.

2.2 Synthetic difference-in-differences

The treatment group consisted of all public hospitals except for the historical IOC, i.e. university hospitals in the three major french cities (Paris, Lyon and Marseille) as explained above. It includes large regional and university hospitals (RUH), general hospitals (GH), and local hospitals (LH). This decomposition corresponds to different legal statuses, which are themselves linked to the roles, missions, and resources, of public sector hospitals in the territory. The three categories are in turn, combined and kept separated for the analysis to investigate the overall effect of the reform on the care integration of the public sector, and the potential heterogeneous responses to the treatment. These effects could arise from a lesser marginal effect of the policy on part of the treated group (Heckman and Vytlacil 2005).

The literature presents two types of estimators to address the issue of non-parallel trends: synthetic controls (Abadie, Diamond, and Hainmueller 2010) and synthetic difference-in-differences (Arkhangelsky et al. 2021). Both methods generate a synthetic counterfactual by applying a weighted transformation to the control group. The synthetic control (SC) estimator relies on individual weights to construct a synthetic control group that closely matches the treated units based on pre-treatment trends. However, the synthetic difference-in-differences (SDID) estimator introduces several key innovations to enhance flexibility and robustness. First, SDID incorporates individual intercepts, allowing for level differences between the treated group and the synthetic counterfactual, which permits the inclusion of control units that might not have been selected by SC due to level differences (Arkhangelsky et al. 2021, p. 4092). Second, SDID employs a regularization penalty that increases the dispersion of individual weights, preventing over-reliance on a small subset of control units and ensuring a more diverse synthetic counterfactual (Arkhangelsky et al. 2021, p. 4092). Third, SDID introduces time weights to improve the stability of the counterfactual over time, giving less weight to individual of the control pool subject to exogenous short-term changes in outcome (Arkhangelsky et al. 2021, p. 4090). In theory, these innovations make SDID a more flexible and accurate method compared to SC. The resulting accuracy improvement is formally tested with a comparative analysis of the RMSE in Arkhangelsky et al. 2021 (p.4099-4101).

Formally, the synthetic diff-in-diff estimator is:

$$(\hat{\tau}^{sdid}, \hat{\gamma}, \hat{\delta}, \hat{\alpha}) = \underset{\tau,\gamma,\delta,\alpha}{argmin}\{\sum_{i=1}^{N}\sum_{t=1}^{T}(Y_{it}^{adj} - \delta - \gamma_t - \alpha_i - W_{it}\tau\}^2 \hat{\omega}_i^{sdid} \hat{\lambda}_t^{sdid}$$

where $Y_{it}^{adj} = Y_{it} - X_{it}\hat{\beta}$; Y_{it} denotes the outcome of interest for hospital i in year t; and X_{it} is a matrix of time-varying covariates. W_{it} is a binary treatment variable, with $W_{it} = 1$ if i is treated at time t and $W_{it} = 0$ if i is untreated at time t; γ_t and α_i are respectively time and individual fixed effects. $\tau, \gamma, \delta, \alpha$ and β are the parameters to be estimated. Synthetic difference-in-differences alleviate the parallel trend assumption by adding weights both on time trends $\hat{\lambda}_t^{sdid}$ and control individuals $\hat{\omega}_i^{sdid}$, see Arkhangelsky et al. 2021 and Clarke et al. 2023 for in depth presentation of the weighting scheme. We use both Arkhangelsky et al. 2021 and Kranz 2022 covariate preprocessing techniques. The former computes the outcome variable of the SDID from the estimated residuals of the OLS regression on the sub-sample excluding post-treatment treated hospitals. The latter improves on this approach by proposing to use a two-way fixed effect regression instead of the OLS. Kranz 2022 shows that using a fixed effect regression improves the precision of the estimator (based on the RSME criteria).

3 Data

3.1 Source and sample

This study uses data from the French national hospital database (*Programme de Médicalisation des Systèmes d'Information*, PMSI). Resulting from the processing of the DRG payment system in France (*tarification à l'activité*, T2A), the PMSI is an exhaustive dataset, recording all claims paid by the National Health Insurance system (regardless of the specific health insurance scheme) to public and private hospitals. For each patient, it provides details of all overnight inpatient stays and day hospitalization during the year, including patients' demographics (age, gender), medical diagnoses and associated conditions (including social aspects that could have had an impact on the hospitalization), medical procedures, and other discharge information. This dataset is widely used for epidemiological and health economics studies. It is usual to restrict the sample to medical, surgical, and obstetrics care (PMSI-MCO), a well-defined category simplifying the analysis, but encompassing about 85% of all hospital stays. We complement this patient level data with yearly-based hospital-level data from healthcare authorities: (i) a comprehensive survey of hospitals (*Statistique annuelle des établissements*, SAE), including their location, size, legal structure, economic activity, and employment statistics; (ii) a set of healthcare quality measures (HAS data), and (iii) a yearly study on hospital costs (*Etude Nationale des Coûts*, ENC) letting us compute the value of each hospitals' output.

Our sample extends from 2013 to 2021; in order to avoid the effects of the Covid-19 pandemic starting in 2020, we provide results for the 2013 to 2019 and 2013 to 2021 periods separately. The initial sample consisted of 272 million patient-level observations aggregated into 19,720 hospital-level observations.

The synthetic control difference-in-difference method needs a balanced panel, to achieve this, we discarded (i) any hospital with a missing observation year (17,748 obs.), (ii) Observations from the non-lucrative private sector (14,292 obs.) (ii) any missing data, mainly from staffing, case mix, r80, value of output and rehospitalizations at 30 days (11,521 obs.) this large number of missing values is due to missing observations for the r80, and (iii) balancing the panel (9,999 obs.). The working sample is eventually made of 9,999 observations balanced over nine years (2013-2021) and 1111 hospitals. The sample for the period 2013-2019 is eventually made of 7777 observations

3.2 Outcome variables

Our outcome variable is the inter-facility patients transfer rate (IFTR). This measure indicates the share of care activity realized in collaboration with other healthcare organizations, capturing effects on entering and exiting patient flows. Drawing on the existing literature (for a survey, see Table 6 in the Appendix), we measure the IFTR for hospital i over period t as the share of patient transferred, i.e. the average of the shares of patients sent to and received from other facilities. With n_{it} the total number of stays in the facility, O_{it} and M_{it} the number of stays that implied the use of health services between two hospitals (respectively outbound and inbound transfers), we get:

$$IFTR_{it} = \frac{1}{2}(\frac{O_{it}}{n_{it}} + \frac{M_{it}}{n_{it}})$$

The PMSI-MCO databases offer two different methods to account for patients' inter-facility transfers (O_{it} and M_{it}), through *discharge* or *detection.* Hospital *discharges* are widely used for various purposes (Schoenman et al. 2007; Andrews 2015); in our case, they indicate whether the patient was transferred from or to another facility, although the place of origin or destination is not specified. *Detected* data allow instead to track the patient's pathway of care from one facility to the other (Zachrison, Boggs, et al. 2021,Zachrison, Onnela, et al. 2020;R. L. Fan, Zhao, and Peng 2021; L. X. Lu and S. F. Lu 2018). Inter-hospital transfers thus defined "as temporally adjacent hospitalizations in the same patient at two different facilities; the discharge day for the non-revascularization (here receiving) hospital had to be the same or 1 day less than the admitting date of the revascularization hospital." (Iwashyna et al. 2010). Following Lomi and Pallotti 2012 methodology, we constructed two matrices over the period 2013-2021, for inbound and outbound transfers (O_{it} and M_{it}), using alternatively *discharge* and *detected* data. In total, *discharge* data account for 14,940,956 transfers over the period (resp. 9,772,794 with *detected* data). The volume of transfers per hospital range from 0 to 20,565 patients per year (resp. 0 to 18,086 patients), with an annual average of 1,405.017 transfer (resp. 919.360). Table 7 in the Appendix provides a description of the pathologies most transferred, by type of hospital for the year 2016.

We chose to retain *detected* data for our main policy analysis. Our motivation behind this choice is the granularity permitted by this data source, as it lets us analyze transfer patterns between hospitals, such as intra-GHT transfers. We use *discharge* transfers for robustness checks on observation bias as it permits minimization of data loss; approximately 15% of transfers are lost in large hospitals due to the one-day threshold of *detected* data. *Discharge* and *detected* have a 92% match, suggesting that they are both valid data sources for transfer analysis. Furthermore, data precision is higher for the *discharge* data as the coefficient of variation is lower (Figure 2 in the Appendix).

3.3 Covariates

Other explanatory variables include some of the usual determinants of IFTR. From a simplified economic perspective, the decision to transfer a patient between two facilities can be motivated by supply-side variables (the availability of necessary resources, such as medical equipment or personnel, bed availability, etc.); demand-side variables (the patient's health status and preferences, including quality outcomes), and hospital market structure (competition). It should be noted that the very design of synthetic difference in differences do not allow the direct analysis of the covariates, as they are used to create the synthetic counterfactual.

Hospital resources, or output and technical (in)efficiency, are obtained from a stochastic frontier analysis (SFA) model. These models of production frontier are popular in studies of hospital efficiency analysis and policy analysis (Rosko and Mutter 2011). We chose a Cobb-Douglas frontier model, estimated over the 2013-2021 period. The outcome variable, the value of the output (number of stay multiplied by their cost as calculated by the ENC), is regressed over labor, a standardized staffing index, and capital measures, number of beds and the Saidin index for health technology (Spetz and Maiuro 2004. All variables are expressed in natural logarithms. Notice that we introduced a time dummy and we also introduced the inverse Mill's ratio for missing data (more details provided in Box A1 in the appendix). Notice that we also retained the R80, a measure of hospital activity diversification which accounts for the number of DRG types comprising 80% of the hospital total activity.

Patients characteristics, such as medical and social conditions, are available from medical diagnoses, associated conditions and discharge claims. They include: (i) the share of patients classified as bed blockers (ii) patient mean age (iii) The Charlson index of comorbidities. Patient's preferences such as perceived quality drive hospital choice, at least partially (Lescher and Sirven 2019), and quality concerns are a major reason behind patient transfer (Lomi, Mascia, et al. 2014), therefore, we also retained a standardized readmission rate at 30 days as a quality outcome.

Hospital market structure, is described using a concentration index (Desai et al. 2023; Gaynor, Moreno-Serra, and Propper 2013; Keeler, Melnick, and Zwanziger 1999) and uses the Herfindal-Hirshman index (HHI). First, we computed the HHI for 28 DRG categories, as defined by the ATIH[9]. The relevant market for a hospital, or recruitment zone, is defined by the towns/cities where the hospital realizes its activity. The hospital's market concentration index is a weighted average of the HHIs of the activity-zone in its recruitment zone, with the proportion of patients from that activity-zone combination used as the weight. The concentration index is then aggregated at the hospital level by weighting each activity by its patient share in the total activity of the hospital (c.f. Box A2).

4 Results

4.1 Pre-treatment descriptive statistics

Table 1 provides baseline descriptive statistics of the sample for the period prior to the GHT reform, between 2013 and 2016, for all hospitals and broken by status. French hospitals are heterogeneous in IFTR according to their status. The high level of IFTR for local hospital is a general finding in the

[9] Agence technique de l'information hospitalière

literature (e.g. Bennett et al. 2019). Other differences are also coherent with size, roles and missions of the different hospital types. For instance, LHs exhibit lower output and higher technical inefficiency, a lower degree of specialization (R80), and more complex patients (Charlson), etc.

Table 1: Summary statistics, 2013-2016

	Total	RUH	GH	LH	Private	Historic IOC
IFTR						
Mean	5.462	1.984	4.194	15.888	2.318	7.017
SD	7.63	1.38	5.10	8.91	5.23	7.06
Predicted output						
Mean	17.139	18.460	17.676	15.413	17.035	18.208
SD	1.32	1.25	1.15	0.74	0.76	1.36
Technical innefficiency						
Mean	0.554	0.427	0.551	0.767	0.488	0.475
SD	0.21	0.12	0.14	0.27	0.20	0.11
R80						
Mean	147.696	258.124	225.668	75.091	77.170	184.144
SD	110.96	142.65	98.28	41.58	44.18	130.41
Charlson Index						
Mean	2.366	2.075	2.209	4.386	1.647	2.197
SD	1.40	1.37	1.07	1.03	0.86	1.47
Patient mean age						
Mean	59.657	52.849	57.610	76.936	55.559	53.596
SD	13.30	16.31	10.92	7.38	8.66	20.74
Competition Index						
Mean	0.292	0.319	0.335	0.280	0.259	0.186
SD	0.09	0.09	0.10	0.06	0.08	0.04
Bed blockers						
Mean	0.738	0.581	0.717	2.051	0.162	0.803
SD	1.72	1.15	1.42	3.11	0.38	1.18
30 day re-hospitalization						
Mean	11.469	15.498	13.259	10.938	8.745	14.934
SD	6.06	7.53	4.42	8.11	4.44	7.65
N.obs	4444	292	1636	748	1588	180
N. groups	1111	73	409	187	397	45

Notes: This table reports summary statistics on all variables used in the final model, before the policy implementation and for different hospital categories. N.groups is the number of individual hospital within each category.

Table 2 displays the time and individual fixed effects estimates of the determinants of the IFTR for the pre-treatment period (2013-2016), for all hospitals and broken by legal status. The model with all hospitals provides us with overall relationships, but might conceal heterogeneous relationships, which we tackle using separate models for each type of hospitals. Given this nuanced approach, it is recommended that these results be interpreted alongside the summary statistics presented in Table 1. Nevertheless, the interpretation of these findings is reasonably straightforward, and concurs with previous literature.

A first set of results deals with hospitals size and patient complexity. (i) The share of patients trans-

Table 2: Two Way Fixed Effects (TWFE) Estimates of the Determinants of the IFTR, 2013-2016

	All hospitals	RUH	GH	LH	Private	Hist. IOC
Predicted output	0.711	-1.293*	0.122	3.519**	0.685	0.119
	0.415	0.637	1.550	1.058	0.388	0.684
Technical inefficiency	-1.785	5.135	-0.788	-3.385	-2.345*	-1.064
	1.102	3.075	4.149	1.943	1.083	1.669
R80	0.002	0.003	-0.005	0.014	0.003	0.008*
	0.004	0.002	0.007	0.014	0.010	0.004
Charlson Index	1.598**	0.210	4.038	-0.058	2.025**	-0.376
	0.585	0.437	2.095	0.582	0.745	0.830
Patient mean age	-0.058	-0.101***	-0.114	-0.080	-0.077	0.145
	0.075	0.023	0.190	0.113	0.073	0.141
Competition Index	-1.845	-14.936	-0.175	-2.792	-5.111	-15.079
	3.607	7.873	5.568	8.501	3.161	8.235
30 day re-hospit.	-0.080**	-0.036	-0.103	-0.094**	-0.044	-0.056
	0.028	0.019	0.090	0.031	0.036	0.044
Bed blockers	0.096	0.304	-0.216	0.156	-0.048	-0.273***
	0.089	0.174	0.193	0.091	0.377	0.071
2014	0.089	0.103	-0.087	1.001**	-0.039	-0.471
	0.065	0.066	0.100	0.313	0.049	0.275
2015	0.016	0.144	-0.308	0.804	0.053	-0.253
	0.094	0.094	0.199	0.421	0.062	0.337
2016	0.091	0.050	-0.299	1.562***	0.047	-0.340
	0.115	0.159	0.234	0.407	0.057	0.318
Constant	-5.005	32.935*	3.027	-29.800	-5.762	1.073
	6.632	13.407	23.320	18.198	6.520	15.697
Observations	4444	290	1638	748	1588	180
R2 overall	0.192	0.017	0.450	0.068	0.183	0.114
R2 within	0.046	0.271	0.112	0.098	0.133	0.215

Legend: * $p < 0.05$, ** $p < .01$, *** $p < .001$

Notes: This table present the two-way fixed effect estimates latter used to create the counterfactual for the Synthetic difference-in-differences. Standard errors are not clustered. Each column correspond to a hospital category, revealing heterogeneous determinants of the transfer rate.

ferred increase with the level of production and technical efficiency for private hospitals due to the fact that the increase in production is dependent on patient transfers, likely because they do not have all the necessary equipment to provide complete care pathways. This is in line with the literature pointing that the size of hospitals is linked to a lower transfer rate (Bennett et al. 2019, Fernandes-Taylor et al. 2021, Ingraham et al. 2019). In particular, LHs share fewer patients as their size increases. (ii) Hospitals treating more complex patients (as measured by the Charlson Index) tend to rely more frequently on transfers, likely because these patients require more specialized or acute care that cannot be provided by medium-sized facilities, such as GH and private institutions. Indeed, GH increase their number of patient transferred with respect to their complexity, while this relationship is not significant and we do not find a correlation for LHs, it can be noted that they have both a high level of transfers and of complex patients. This finding aligns with the existing literature, which shows that complex patients, particularly in rural settings, face higher odds of being transferred (Fernandes-Taylor et al. 2021). On the other side private hospitals are well known to select their patients, and when faced with complex case, they can use transfers as a discharge strategy.

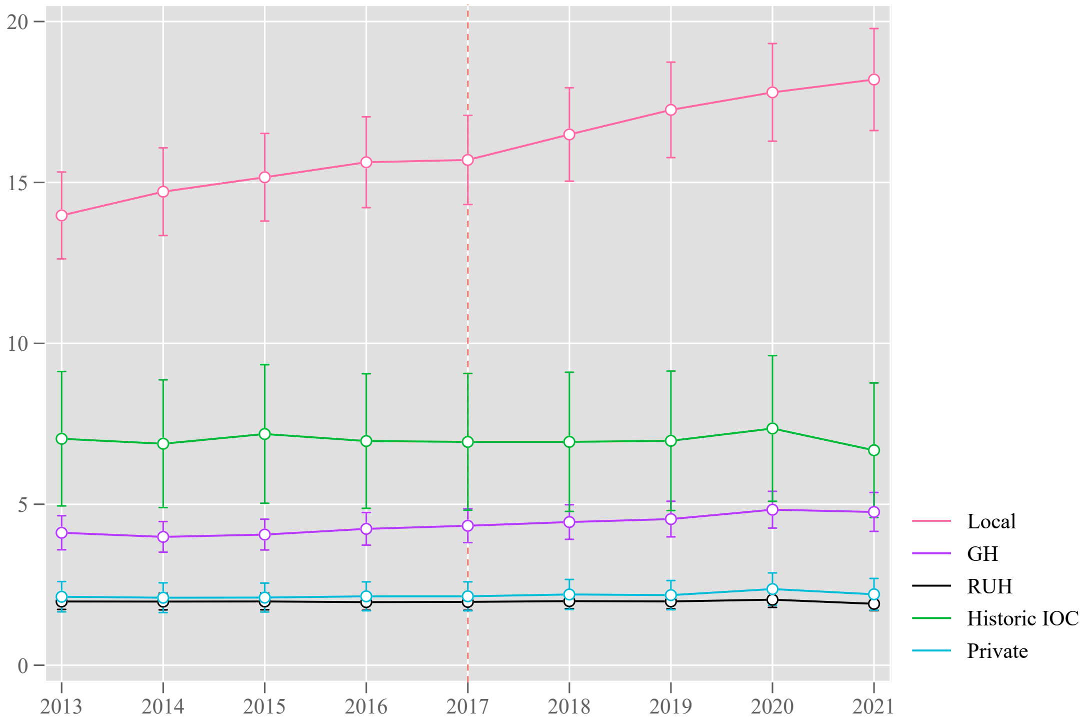
A second set of results in Table 2 deals with hospitals market structure and patient outcomes. (i) Mascia, Di Vincenzo, and Cicchetti 2012 finds a link between transfers and competition, hospitals in competitive markets (as measured by the Competition index) tend to share patients, particularly LHs. Dynamically, this relationship also appears in RUHs and private hospitals, where higher competition leads to a greater willingness to transfer patients, suggesting that competition encourages more patient-sharing practices. None of those correlations are significant using robust standard errors, all coefficients point in the direction of the litterature. (ii) This could explain the rather counter-intuitive result about 30 days re-hospitalization. Quality measures are usually independent from transfers at the individual level (respiratory failure: Ludwig et al. 2024, trauma: A. D. Hill, Fowler, and Nathens 2011, critical care: E. Fan et al. 2005) or exhibit higher mortality and complications (overall: Bristol et al. 2020, general surgery: Emanuelson, S. J. Brown, and Termuhlen 2022, Allen et al. 2021). The regulated prices in France push competition on quality and higher competition could lead to more transfers.[10] (iii) The analysis do not reveals any relationship between patient transfers and bed blockers. LHs exhibit the highest rates, followed by GH, RUH, and private hospitals for both transfers and bed blocking (see table 1). Transfers after a patient becomes a bed blocker may reflect delays in accessing appropriate care (Gaughan, Gravelle, and Siciliani 2015).

A third set of results addresses time fixed effects. While no distinct trend is evident for the entire sample during the period analyzed, the heterogeneity analysis reveals that LHs experience a substantial, significant increase in transfer rates starting in 2014 and increasing in 2016. This strong pre-trend will be the reason behind our use of the synthetic difference-in-differences methodology.

[10] It may also be that French hospitals (outside RUHs) with higher patient transfer rates over time experience better care quality because transfers ensure that patients receive specialized care in facilities better equipped for their needs.

4.2 Event analysis

Figure 1: Mean Interfacility transfer rate (IFTR) by sector



Notes: This figure presents the raw evolution of our main variable over time, with their 95% confidence intervals for each hospital categories.

Figure 1 displays the average annual value of the IFTR with 95%CI, broken by hospital status. LHs (and GH to a lesser extent) experience the highest increase in the share of patients transferred, while the IFTR stagnated for any other types of hospitals, whether in the treatment or the control group. This sustained upward trend in IFTR for LHs seems to be the driving force behind the continuous evolution of patient transfers observed by Chrusciel et al. 2023 at the patient level, in public hospitals. The flat trend observed for the control group justifies the use of a SDID approach to address the absence of parallel trends in the pre-treatment period. Conversely, the lack of significant changes in patient transfer patterns following the reform for the pool of hospitals in the control group (specifically historically integrated and for-profit hospitals) supports the SUTVA, suggesting that the non-treated group did not react with a vertical integration strategy.

Figures 5 to 10 in the Appendix provide complementary statistics using the IFTR from *detected* patients' pathways, making it possible to identify the source and destination of transfers. Historic Public IOC appears highly independent from any other type of hospitals, with less than 2% of its patients coming from, or going to other public hospitals, and only 0.5% shared with private (profit or non-profit) hospitals. The for-profit sector also displays a low propensity to transfer patient, as they exchange 2% of their patients with public hospitals, and are situated in the downstream of the care pathway, as they receive more than they send to public hospitals. The non-profit sector however, exchanges a large share (8.8%) of its patients with the public sector.

4.3 Average treatment on treated

Table 3 displays SDID estimates in the first column for our baseline model. This model, utilizing historically integrated hospitals as the control group, spans from 2013 to 2019 and employs the Arkangelsky covariate pre-processing methodology.[11] The results indicate a statistically significant overall increase of 0.522 points in the IFTR (0.158; 0.886 95% CI) for the treated group. The reform's primary impact is particularly pronounced for LHs, which show an Average Treatment Effect (ATT) of 1.36 percentage points (0.641; 2.077 95% CI)(see Appendix Table11. Specifically, the post-treatment increase in IFTR for LHs is characterized by a substantial rise in the number of patients received from GHs and other LHs (see Figures 3 and 4 in the Appendix).[12]

Additional results in Table 3 confirm the absence of changes in IFTR trends post-treatment for RUHs and GHs. It appears that vertical integration primarily reshaped patient care pathways for LHs with lower levels of care intensity, while RUHs and GHs did not exhibit changes in their transfer behaviors. The reform has mobilized LHs to enhance their role as a relief valve for larger hospitals, thereby improving their function in the care production chain by alleviating patient load across the region. In other words, the rate of patient transfers from public LHs would have plateaued in the absence of the reform. Overall, these results suggest that the 2016 reform has improved care coordination among public hospitals.

Table 3: SDID estimates, heterogeneity analysis, baseline control group, 2013-2019

Arkangelsky	Total	RUH	GH	LH
ATT	0.522***	0.158	0.171	1.359***
(S.E.)	(0.19)	(0.17)	(0.12)	(0.30)
Observations	4998	702	1624	1337
N cluster	714	117	232	191

Legend * $p < 0.05$, ** $p < .01$, *** $p < .001$

Notes: ATTs are reported. S.E. between parentheses. These ATT are estimated using synthetic difference in differences on the 2013-2019 period. The synthetic counterfactual uses covariate pre-processing. Each coefficient is the result of a separate estimation on a subsample comprising the synthetic group and the treated hospitals mentioned.

Additional results in Table 8 in the Appendix show the ten most frequently transferred diagnoses. It appears that most transfers occur within the same specialties and correspond to logical steps in patients' care pathways, often involving a transfer from diagnosis at one hospital to intensive care at another. A comparison between 2015 and 2018 shows that while the composition of transfers remains constant, certain categories saw a significant increase in the number of transfers (e.g., stroke care,

[11] The computation of the ATT is dependent on a pre-processing step, using the residuals of a regression before the synthetic control difference in differences. This regression is ran on the control pool over the full period of interest. The model specification can be available upon request.

[12] Notice that the ATT for LH is similar to the natural trend prior to the reform displayed in Table 2 (as measured by the time fixed effects). This result is similar to Chrusciel et al. 2023 who concluded, without counterfactual, that the GHT reform did not modify patients transfers.

coronary catheterization, neonatal conditions, spinal cord injuries, and respiratory infections). This increase aligns with our hypothesis of reorganization along care pathways, rather than at a horizontal level.

5 Robustness checks

5.1 Treatment time placebo test

Following the methodology outlined by Du and Shepotylo 2022, we explore all dates between 2015 and 2017 as potential treatment dates, seeking any pre-existing effects on our treated groups. A successful outcome of the placebo test necessitates the absence of any significant effects throughout this period. The results presented in Table 4 suggest that both LHs and RUH pass the test. However, GH appears to have experienced a pre-existing trend disruption in 2015, extending into 2016.

Table 4: Placebo SDID estimates, baseline control group (2013-2017)

Placebo SDID (13-17)	RUH		GH		LH		Total	
Years	ATT	S.E	ATT	S.E	ATT	S.E	ATT	S.E
2014	-0.032	(0.07)	0.138	(0.11)	0.409	(0.35)	0.191	(0.16)
2015	-0.096*	(0.06)	0.125	(0.08)	0.191	(0.27)	0.127	(0.11)
2016	-0.011	(0.05)	0.081	(0.10)	0.024	(0.34)	0.023	(0.13)

Legend * $p < 0.05$, ** $p < .01$, *** $p < .001$

Notes: ATTs are reported. S.E. between parentheses. This table reports synthetic difference in differences estimates calculated before the policy implementation. The models uses the period 2013-2016 and cycle the "treatment" date through the years in search for preexisting significant trend disruptions.

5.2 Outcome variable alternative measure

The choice between *detected* or *discharge* data for the outcome measure could raise issues associated with measurement error of the dependent variable, causing potential bias and inefficiency in parameters estimates. Since detected data consider a transfer happens when two hospital stays are recorded for a patient in two different facilities during the same day, they may also consider two independent medical procedures happening the same day at two different hospitals as a transfer – a rare occasion but still a possibility. *Discharge* data however, are not subject to over detection and can identify a multiple day transfer. They can be subject to human error, miss reporting and to the patient accounting change in 2016.

In addition to the previous descriptive statistics tests for equivalence in the outcomes variables (see section 3.1.), we re-ran the models on discharge data and found generally consistent results. By and large, there is no evidence of systematic difference between model estimates whether the outcome measure is based on detected or discharge data. Second, using *detected* data we need to make a choice between two aggregation levels: geographical location or legal entity. In the main body of the text, hospitals where considered as a legal entity, but by dis-aggregating to the geographical location and retaining only mono-site hospitals, we can offer an alternative way of defining transfers. This methodology yield similar results to our main analysis.

5.3 Alternative model specifications

In alternative model specifications, we first focused on selecting covariates and defining treatment variables. A simple approach involved rerunning all our models without covariates, which produced results equivalent to those of our main analysis. Following the methodology outlined by Kranz 2022, we then estimated a two-way fixed-effect regression on covariates, expected to yield more precise estimates compared to a simple regression as in Arkhangelsky et al. 2021. Additionally, to enhance the robustness of our analysis, we expanded the sample size by including data from the years 2020 and 2021, coinciding with the Covid-19 pandemic. Furthermore, we extended our sample to include private sector hospitals in the pool for the control group ("extended control group"), under the assumption of absence of general equilibrium effects (a.k.a spillover or contamination effects).

Table 5: SDID estimates, all and local public hospitals, baseline and extended control groups

Sample		Total		LH	
Ctrl. Gr.	Years	Arkhangelsky	Kranz	Arkhangelsky	Kranz
Baseline	2013-19	0.522***	0.461***	1.359***	1.450***
	N.= 4998	(0.19)	(0.16)	(0.32)	(0.33)
	2013-21	0.690***	0.664***	1.614***	1.885***
	N.= 6426	(0.18)	(0.19)	(0.39)	(0.40)
Extended	2013-19	0.377***	0.340***	1.095***	1.019***
	N.= 763	(0.12)	(0.09)	(0.29)	(0.27)
	2013-21	0.545***	0.592***	1.557***	1.746***
	N.= 9981	(0.11)	(0.18)	(0.38)	(0.50)

Legend * $p < 0.05$, ** $p < .01$, *** $p < .001$.

Notes: ATTs are reported. S.E. between parentheses. This table report different alternative use of the sample and of covariate processing methods. The control group can be "Baseline" (only historically integrated) or "Extended" (historically integrated and private). We propose ATTs for the 2013-19 and 2013-21 period. The later being biased by the Covid-19 pandemic. Finally, the covariate processing can be "Arkhangelsky", see Arkhangelsky et al. 2021 or "Kranz", see Kranz 2022. The dependent variable is the inter-facility transfer rate

Table 5 displays a summary of findings. Estimates found after Arkangelsky's and Kranz's method yield significant and comparable results to those obtained previously in the main analysis, with a consistently stronger effect observed for LHs, regardless of sample modifications.

The inclusion of the year 2020 & 2021 changes the interpretation of our results. By 2020 the reform had been in effect since three years, and its coordination tools available to managers. It appears that the pandemic did not change the trend of increased transfers for LHs. Nonetheless, we are not able to say if the continued increase in those hospitals is linked to an amplification of the reform during the Covid-19 years or a simple Covid-19 effect. It can be noted that the Covid-19 pandemic implied rapid reorganization and transfers between hospitals (Lebreton et al. 2021), some territorial groups had a pro-active role in this reorganization (Faugère 2020). We find that the interdependence of LHs continued to increase during the pandemic.

5.4 Switching between treated sub-groups

One last approach considered the decomposition of public hospitals according to their status (Regional or University Hospital, General Hospital, and Local Hospitals) is rather arbitrary and may conceal other forms of heterogeneous effects of the treatment. It sometimes happens that General Hospitals (GH) take on missions typically associated with local hospitals (LH), and vice versa. This situation can arise from geographical, demographic, or organizational considerations, where a General Hospital may expand its services to meet the local population's proximity needs. Similarly, some local hospitals may offer specialized services or cooperate with General Hospitals to address specific healthcare needs in their region. The 2016 GHT reform could have influenced these mission changes, leading to an overlap in roles between General Hospitals and local hospitals, and potentially Regional or University Hospitals. We propose to explore further the heterogeneous effect of the treatment based on the decomposition between types of public hospitals by redefining the three baseline groups. We opt for automatic clustering to identify intrinsic similarities between establishments over purely data-driven methods like machine learning based on heterogeneous outcome effects. This approach aligns better with our theoretical framework, recognizing that public hospitals vary in size, resources, and missions or roles within their communities.

In the details, we implemented a k-means clustering algorithm using our control variables as indicators. Values for Caliński and Harabasz 1974 pseudo-F index suggest to retain two groups. The first one (named "Big") is mainly composed of RUH and GH, and only three LH; the second one (named "small") is only made out of GH and LH. Using these two new categories in the analysis instead of the baseline ones (RUH, GH, and LH), leads to the disappearance of prior effects of public policy: the associated coefficients to the "Big" categories have lower and non-significant values, whereas the associated coefficients to the "small" categories have lower and weaker values. In summary, it appears that the effect of the GHT reform is linked with the legal status of the establishments (de jure) as well as with their actual activity (de facto). These results argue in favor of the idea that the drivers of public hospital reorganization are legal in nature.

6 Conclusion

The 2016 GHT reform in France established territorial groupings of public hospitals with the goal of promoting integrated healthcare delivery, facilitate coordinated patient care, pool resources among participating institutions, implement shared governance models, and improve access to healthcare services. Health authorities have imposed a set of constraints on public institutions, both technical and financial, with the aim of discouraging non-cooperative behaviors. However, this policy only partially follows the recommendations of agency theory, which also advocates for the implementation of individual or collective incentives. This lack of incentives, together with the fact that the constraints were not overly binding, may have caused the GHT to not fully achieve healthcare integration between hospitals. We tested this assumption on the grounds that, in the case of successful integration, public hospitals would provide complementary segments of care pathways, so that in the short term, more patient transfers would be needed to achieve the completion of care.

6.1 Summary of findings

Two main results emerge from our analysis. First, we found that that the GHT reform contributed to increase the rate of patients transferred between public hospitals. It is possible that the reform facilitated continuity in the integration of public hospital services, a process already initiated by the CHTs in 2009. The implementation of the GHTs thus accompanied, rather than disrupted, the transformation of the healthcare system, representing another step in the continuation of a long-term integration policy. This result concurs with previous findings from Chrusciel et al. 2023 who found that the GHT reform did not modify the overall trend in patients' transfers, although the interpretation is different in our case. Here the use of synthetic diff-in-diff model indicates that in the counterfactual case, the rate of patients' transfers of public hospitals would have plateaued without the GHTs.

Second, we found that the GHT reform specifically strengthened the integration of local hospitals with other public healthcare facilities in the region. We assume that smaller hospitals could have offered a more diverse range of services to meet the needs of the local population while referring patients to larger hospitals that specialize in advanced complementary care. This interpretation relies in part on the definition of a PMP, which formally establishes the role and missions of local hospitals as the primary entry and exit points in the patient's healthcare pathway. However, from an empirical perspective, their exact role remains unclear. It is assumed that the increase in IFTR stems from better coordination of complementary care segments across public hospitals in the region. Future studies could focus on analyzing the evolution of care pathways between institutions in greater detail, rather than merely assessing the volume of transferred patients.

6.2 Perspectives

In theory, regionalized graduated care provision networks grant patients, at the entry point, direct access to virtually all the resources of the facilities through transfers. This is intended to reduce the duplication of resources within the network, as long as each hospital provides complementary segments of care pathways and patients are transferred between facilities to complete their care. Coordinating these complementary activities across multiple sites enhances regional healthcare delivery, allowing patients to access a more integrated and comprehensive care pathway. From the regulator's perspective, virtual integration is intended to bear the same benefits for healthcare provision as vertical integration (Robinson and Casalino 1996) – economies of scale and scope, lower transaction costs, higher risk-bearing capacity (e.g. Trybou, Gemmel, and Annemans 2015), and managerial innovation through better control of internal information – while introducing flexible legal mechanisms that facilitate collaboration between public hospitals (Keller 2020).

From a theoretical perspective, the 2016 GHT reform challenges the assumed ineffectiveness of "meaningless mandates" without incentives to achieve coordinated care between agents. Although agency theory recommends that large organizations should implement relative or collective performance compensation schemes to alleviate non-cooperative behaviors, in our case, a set of (non-overly binding) constraints likely sufficed to modify behaviors. Gains from managers' opportunistic behaviors may be less prevalent in local hospitals with fewer resources and more social control. For instance, managers' actions may be more visible to staff and the community in smaller institutions, increasing accountability and reducing opportunities for self-serving behaviors. However, our results advocate against the effect of the size of the institution in favor of the legal form of the establishments. A hypothesis to consider for future research is that local hospitals may be subject to different levels or types of oversight, potentially from other hospitals in the GHT, which can affect the opportunities for and detection of opportunistic behavior. It may also be that managers in local hospitals often have closer ties to the communities they serve, which can foster a sense of responsibility and ethical behavior. This calls for a better understanding of what motivates public hospital managers. A rejoinder of standard management and economic theory with behavioral economics (e.g. Grimmelikhuijsen et al. 2017; Battaglio Jr et al. 2019) could provide new hypotheses.

From a public policy perspective, our results do not totally rule out the potential for economic incentives to achieve greater effective integration among public hospitals. The next steps towards stronger vertical integration could include better defining the operational objectives of integration and linking them to specific individual or collective incentives. Additionally, granting legal personality to hospital groups could strengthen and clarify the role of managers in the chain of command within these institutions, thus achieving full over virtual integration. In this case however, the debate about the consequences of stronger public local monopolies should also be addressed, namely the potential for *foreclosure* (Hart et al. 1990) and *hold-ups* (Allain, Chambolle, and Rey 2016) of other care providers.

Finally, an appraisal of the GHT reform from the patients' perspective should consider the net gains in quality of care. On the one hand, a better integration of public hospitals grant patients, at the entry point, direct access to virtually all the resources of the facilities, allowing them access to a more integrated and comprehensive care pathway. On the other hand, more transfers are needed, which generate to a dis-utility for the patients. The existing literature points towards both quality of care and distance as being strong determinant in patient choices (Beckert, Christensen, and Collyer 2012, Victoor et al. 2012) and those results seem to be reproducible in the french context (Huguet 2020). Even if transfers are used to improve access to advanced and high-quality care they can be perceived as disrupting a seamless care pathway. This implies a trade-off between distance and care quality. Although patients are willing to travel for better quality of care (Varkevisser, Geest, and Schut 2012). Further research could focus on measuring the marginal benefit for French patients, on average, but especially based on their socioeconomic status, as transfers may represent prohibitive costs for the most disadvantaged ones.

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Appendix

Box A1: Efficiency and Output

We measure hospital efficiency and output following a Stochastic Frontier Analysis (SFA) model of production frontier. SFA models have their use in hospital efficiency analysis and policy analysis. Rosko and Mutter 2011 reviewed 27 published paper using SFA model. Various study use this type of model to link hospital characteristics (market concentration, case-mix or hospital status) and their efficiency.

We chose a Cobb-Douglas frontier model, only retaining the significant parameters as the insignificant ones added noise, therefore devolving the model to a functional form. Such models inform the predicted output of a hospital and its ineff. when compared to a given theoretical production function. The model use the following function:

(1) $output_{it} = \sum nbstay_{it}^{drg} * cost_{t}^{drg}$

(2) $lnoutput_{it} = \alpha + \beta_1 lnstaff_{it} + \beta_2 lnbeds_{it} + \beta_4 lnSaidin_{it} + \beta_5 IMR_{it} + i.year_i + \epsilon_{it}$

The left side of the function represents the output of the hospital and uses the number of MSO stay multiplied by the national average cost for this type of stay, informed by the ENC database. The right side is dedicated to the inputs with *Staff*, number of MSO beds, technical complexity (Saidin). As the three input variable come from the SAE, a less reliable source than the PMSI, we try to control for missing values. The inverse Mill's ratio control for missing observation bias by explaining it with missing values in the e-satis variable, as non-reporting in the the SAE and the e-satis may be caused by an overall non-reporting strategy. *Staff* is the result of a principal component analysis of the different medical staff categories in the hospital. We derived two control variables from this model: technical ineff. and predicted output.

Box A2: Market concentration Index

For Hospital i, geographical zone g and sector s:

$$CI_i = \sum CI_i^s * Weight2_i^s$$

$$CI_i^s = \sum (HHI_g^s * Weight1_{ig}^s)$$

$$HHI_g^s = \sum (ms_{ig}^s)^2 = \sum (\frac{Nbstay_{ig}^s}{Nbstay_g^s})^2$$

$$Weight1_{ig}^s = \frac{Nbstay_{ig}^s}{Nbstay_i^s}$$

$$Weight2_i^s = \frac{Nbstay_i^s}{Nbstay_i}$$

Step 1: create HHI_g^s by zip code g for MSO activity s

Step 2: create $Weight1_{ig}^s$ by zip code g of hospital i for MSO activity s

Step 3: multiply HHI_g^s by $Weight1_{ig}^s$ giving CI_{ig}^s by zip code g of hospital i for MSO activity s

Step 4: Sum CI_{ig}^s by hospital, to obtain CI_i^s for hospital i and MSO activity s

Break : at this step we have three CI_i^s by hospital : CI_i^{med} ; CI_i^{sur} ; CI_i^{obs} .

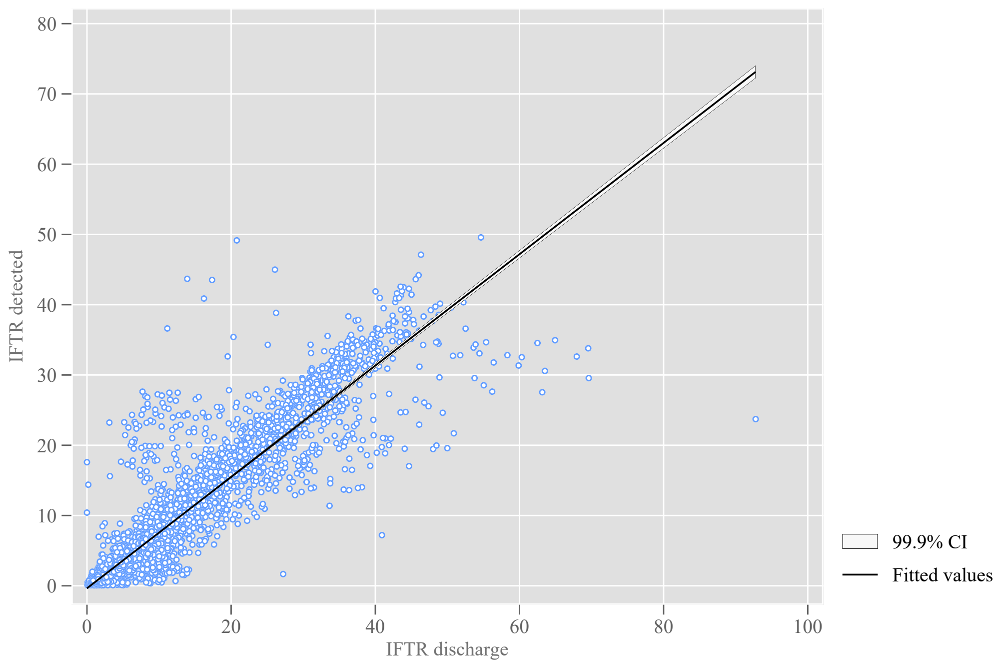
Step 5: Create $Weight2_i^s$ by hospital i for MSO activity s

Break : We obtain $Weight2_i^{med}$; $Weight2_i^{sur}$;$Weight2_i^{obs}$

Step 6: multiply CI_i^s by $Weight2_i^s$. We rename the weighted CI_i^s $CI\_OK_i^s$.

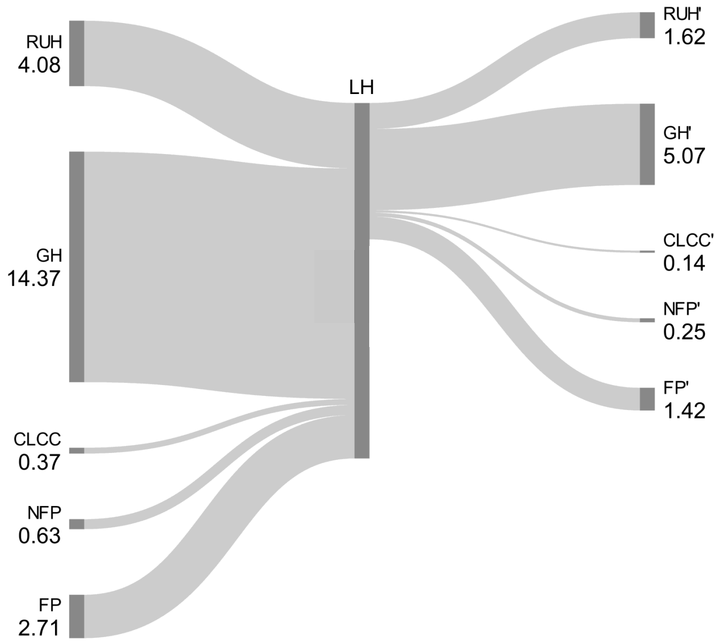
Step 7: Sum $CI\_OK_i^s$ by hospital, giving one unique CI_i

Figure 2: Correlation between IFTR *discharges* and *detected*



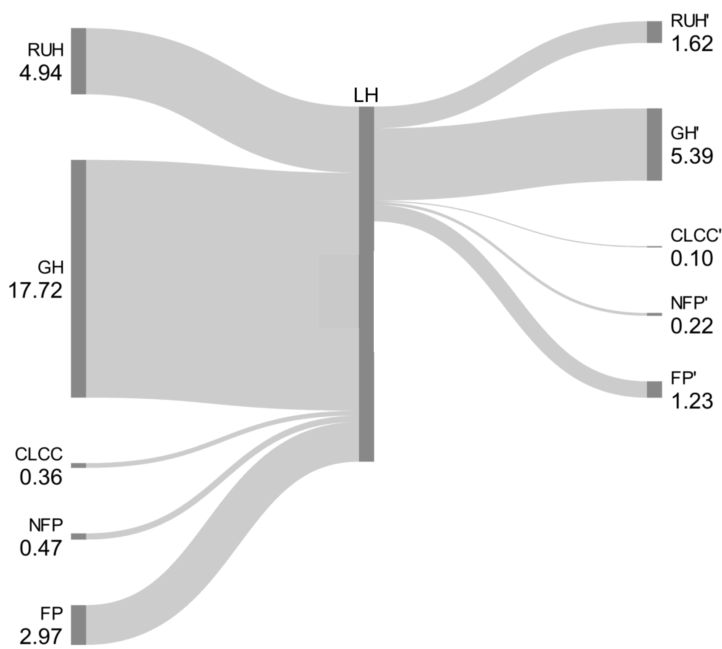
Notes: The Programme de Médicalisation des Systèmes d'Information (PMSI) let us compute two distinct inter-facility transfer rates. Though they use two different sources of data to characterize transfers, the relationship between the two is strongly (R-sq=0.86) significant (Coef: 1.19; S.E= 0.01; p-value< 0.001)

Figure 3: Flow chart of local hospitals 2013-2016



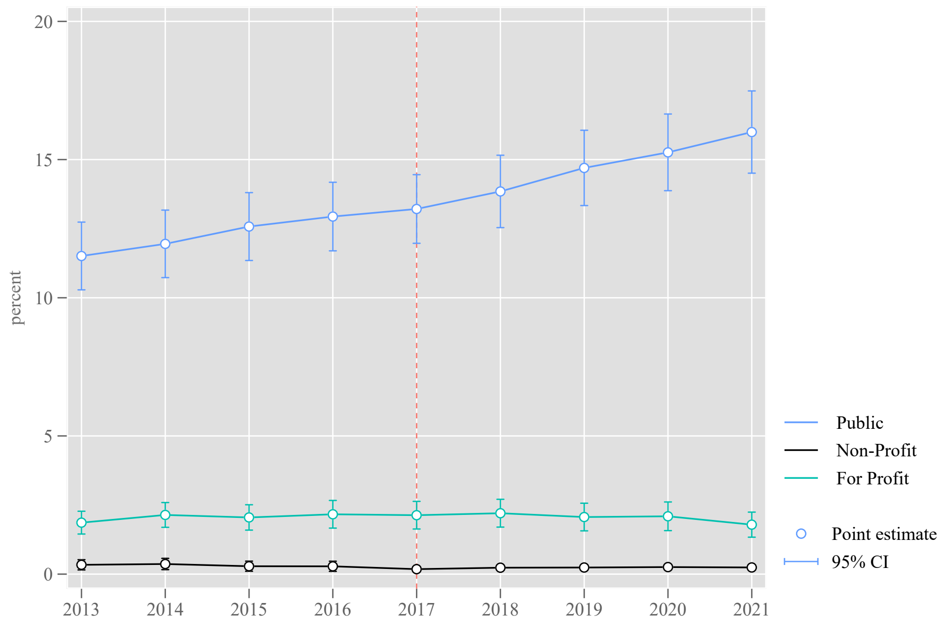
Notes: The flows represent the % of activity linked to a transfer, to or from a hospital category, for a mean local hospital during the pre-treatment period (2013-2016).

Figure 4: Flow chart of local hospitals 2017-2021 (flow in % of total activity)



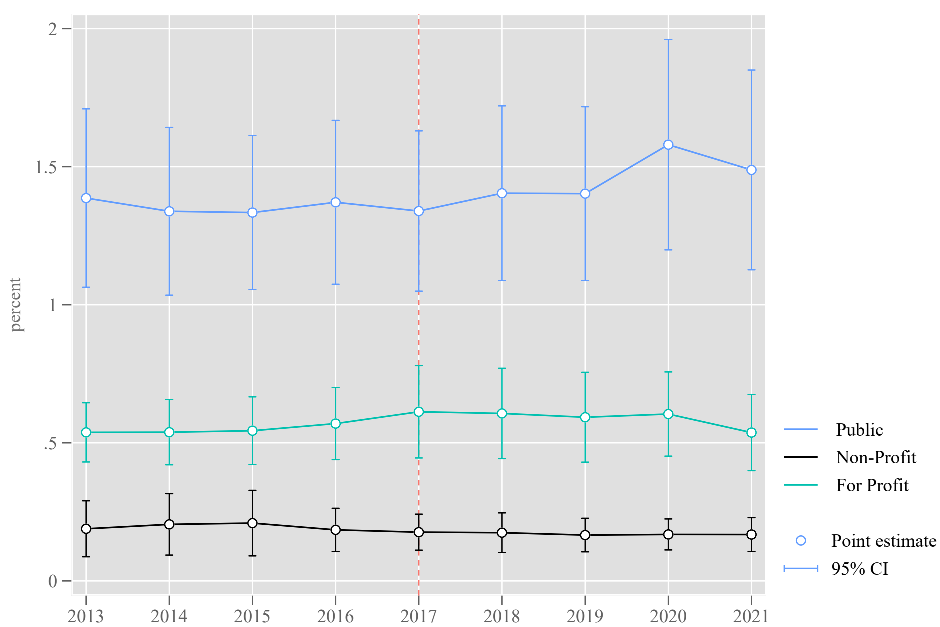
Notes: The flows represent the % of activity linked to a transfer, to or from a hospital category, for a mean local hospital during the pre-treatment period (2017-2021).

Figure 5: Mean IFTR of Local Hospitals with other sector



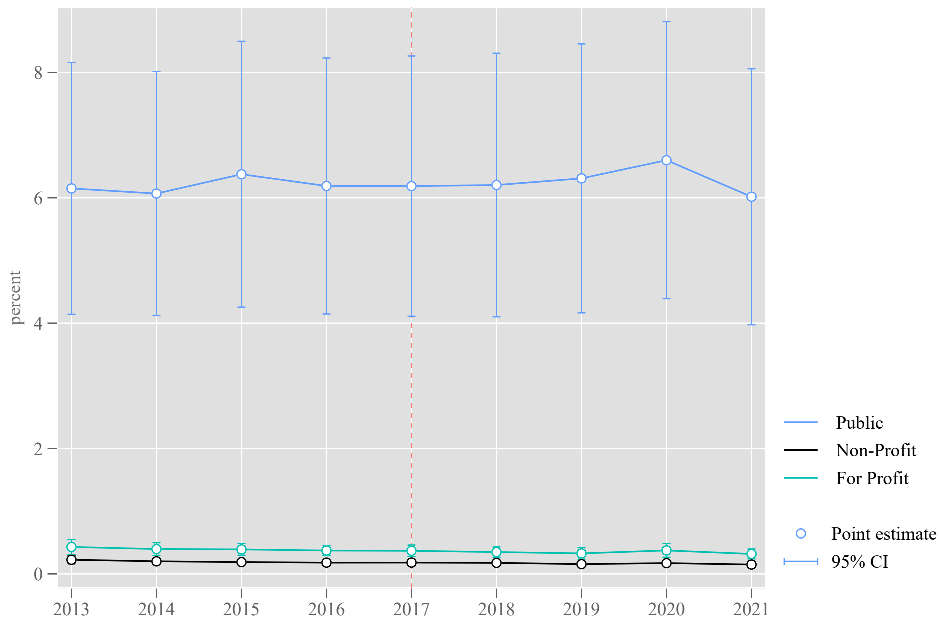
Notes: This figure presents the raw evolution of the inter-facility transfer rate to and from the categories in the legend for Local hospitals, with their 95% confidence intervals.

Figure 6: Mean IFTR of for-profit Hospitals with other sector



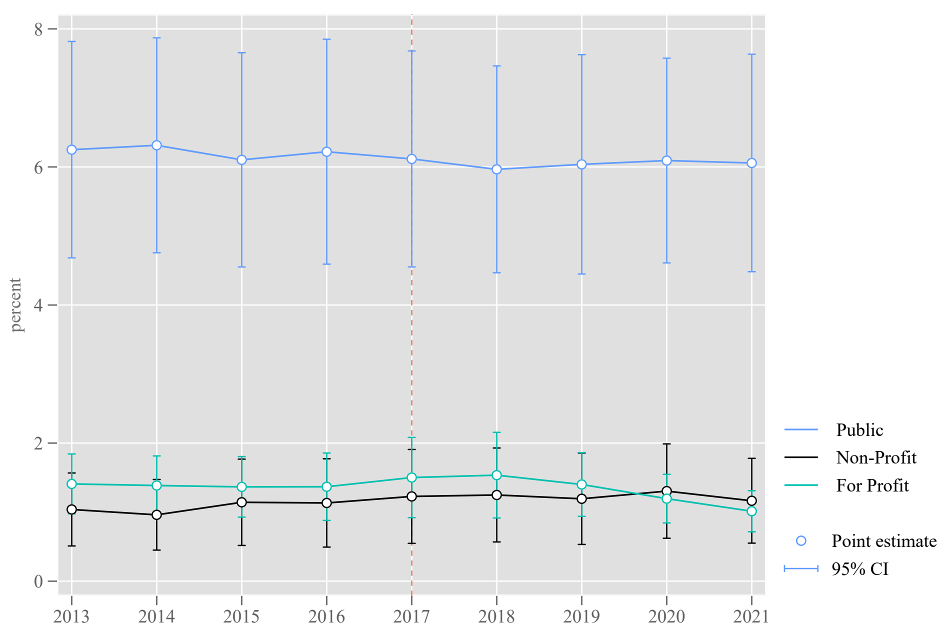
Notes: This figure presents the raw evolution of the inter-facility transfer rate to and from the categories in the legend for private hospitals, with their 95% confidence intervals.

Figure 7: Mean IFTR of historically integrated hospitals with other sector



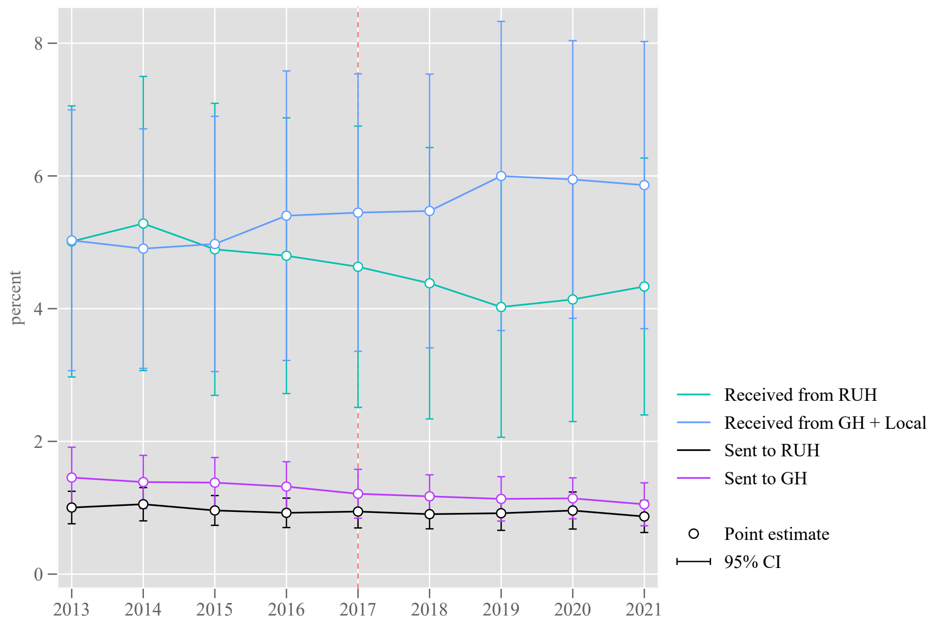
Notes: This figure presents the raw evolution of the inter-facility transfer rate to and from the categories in the legend for historically integrated hospitals, with their 95% confidence intervals.

Figure 8: Mean IFTR of non-profit Hospitals with other sector



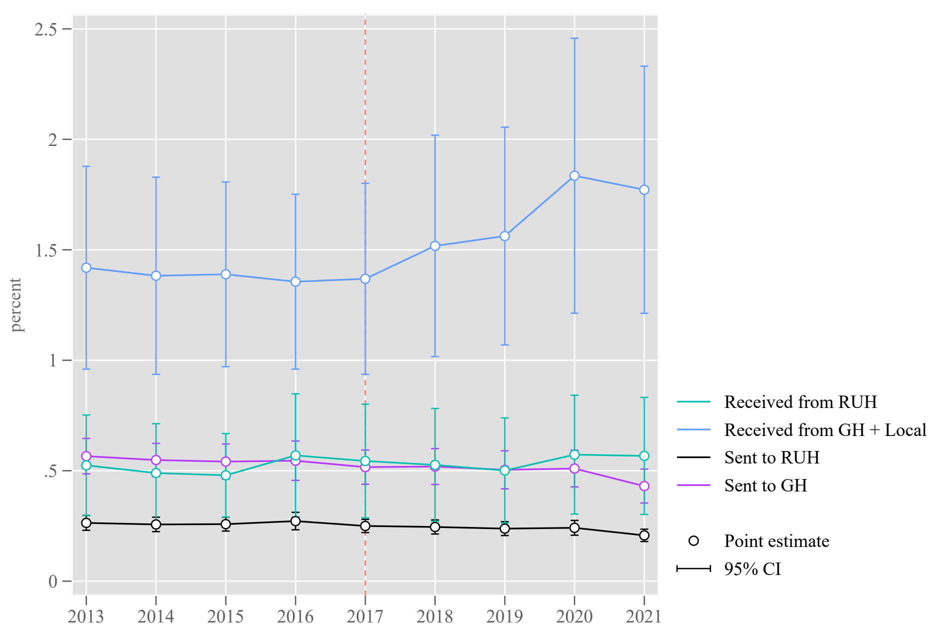
Notes: This figure presents the raw evolution of the inter-facility transfer rate to and from the categories in the legend for non-profit hospitals, with their 95% confidence intervals.

Figure 9: Mean IFTR of non-profit Hospitals with other public hospitals



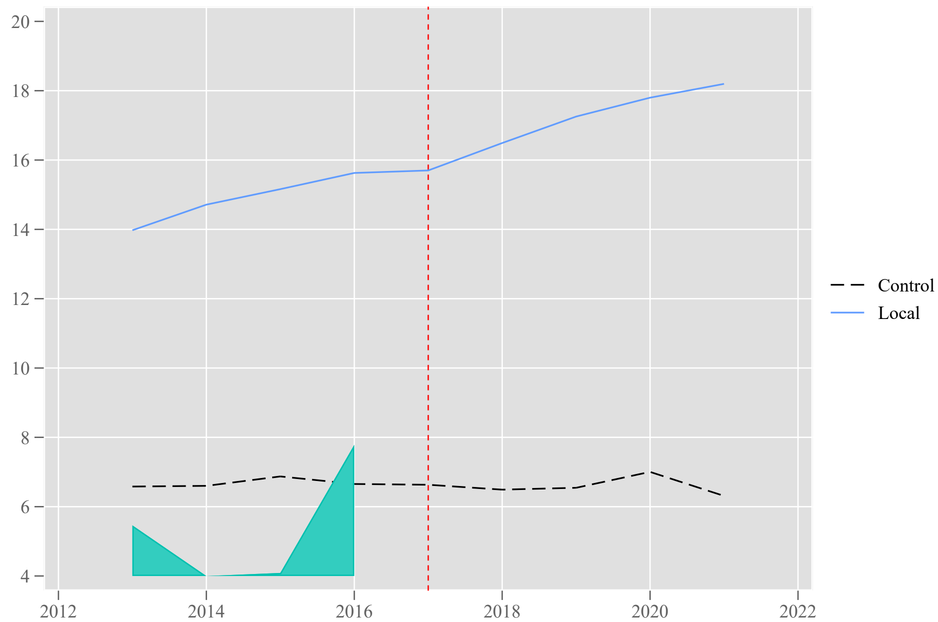
Notes: This figure presents the raw evolution of the inter-facility transfer rate to and from the categories in the legend for non-profit hospitals, with their 95% confidence intervals.

Figure 10: Mean IFTR of private Hospitals with other public hospitals



Notes: This figure presents the raw evolution of the inter-facility transfer rate to and from the categories in the legend for private hospitals, with their 95% confidence intervals.

Figure 11: Synthetic DiD results for Local hospitals



Notes: This figure represents the estimated effect of the policy change on local hospitals. the synthetic control is displayed through the dashed line. Time weights can be found represented as the gray area beneath the curb and before the treatment. The presentation of the individual weighting would not be readable due to the high number of individuals forming the control group.

Table 6: Non exhaustive list of use of the IFTR indicator in the literature

Authors	Field	Y/X	Measures/Findings
Hao et al. 2019	Econ.	Y	Correlates hospital and case mix caracteristics with the IFTR.
N. H. Yang et al. 2015	Econ.	Y	Cost-effective transfer decision with telephone or telemedecine consultations.
Acton et al. 2022	Medical	Y	Assessed the prevalence, temporal trends, and patterns of interfacility transfers following seizure-related ED visits.
Evans et al. 2022	Medical	Y	Transfer rate at hospital and patology level, linked with hospital caracteristics.
Jenkins et al. 2022	Surgery	Y	Explain multiple outcome variable (& IFTR) with hospital characteristics and bayesian technics
Haynes et al. 2020	Econ. Medical	Y	Findings suggest that telemedicine may have potential to reduce potentially avoidable transfers of term and late preterm newborns.
Kotwal et al. 2017	Medical	Y	Rural residents receiving RRT have markedly higher rates of IFT compared to their urban counterparts.
Panlaqui et al. 2017	Medical	Y	The proportion of inter-hospital transfers was lower in the telemedicine group.
Izadnegahdar et al. 2016	Medical	Y	Compares transfer rates by sex, age and year using logistic regression models.
Rydenfelt et al. 2015	Medical	X	Choice of mortality end-point influences SMR. The extent of the influence depends on [...] inter-hospital transfer rates.
Sampalis et al. 1999	Policy analysis	X	The proportion of patients transferred to tertiary centers from other hospitals increased. Linked with lower mortality rates outside of tertiary hospitals.
Mann et al. 1997	Policy analysis	X	A higher proportion of rural trauma patients presenting to Lvl-4 trauma hospitals were transferred after trauma system implementation.

Notes: this tables represent a non exhaustive list of the use of the interfacility transfer rates in the literature. When it is used as a dependent variable, we note it Y. When it is used as a covariate, we note it X.

Table 7: Three most transferred pathologies, by hospital status, 2016

					Provenence						
Statut	Pathology	Nbtsf	ghm34	SDRG	MSO	SMR	Emerg.	LTC	HPS	Resu.	NA
RUH	Diag. procedures through the vasc. route	2984	13,4	84,3	54,7	1,4	8,1	0,7	0,1	0,0	35,0
RUH	Non-transient intracerebral vasc. accidents	2541	41,0	87,5	33,8	2,1	18,6	0,8	0,2	0,0	44,6
RUH	Craniotom. unrelated to trauma, age over 17	2418	57,6	88,8	38,4	2,5	13,7	0,8	0,5	0,1	44,0
GH	Surgical follow-up care	13963	20,5	1,5	88,3	0,8	1,2	0,2	0,1	0,5	8,9
GH	Non-transient intracerebral vasc. accidents	7326	48,1	87,1	63,9	1,1	12,1	0,1	0,1	0,8	21,9
GH	Heart failure and circulatory shock states	5065	49,0	62,0	65,9	1,3	12,7	0,2	0,4	2,0	17,4
Local	Palliative care, with or without procedures	3209		23,7	93,4	0,8	0,3	0,1	0,3	0,0	5,1
Local	Surgical follow-up care	1513	42,0	1,4	93,7	0,5	0,5	0,0	0,1	0,1	5,0
Local	Heart failure and circulatory shock states	1394	52,6	64,3	82,1	0,4	3,0	0,0	1,4	0,2	12,8
NLP	Palliative care, with or without procedures	5252		34,3	91,6	1,7	0,3	0,1	0,1	0,1	6,0
NLP	Hemodialysis, in sessions	2975		51,7	0,0	0,0	0,0	0,0	0,0	0,0	100,0
NLP	Heart failure and circulatory shock states	2409	51,9	63,0	70,7	1,7	1,1	0,1	1,1	0,9	24,4
LP	Surgical follow-up care	5961	16,4	3,5	82,3	2,3	0,6	0,1	0,1	5,0	9,7
LP	Disorders of the biliary tract	5203	5,6	84,4	85,6	1,1	1,9	0,1	0,1	0,1	11,0
LP	Diag. procedures through the vasc. route	4483	7,0	80,8	67,4	1,7	4,3	0,0	0,1	0,3	26,1
HIOC	Palliative care, with or without procedures	863		27,7	66,9	3,5	2,3	0,5	0,5	0,1	26,3
HIOC	Craniotom. unrelated to trauma, age over 17	668	53,4	85,3	34,9	3,3	26,5	2,8	2,6	0,2	29,8
HIOC	Non-transient intracerebral vasc. accidents	645	43,4	84,7	39,1	1,6	18,6	0,3	2,2	1,2	37,1

Notes: Nbtsf: Number of transfers; ghm34: share of complex patients; SDRG : Same DRG; MSO: Medecine, surgery, obstetrics; SMR: Medical and Rehabilitation Care; HPS : Home, psychiatry, Socio-medical housing; LTC: Long term care; Resu: resuscitation service. Using discharge data, this table characterize the main transferred pathology for the year 2016.

Table 8: Most transferred pathologies, sending and receiving

	Nbtsf.	GHM hosp. 1	GHM hosp. 2	Type of care first hospital	Type of care second hospital
2015	1925	01M30T	01M301	Stroke	Stroke
2015	1605	05M04T	05K051	Coronary artery disease	Therapeutic Cardiac Stenting
2015	1347	05M09T	05M092	Heart diseases, valvular diseases	Heart diseases, valvular diseases
2015	1243	14Z16T	14Z16Z	Antepartum conditions	Antepartum conditions
2015	1148	23Z02Z	23Z02Z	Palliative care	Palliative care
2015	809	05K051	05M161	Therapeutic Cardiac Stenting	Coronary artery disease
2015	751	14C08A	14M02A	Cesarean sections	Postpartum conditions
2015	715	14Z16Z	14Z16Z	Antepartum conditions	Antepartum conditions
2015	714	05M09T	05M093	Heart diseases, valvular diseases	Heart diseases, valvular diseases
2015	605	05M061	05K101	Coronary artery disease	Diagnostic cardiac catheterizations
2015	586	15M02Z	15M05B	Early neonatal transfers	Medical conditions of the newborn
2015	564	04M05T	04M053	Respiratory infections	Respiratory infections
2015	518	08M261	08C511	Spinal cord injuries	Spinal cord/spinal surgeries
2015	495	15M02Z	15M05A	Early neonatal transfers	Medical conditions of the newborn
2015	472	05M04T	05K052	Coronary artery disease	Therapeutic Cardiac Stenting
2015	465	05M061	05K061	Coronary artery disease	Therapeutic Cardiac Stenting
2015	460	11M02T	11C111	Kidney, urinary lithiasis	Transurethral and other surgeries
2015	444	14Z14T	14M02A	Vaginal deliveries	Postpartum conditions
2018	2803	01M30T	01M301	Stroke	Stroke
2018	2683	05M04T	05K051	Coronary artery disease	Therapeutic Cardiac Stenting
2018	1626	05M09T	05M092	Heart and valvular diseases	Heart diseases, valvular diseases
2018	1331	14Z16T	14Z16Z	Antepartum conditions	Antepartum conditions
2018	1255	23Z02Z	23Z02Z	Palliative care	Palliative care
2018	997	05K051	05M161	Therapeutic Cardiac Stenting	Coronary artery disease
2018	956	05M04T	05K052	Coronary artery disease	Therapeutic Cardiac Stenting
2018	902	05M09T	05M093	Heart diseases, valvular diseases	Heart diseases, valvular diseases
2018	723	14C08A	14M02A	Cesarean sections	Postpartum conditions
2018	691	15M02Z	15M05A	Early neonatal transfers	Medical conditions of the newborn
2018	665	08M261	08C511	Spinal cord injuries	Spinal cord/spinal surgeries
2018	662	04M05T	04M053	Respiratory infections	Respiratory infections
2018	614	11M02T	11C111	Kidney, urinary lithiasis	Transurethral and other surgeries
2018	572	15M02Z	15M05B	Early neonatal transfers	Medical conditions of the newborn
2018	544	01M30T	01K031	Stroke	Neurovascular Therapeutic Catheter.
2018	534	14Z16Z	14Z16Z	Antepartum conditions	Antepartum conditions
2018	525	14Z14T	14M02A	Vaginal deliveries	Postpartum conditions
2018	503	08M261	08C512	Spinal cord injuries	Spinal cord/spinal surgeries

Notes: Top 10 pathology dyads by number of transfers. GHM: *Groupe Homogène de Maladie*, Homogeneous Disease Group (similar to DRG); version 2023, more information on each GHM can be found using https://www.aideaucodage.fr/ccam.

Glossary:

- GHT: Groupement Hospitalier de territoire. Hospital territorial groups are legal constructs created in 2016. Public hospital must use it for common projects and care coordination.
- CHT: Comunautés hospitalières de territoire, legal construct. Hospital territorial communities are legal constructs created in 2009, used by public hospital to collaborate for common projects.
- PMP: Projet médico-partagé. The shared medical project is one of the funding documents of the GHT. It enumerates the strategies of the GHT.
- T2A: Tarification à l'activité. Activity based payements, the hospital financing system in France.
- MSO: Medecine Surgery Obstetrics and odontology
- PMSI: Programme de médicalisation des systèmes d'information. Created in 1996, it is a central database of all hospital stays in France and leverage the T2A for data collection.
- RUH: Regional and University Hospitals, legal status containing the largest hospitals in France.
- GH: General Hospitals, legal status, medium sized hospital.
- LH: Local hospitals, legal status created in 2016, very small hospitals, do not perform surgery on site, often located in a rural setting.
- SAE: Statistique annuelle des établissments. Declarative dataset on hospital endowments.
- HAS: Haute autorité de la santé. High health authority, a regulating body publishing data, good practicies and performing arbitrage.
- ENC: Etude National des Coûts. National cost survey, used yearly to compute the T2A.