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Rangmi Myung
National Health Insurance Service
Yujin Lee
National Health Insurance Service
Namkyu Seo
ibid00@hanmail.net

National Health Insurance Service

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Facility-Level Determinants of Non-covered Expenditures in Korean General-Purpose Hospitals: A Repeated Cross-Sectional Analysis, 2015-2024

(June 2026)

Rangmi Myung[1*], Yujin Lee[1], Namkyu Seo[1†]

[1]Department of Non-benefits Management , National Health Insurance Service , Wonju-si, Gangwon-do, 26464, South Korea

*First author. E-mail: fadalmrm@naver.com ;
†Corresponding author. E-mail: ibid00@hanmail.net ;
Contributing author. E-mail: leeyj4612@gmail.com

Abstract

Background South Korea's National Health Insurance system operates under a dual pricing structure in which covered services are subject to government-regulated fee schedules while non-covered services remain entirely market-priced. This structural duality creates strong incentives for providers to expand non-covered service provision as a revenue supplement. Despite growing policy concern over rising non-covered expenditures, facility-level supply-side determinants of non-covered expenditure at small-to-medium-sized hospitals remain poorly understood.

Methods We analyzed data from the Survey on the Benefit Coverage Rate of National Health Insurance (2015–2024), covering 214–322 Korean general-purpose hospitals per year (approximately 20% of the national hospital population). Repeated cross-sectional ordinary least squares regression was performed separately for each year. Dependent variables included covered benefit payments, non-covered expenditures, and the non-covered service ratio. Independent variables included bed count, physician and nurse

staffing, high-cost medical equipment, hospital density, ownership type, regional location, and the shares of elderly, cancer, and orthopedic or neurosurgical expenditure.

Results&Discussion Bed count, physician and the elderly patient share were positively associated with covered benefit payments. High-cost medical equipment was consistently associated with higher non-covered expenditure and a higher non-covered service ratio, while its effect on covered payments was negative. Hospital density was positively associated with the non-covered service ratio before 2017 but attenuated thereafter. Cancer and orthopedic or neurosurgical expenditure shares were consistently associated with higher non-covered service ratios.

Conclusions These findings suggest that the determinants of covered and non-covered expenditure growth operate through structurally distinct mechanisms at the facility level: personnel and bed capacity function primarily as inputs to covered therapeutic care, whereas investment in high-cost equipment and concentration in specific clinical departments drive non-covered service expansion. These results offer facility-level empirical guidance for differentiating policy targets — managing staffing and capacity to contain covered expenditure growth, while focusing equipment regulation and departmental oversight on non-covered service expansion in Korea.

Keyword *National Health Insurance, General-Purpose Hospital, Small-to-Medium-Sized Hospital, Non-covered medical expenditure, Repeated Cross-sectional Regression Analysis, Facility-Level Resource Structure, the Survey on the Benefit Coverage Rate of National Health Insurance*

1. Introduction

South Korea's National Health Insurance (NHI) system operates under a distinctive dual pricing structure in which covered services are reimbursed according to government-regulated fee schedules, while non-covered services remain subject to market-determined pricing with no regulatory ceiling [1]. This structural duality creates a distinctive set of incentives for healthcare providers: as fee regulation constrains revenue from covered services, providers may tend to increase the provision of non-covered services in response to revenue constraints [1, 2]. The non-covered sector has consequently become a significant component of provider revenue and a focal policy concern, amplifying worries about rising medical costs and the long-term fiscal sustainability of both public and private health insurance systems [2, 3]. The proportion of out-of-pocket (OOP) payments - including both statutory copayments and full charges for non-covered services - stood at approximately 32.2% of total health expenditure in 2018, far exceeding the levels observed in Japan (13.0%), Germany (12.6%), and France (10.2%) [2].

The expansion of non-benefit service market has been fueled by the rapid growth of supplementary private health insurance (PHI), with household enrollment exceeding 78% by 2020 [4, 5]. The dominant form is indemnity insurance, which reimburses OOP expenses including non-covered service costs, thereby reducing the marginal cost perceived by patients and weakening their incentive to decline provider recommendations for non-covered care [2, 6]. This creates a mutually reinforcing dynamic: from the provider perspective, non-covered services offer higher unit prices and profit margins than covered care; from the patient perspective, indemnity coverage renders the additional cost negligible [6, 7]. It is reported that individuals with indemnity insurance spent 36% more on OOP expenditure [7]. Simultaneously, hospital-level supply factors drive expenditures through the medical arms race, whereby hospitals compete by expanding high-tech equipment rather than reducing prices [8]. Liu et al. [8] found that government regulations may consequently accelerate the medical arms race among public hospitals, as strict price controls on medical services leave equipment and examination fees among the few remaining sources of extra income. In the Korean context, Seo et al. [9] similarly observed that as benefit expansion reduced revenue from covered services, hospitals — particularly smaller ones facing excess bed supply relative to demand — responded by investing in high-cost

medical equipment and expanding non-covered service provision to offset the revenue loss.

The non-covered service ratio has increased especially among hospitals and clinics. The Korean government has implemented successive rounds of benefit expansion policies since 2010s, which aimed to incorporate non-covered items into the NHI benefits package [3]. However, these policies primarily expanded coverage for services concentrated in tertiary and secondary hospitals - such as treatments for severe diseases, advanced hospital room fees, ultrasonography and MRI - while failing to control the creation of new non-covered services at smaller facilities [3, 9]. The non-covered sector in Korea encompasses a broad spectrum of services — including dental prosthetics, vision correction surgery, manual therapy, and treatments based on emerging health technologies — that fall mostly outside NHI fee regulation [2]. The predominantly private ownership structure of Korean hospitals (approximately 90%) [1] creates structural incentives for providers to expand non-covered service provision as a revenue supplement, and the non-covered share of total healthcare expenditure has shown a sustained upward trend in the context of these incentives [9]. After benefit expansion, the ratio of non-covered costs increased over time in hospitals with fewer than 300 beds while declining in larger institutions, indicating that the revenue loss from coverage conversion was offset by expanded non-covered service provision at smaller facilities [9]. This finding underscores the critical importance of examining non-covered expenditure patterns specifically at hospitals, which occupy a unique position between the heavily regulated tertiary sector and the clinic-level primary care market. Understanding how hospital-level resource structures influence the balance between these two revenue streams is therefore critical for designing effective benefit coverage and provider payment policies.

The provider behavior observed in this dual pricing structure can be analyzed in the context of supplier-induced demand (SID). Arrow [10] first articulated that information asymmetry between physicians and patients creates conditions for providers to influence demand beyond clinically warranted levels, and subsequent theoretical work formalized SID as physicians' capacity to shift patient demand curves under fee-for-service (FFS) payment systems [11, 12]. Empirical identification of SID has been pursued through examining physician density–utilization associations [13–15], exploiting nat-

ural experiments in remuneration systems [16], and qualitative assessment of institutional factors [17]. In the Korean context, Shin et al. [18] demonstrated the existence of SID in the Medical Aid program across multiple facility types, finding that hospital-level supplier-induced demand accounted for the largest share of utilization increases.

Previous studies on healthcare expenditure in Korea have primarily examined either aggregate physician supply effects on utilization, demand-side effects of private health insurance [4–7], or the aggregate impact of benefit expansion policies [3, 9]. However, few studies have examined NHI-covered and non-covered expenditures separately at the hospital level, and the facility-level structural determinants of this spending composition—including resource endowments such as the number of beds, physicians, and high-tech medical equipment—remain poorly understood for small-to-medium-sized hospitals. Therefore, the purpose of this study is to examine the factors affecting NHI benefit payments and non-covered expenditure ratios at hospitals in Korea, with particular attention to facility-level resource structures. By modeling each component of hospital revenue separately, this study aims to provide empirical evidence on how supply-side characteristics are systematically associated with NHI-covered and non-covered expenditures, thereby contributing to the policy discourse on benefit coverage design, provider payment reform, and the regulation of non-covered medical services in Korea.

2. Materials and Methods

2.1. Data

The analysis utilized data from the 'Survey on the Benefit Coverage Rate of National Health Insurance' [19]. This survey is conducted annually on sample medical institutions to collect medical expense data for health insurance patients, including the amounts reimbursed by the NHIS to the facility for insured services(hereafter, NHI-benefit), the statutory copayment(hereafter, OOP1), and non-benefit medical expenses fully borne by the patient(hereafter, OOP2). The survey collects medical cost data from patient receipts issued in June and December of each survey year. Information

regarding institutions' equipment, personnel, and number of beds was obtained from the National Health Insurance Service database and the Health Insurance Review and Assessment Service open data portal [20].

Medical institutions can be broadly classified into tertiary hospitals, secondary hospitals, hospitals, and clinics. The 'hospital' category includes long-term care hospitals, mental hospitals, dental hospitals, and traditional Korean medicine hospitals depending on the medical subjects and purpose, in addition to general-purpose hospitals. This analysis included only general-purpose hospitals, defined under Korean law as licensed medical facilities with 30 or more beds that do not meet the criteria for secondary hospitals (100 or more beds). Mental hospitals were newly established as a separate category in 2021, but prior to that, they were included within long-term care hospitals or general-purpose hospitals. When the proportion of psychiatric care is high, these institutions show distinct characteristics from other hospitals, such as higher proportion of benefit treatments, and fewer medical personnel and equipment. To control for changes resulting from the separation of mental hospitals and to examine the characteristics of 'hospitals' under current standards, institutions among existing hospitals that had a history of changing their type to mental hospitals after 2021 were excluded from the analysis for all study years to ensure consistent facility classification throughout the 2015–2024 study period.

Additionally, cases with no annual benefit medical expenses were excluded, and institutions that did not meet the hospital licensing standard of having at least 30 beds, or where the number of physicians or nurses was missing or zero, were also excluded from the analysis. High-cost medical equipment includes C-Arm type X-ray devices, computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), and robot surgical devices. The analysis period was limited to the recent 10 years from 2015 to 2024, and to control for the increase in medical expenses due to inflation, all medical expenses were adjusted to a 2020 baseline using the annual consumer price index and converted to USD using the 2020 exchange rate(1 USD = 1,180.01 KRW).

Table 1: Descriptive Statistics

	Year									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
	N (%)									
Total	214	205	209	234	246	256	258	281	291	322
	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)
Region										
Seoul	26	31	33	30	32	35	37	40	32	41
(Capital City)	(12.1%)	(15.1%)	(15.8%)	(12.8%)	(13.0%)	(13.7%)	(14.3%)	(14.2%)	(11.0%)	(12.7%)
Metropolitan	63	70	77	74	86	82	90	104	107	120
	(29.4%)	(34.1%)	(36.8%)	(31.6%)	(35.0%)	(32.0%)	(34.9%)	(37.0%)	(36.8%)	(37.3%)
etc.	125	104	99	130	128	139	131	137	152	161
	(58.4%)	(50.7%)	(47.4%)	(55.6%)	(52.0%)	(54.3%)	(50.8%)	(48.8%)	(52.2%)	(50.0%)
Ownership										
Public or Corpor	74	59	67	68	77	75	74	75	82	88
	(34.6%)	(28.8%)	(32.1%)	(29.5%)	(31.3%)	(29.3%)	(28.7%)	(26.7%)	(28.2%)	(27.3%)
Private	140	146	142	165	169	181	184	206	209	234
	(65.4%)	(71.2%)	(67.9%)	(70.5%)	(68.7%)	(70.7%)	(71.3%)	(73.3%)	(71.8%)	(72.7%)
	Mean (SD)									
Expense(1,000USD)										
NHI-benefit	478	699	795	864	885	919	1046	903	1,011	1,087
	(494.7)	(587.7)	(705.0)	(697.7)	(739.4)	(735.2)	(960.6)	(716.9)	(823.8)	(901.4)
OOP1	182	283	301	325	324	337	367	338	357	375
	(194.1)	(255.3)	(285.9)	(296.0)	(302.3)	(274.7)	(319.4)	(284.3)	(301.2)	(329.1)
OOP2	306	450	549	560	488	533	531	486	546	580
	(462.8)	(488.7)	(681.1)	(636.0)	(574.6)	(641.7)	(661.5)	(577.9)	(647.1)	(797.8)
OOP2 Rate(%)	24.8	27.1	28.7	27.1	25.3	26.0	26.3	26.5	27.5	26.4
	(20.2)	(17.9)	(19.2)	(18.3)	(16.6)	(17.1)	(16.9)	(16.6)	(17.8)	(18.0)
Density	0.39	0.38	0.38	0.38	0.4	0.4	0.37	0.37	0.39	0.38
	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)
Bed	99.4	106.2	111.7	109.9	106.6	107.3	110.8	103.9	108.7	110.1
	(72.1)	(65.2)	(69.1)	(64.7)	(66.1)	(67.5)	(66.6)	(63.8)	(68.2)	(65.9)
Equipment	1.5	1.9	2.2	2.0	2.2	2.5	2.6	2.5	2.6	2.5
	(1.5)	(2.0)	(2.3)	(2.1)	(2.4)	(2.4)	(2.4)	(2.3)	(2.5)	(2.6)
Physician	7.2	10	10.2	10.3	10.1	10.4	10.3	9.7	9.9	10.3
	(6.1)	(7.9)	(8.1)	(8.1)	(7.9)	(7.1)	(8.0)	(7.8)	(8.4)	(8.9)
Nurse	20.3	30.2	34.3	34	36.8	38	38.7	35.6	42.6	44.3
	(23.4)	(28.8)	(32.3)	(29.6)	(34.1)	(33.8)	(33.1)	(32.2)	(34.9)	(35.3)
Eldearly(%)	25.5	26.8	31.1	30.3	31.4	32	35.8	34.8	38.3	39.5
	(19.3)	(19.4)	(20.3)	(20.5)	(22.2)	(21.6)	(22.6)	(22.5)	(24.4)	(24.8)
Cancer(%)	3.4	2.2	2.1	2.4	2.8	1.9	2.2	3.9	4.4	3.5
	(13.5)	(10.4)	(9.5)	(10.8)	(12.0)	(7.2)	(6.6)	(14.3)	(15.5)	(12.9)
Ortho/Neuro(%)	31.8	34.8	36.5	34.0	29.7	34.8	35.7	33.4	32.5	31.5
	(38.7)	(38.2)	(40.4)	(39.2)	(38.3)	(40.0)	(40.2)	(39.1)	(39.5)	(39.1)

NHIS-benefit: the amounts reimbursed by the NHIS; *OOP1*: statutory co-payment; *OOP2*: non-benefit medical expenses; *Density*: number of hospitals per 10,000 population in the same district(Si/Gun/Gu); *Bed*: number of beds; *Equipment*: number of high-cost medical equipment (e.g., MRI, CT, PET, C-Arm, robot surgical devices); *Physician* and *Nurse*: number of physicians and nurses, respectively; *Elderly*, *Cancer*, and *Ortho/Neuro*: share of medical expenditure attributed to elderly patients, cancer, and orthopedic & neurosurgery departments, respectively(%).

2.2. Statistical Methodology

Since the institutions included in the survey change across years, the data are not suitable for panel data analysis. Therefore, repeated cross-sectional regression analysis was performed with separate models for each dependent variable—NHI-benefit payments, OOP1, OOP2, and the OOP2 rate—to examine their respective facility-level determinants, and the year-specific coefficient estimates were plotted to illustrate how facility-level associations varied across the study period. Cross-year coefficient magnitudes should be interpreted cautiously because each year represents an independent sample.

$$\begin{aligned} Outcome_i &= \beta_0 + \beta_1 Seoul_i + \beta_2 Metro_i + \beta_3 Private_i + \beta_4 Density_i \\ &\quad + \beta_5 Bed_i + \beta_6 Equipment_i + \beta_7 Physician_i + \beta_8 Nurse_i \\ &\quad + \beta_9 Elderly_i + \beta_{10} Cancer_i + \beta_{11} Ortho/Neuro_i + e_i \end{aligned}$$

The dependent variables were the NHI-benefit, OOP1, OOP2 in 1,000 USD, and the OOP2 rate (%), defined as OOP2 / (NHI-benefit + OOP1 + OOP2) $\times$ 100. Unlike the absolute expenditure variables, which scale with institutional size, the OOP2 rate reflects the compositional balance between covered and non-covered revenue streams within a given facility. Accordingly, a facility-level characteristic may show divergent associations with absolute OOP2 and the OOP2 rate when its marginal effect on covered expenditure differs substantially from its effect on non-covered expenditure—a pattern examined in the results.

The independent variables considered factors that could affect benefit or non-benefit medical expenses, which included the number of beds (*Bed*), physicians (*Physician*), nurses (*Nurse*) and high-cost medical equipment units(*Equipment*). The proportion of medical expenses for those aged 65 or older (*Elderly*), cancer (*Cancer*) and orthopedics or neurosurgery (*Ortho/Neuro*), a regional dummy variable with three categories (Seoul, Metropolitan cities, and others), and ownership type (*Private*; 1 = privately owned, 0 = public or corporate ownership) were considered. The number of general-purpose hospitals per 10,000 population in the district (*Density*) where the institution is located to examine the competition level is also incorporated. Elderly patients (aged 65 or older) tend to have lower enrollment rates in private indemnity insurance due to age-based underwriting restrictions, which is expected to be associated with lower utilization of non-covered ser-

vices [4]. The rate of cancer patients was included because non-benefit expenses for cancer diseases have recently been increasing significantly, centered on general-purpose hospitals, and orthopedics and neurosurgery were included in the model because they not only show a high proportion of medical expenses among hospitals but also consistently show high levels of non-covered expenditure, driven by items such as manual therapy, cervical spine MRI, and other procedure-based non-covered services.

Table 1 shows the descriptive statistics on the analysis data. As the sample size of the Survey generally increased every year, the number of institutions subject to analysis also increased from 214 in 2015 to 322 in 2024. Prior to regression estimation, multicollinearity among independent variables was assessed using variance inflation factors (VIF). VIF values for all predictors ranged from 0 to 4, well below the threshold of 10, indicating no evidence of multicollinearity in any of the year-specific models.

3. Analysis Results

3.1. Impact on NHI Benefit Expenditure

Regarding the NHI-benefit, *Bed, Physician, Nurse* and *Elderly* showed a significantly positive effect across most periods. As of 2024, the estimated coefficients of *Bed, Physician, Nurse* and *Elderly* are 1.1 (1,100 USD), 48.9 (48,900 USD), 12.4 (12,400 USD) and 1.7 (1,700 USD) respectively. *Physician* and *Nurse* tend to increase over time, suggesting that the marginal effect of staffing on NHI-benefit payments has grown over time. The *Elderly* coefficient also showed a consistently positive effect throughout the study period. The pronounced increase in the *Elderly* coefficient in 2021 may be attributable to the COVID-19 pandemic, during which NHI-covered utilization among elderly patients increased while discretionary non-covered services tended to decline. Conversely, the coefficient for *Equipment* was mostly not significant, recently tending to show significant negative effect. This negative association may reflect that hospitals with more high-cost equipment tend to generate revenue through non-covered services rather than NHI-covered

treatments. Additionally, the *Ortho/Neuro* coefficient showed a tendency toward negative association with NHI-benefit payments in recent years.

Results for OOP1 (statutory copayment) broadly mirrored those for NHI-benefit payments, consistent with its status as a cost-sharing component within the covered benefit framework (see Table A2 in the Appendix). One notable exception was *Equipment*, which showed a consistently positive and statistically significant association with OOP1 across most study years—in contrast to its negative (though mostly non-significant) effect on NHI-benefit payments. This divergence suggests that high-cost medical equipment is associated with utilization of services within the covered benefit framework but with higher patient cost-sharing—such as selective benefit items—rather than fully NHI-reimbursed treatments, thereby increasing OOP1 while reducing NHI-benefit payments.

3.2. Impact on OOP2 Expenditure

For OOP2, a trend contrasting with NHI-benefit expenses was discovered. As shown in Figure 1 to 3, the estimated coefficients for *Bed, Physician*, and *Elderly* were consistently larger for NHI-benefit than for OOP2, whereas those for *Seoul, Equipment*, and *Cancer* were larger for OOP2. While there was no distinct regional difference for NHI-benefit, for OOP2, *Seoul* was significant after 2021 and showed larger OOP2 than *Metro*. *Bed* was positively associated with NHI-benefit but negatively associated with the OOP2, suggesting opposing dynamics across the two expenditure outcomes. For both *Physician* and *Nurse* staffing variables, the estimated effects on the OOP2 were smaller in magnitude than those on NHI benefit payments. However, the difference between the two outcomes was negligible for *Nurse*, whereas *Physician* exhibited a pronounced divergence between its effects on NHI-benefit and OOP2. Moreover, the effect of *Physician* on the OOP2 showed a declining trend over the study period, in contrast to *Nurse*, whose effect on the OOP2 increased over time - a pattern suggestive of contrasting trajectories across the two workforce variables.

Equipment had a significant positive effect throughout the entire analysis period, and the trend was generally increasing. By contrast, the effect

of *Equipment* on NHI-benefit was consistently negative, though it failed to reach statistical significance in most periods examined. Both *Bed* and *Elderly* were negatively associated with the OOP2, indicating that larger bed capacity and a higher proportion of elderly patients were associated with lower non-covered expenditure. The *Cancer* and *Ortho/Neuro* variables showed mostly non-significant associations with OOP2, with the exception of *Ortho/Neuro* in 2018.

3.3. Impact on OOP2 Rate

The non-covered ratio (OOP2 rate), which is the proportion of OOP2 in the total medical expenses of a medical institution, has a different meaning from the scale of NHI-benefit and OOP2 amounts. Unlike the absolute amounts of NHI-benefit and OOP2, which scale with institutional size, the OOP2 rate captures the relative reliance on non-covered services and thus reflects the composition of care rather than its volume.

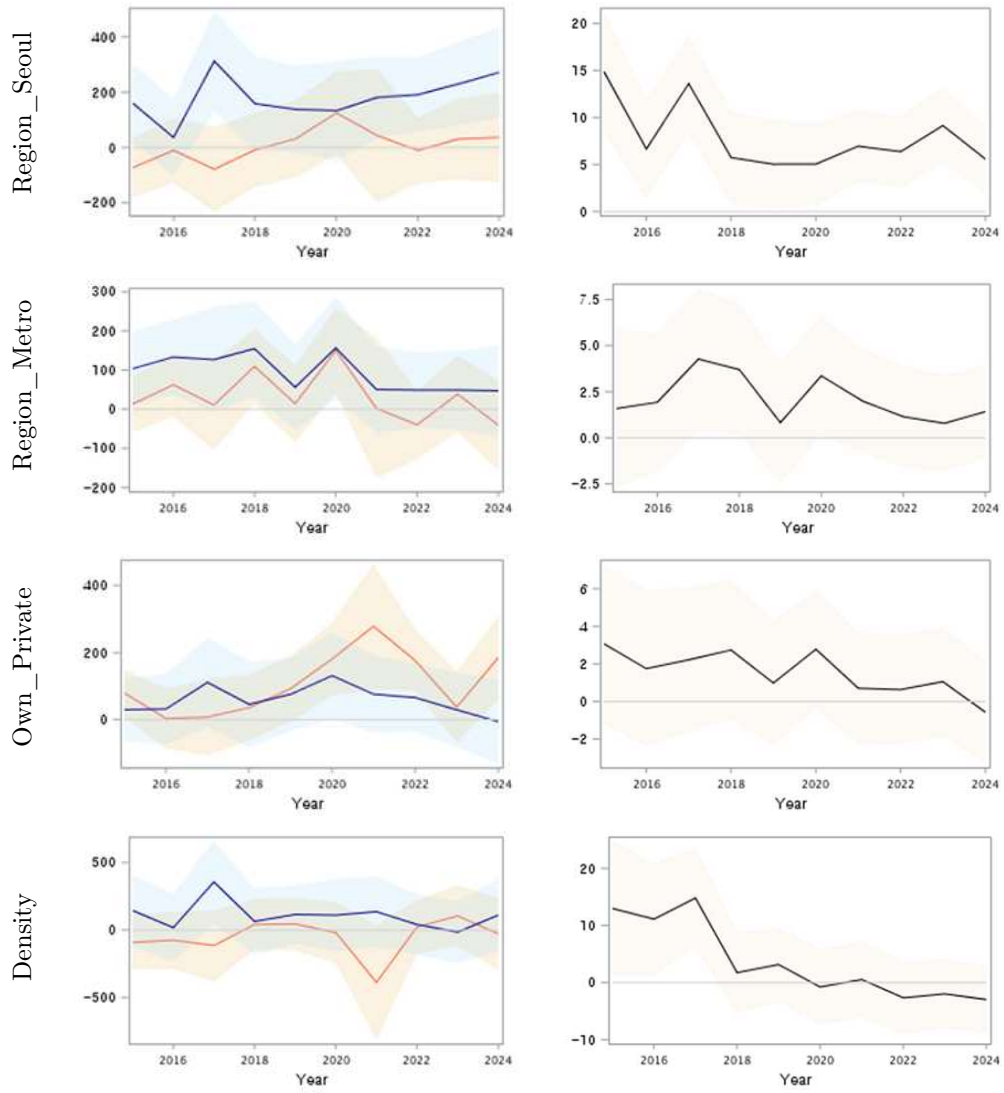
The OOP2 rate in *Seoul* was significantly higher than in other regions, and *Metro* also showed a positive effect, though the effect was smaller than that of *Seoul*. *Density* exhibited a pronounced positive effect on the OOP2 rate prior to 2017, but was no longer significant and reversed in sign in more recent years. *Equipment* and *Cancer* were each found to be significantly associated with higher OOP2 rates. *Ortho/Neuro* similarly showed a consistently positive and significant association with the OOP2 rate throughout the study period. The Survey on the Benefit Coverage Rate of National Health Insurance reported that the OOP2 rate for orthopedics and neurosurgery departments stood at 41.5% and 55.6%, respectively [19], and the 2024 Non-Covered Service Reporting System identified manual therapy, cervical spine MRI, soft tissue reconstruction materials, and neuroplasty among the top five non-covered items at general-purpose hospitals [21]. These publicly reported statistics confirm that non-covered service utilization is disproportionately concentrated in orthopedic and neurosurgical departments, consistent with the present findings.

On the other hand, *Bed* and *Elderly* had the negative impact on the OOP2 rate. The negative association between *Bed* and the OOP2 rate was

consistent across all study years, suggesting that larger facilities tend to generate a higher proportion of covered service revenue relative to non-covered services. *Physician* showed a significant negative effect on the OOP2 rate after 2021, consistent with the declining effect of *Physician* on OOP2 expenditure observed in Section 3.2, suggesting that the marginal contribution of physician staffing to non-covered service provision has diminished over time. Regarding the number of nurses, unlike the non-benefit medical expense results, their coefficients for the OOP2 rate were mostly non-significant.

Figure 1: Year-specific coefficient Estimates with 95% CI by Dependent Variable

(a) NHI Benefit & OOP2 (1 thousand USD) (b) OOP2 Rate(%)

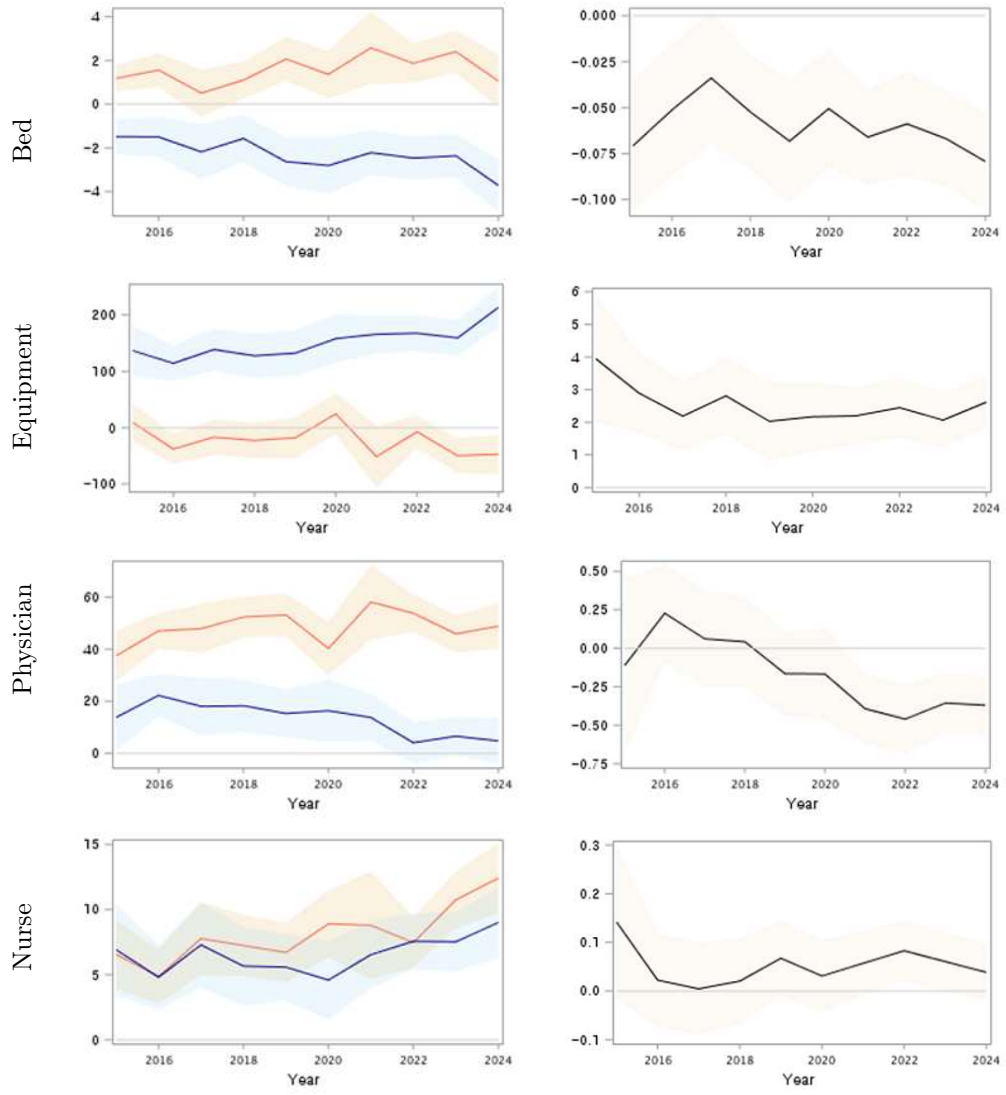


Note: Panel (a) displays year-specific regression coefficients for NHI-Benefit Payment(orange) and Non-Covered Expenditure(OOP2, dark blue). Panel (b) displays coefficients for the OOP2 Rate. Shaded areas indicate 95% confidence intervals.

Figure 2: Year-specific coefficient Estimates with 95% CI by Dependent Variable

(a) NHI Benefit & OOP2 (1 thousand USD)

(b) OOP2 Rate(%)

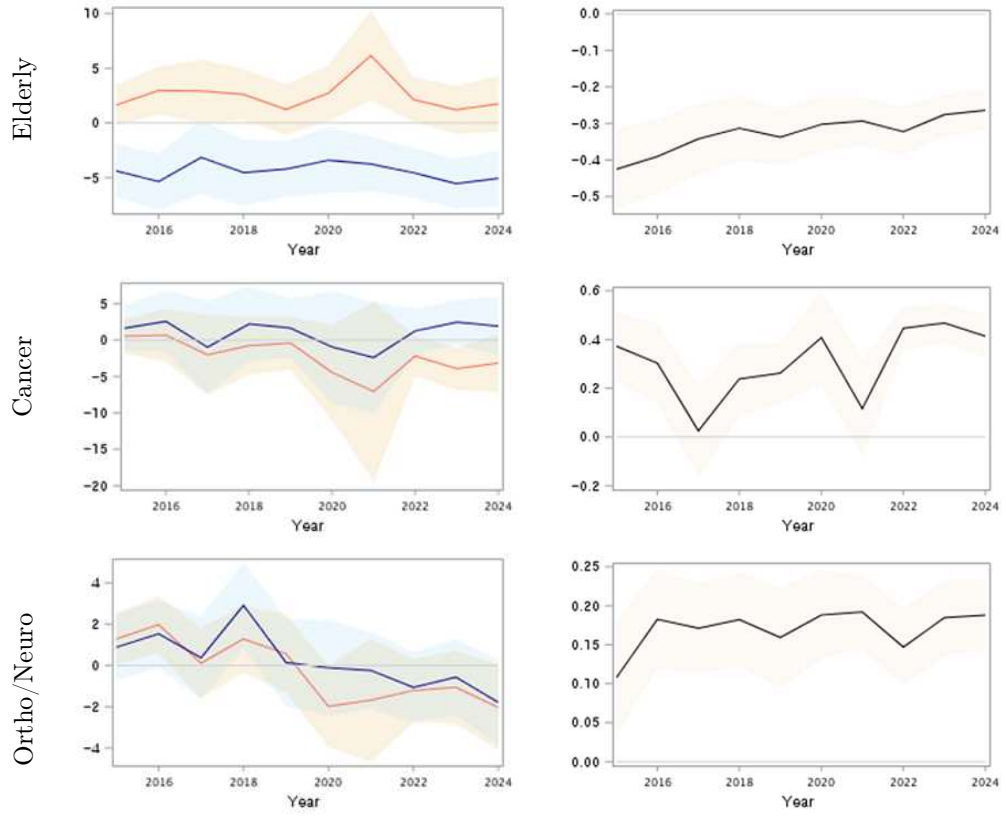


Note: Panel (a) displays year-specific regression coefficients for NHI-Benefit Payment(orange) and Non-Covered Expenditure(OOP2, dark blue). Panel (b) displays coefficients for the OOP2 Rate. Shaded areas indicate 95% confidence intervals.

Figure 3: Year-specific coefficient Estimates with 95% CI by Dependent Variable

(a) NHI Benefit & OOP2 (1 thousand USD)

(b) OOP2 Rate(%)



Note: Panel (a) displays year-specific regression coefficients for NHI-Benefit Payment(orange) and Non-Covered Expenditure(OOP2, dark blue). Panel (b) displays coefficients for the OOP2 Rate. Shaded areas indicate 95% confidence intervals.

4. Discussion

The results of this study show that facility-level characteristics are differentially associated with covered and non-covered expenditure growth at Korean general-purpose hospitals. This finding suggests that the two revenue streams are shaped by distinct supply-side dynamics rather than a single common driver of institutional scale.

With respect to covered expenditure, physician staffing, nurse staffing, and bed count were positively associated with NHI benefit payments throughout the study period. This aligns with the role of workforce and capacity as resource inputs for covered therapeutic care under a fee-for-service reimbursement framework [11, 12]. Notably, the associations for both physician and nurse staffing strengthened over the study period, suggesting that the marginal link between staffing and covered expenditure has grown over time. However, when considered in relation to non-covered expenditure, the two workforce variables showed divergent trajectories: the association between physician staffing and non-covered expenditure declined over the study period, whereas the corresponding association for nurse staffing increased. This divergence suggests that physician and nurse staffing may relate to non-covered service provision through different pathways, although the specific mechanisms underlying this contrast cannot be determined from the present data and warrant further research.

With respect to non-covered expenditure and the non-covered service ratio, two supply-side factors emerge as primary drivers. First, high-cost medical equipment showed a robust and strengthening association with non-covered expenditure throughout the study period, while its association with NHI benefit payments was negative in several years, particularly in more recent ones. Second, clinical department composition was systematically linked to a higher non-covered service ratio: cancer and orthopedic or neurosurgical expenditure shares were each positively associated with the OOP2 rate across most study years. It should be noted, however, that these department composition variables showed no significant association with the absolute level of non-covered expenditure, indicating that their influence operates through the relative composition of care rather than through the volume of non-covered services per se. Both equipment investment and department composition are associated with services that fall outside the NHI benefit package and, in the

context of fee-regulated covered care, may function as alternative revenue sources for general-purpose hospitals.

These patterns extend and are supported by the existing literature. Liu et al. [8] found that strict price controls on covered services left equipment and examination fees among the few remaining sources of discretionary revenue for public hospitals in China, driving increases in total medical expenditure. A broadly similar pattern is observed in the present study, in line with the expectation that equipment investment represents an alternative revenue source when covered service revenue is constrained by fee regulation. The cancer-related finding is particularly noteworthy in light of recent policy trends: while the NHI coverage rate for cancer care increased at tertiary and secondary hospitals between 2015 and 2024, it fell from 65.7% to 52.0% at general-purpose hospitals [19]. This divergence aligns with Ji et al. [3]'s finding that benefit expansion policies reduced non-covered expenditure in policy-targeted settings but failed to control the emergence of new non-covered services at other facility types. One possible interpretation is that general-purpose hospitals serve cancer patients who have received primary treatment at higher-tier facilities and subsequently seek adjunctive care—such as post-operative injections and supportive therapies—that falls outside the NHI benefit package. Taken together, these findings accord with Seo et al. [9]'s observation that non-covered service ratios diverged by hospital size following benefit expansion, with smaller facilities showing sustained increases while larger ones showed declines.

The declining association between physician staffing and non-covered expenditure over the study period, culminating in a significant negative association with the OOP2 rate after 2021, presents an interpretively interesting pattern. The timing of this shift coincides with successive rounds of benefit expansion, and it parallels qualitative evidence identifying fee levels and the availability of non-covered alternatives as contextual determinants of provider behavior [17]. Whether this reflects a systematic change in provider revenue behavior or other facility-level dynamics represents an important question for future research.

Several limitations should be noted. First, the repeated cross-sectional design precludes causal inference. The associations reported here reflect facility-level correlations, and endogeneity—arising from reverse causality or

unobserved confounders such as local income levels, patient severity mix, and competitive dynamics—cannot be ruled out. Second, because the survey sample changes across years, direct comparisons of coefficient magnitudes should be interpreted with caution despite the consistent sampling methodology. Third, the findings are specific to Korean general-purpose hospitals and may not generalize to other facility types or health system contexts. Fourth, while this study identifies which facility-level characteristics are differentially associated with covered and non-covered expenditure, the specific pathways underlying these differential associations—such as the mediating roles of case-mix composition, service substitution, and provider incentive structures—remain unaddressed. Disentangling these pathways would require data linking facility-level resources to service-level utilization and patient-level outcomes, and represents an important direction for future research.

5. Conclusion

This study provides facility-level empirical evidence that covered and non-covered expenditure growth at Korean general-purpose hospitals are associated with distinct sets of supply-side characteristics. Personnel and bed capacity show stronger associations with NHI benefit payments, while investment in high-cost medical equipment and concentration in specific clinical departments—particularly orthopedics, neurosurgery, and cancer care—show stronger associations with non-covered service expansion. These findings extend earlier work by Seo et al. [9] and are consistent with broader international evidence on the medical arms race [8], providing direct facility-level estimates of the resource characteristics associated with the divergence in non-covered service ratios over a ten-year period.

The policy implications of these findings are twofold. For managing covered expenditure growth, staffing levels and bed capacity are the primary supply-side factors to consider. For containing non-covered service expansion, policy attention should focus on monitoring and regulating high-cost medical equipment investment—particularly in Seoul and metropolitan areas—and on reviewing reimbursement arrangements for orthopedic, neurosurgical, and cancer-related non-covered services at the general-purpose hospital tier. In this regard, the Korean government's recent establishment

of a "managed benefit" category—which incorporates previously non-covered but overutilized items including manual therapy, neuroplasty, and radiofrequency thermal therapy into a regulated pricing framework—represents a policy step in a direction consistent with the supply-side patterns identified in this study. Future research evaluating the effects of this intervention on facility-level resource utilization and expenditure composition before and after its implementation would provide valuable evidence for refining benefit coverage design and provider payment reform in Korea.

List of Abbreviations

CI	Confidence Interval
CT	Computed Tomography
FFS	Fee-for-service
HIRA	Health Insurance Review and Assessment Service
MRI	Magnetic Resonance Imaging
NHI	National Health Insurance
NHIS	National Health Insurance Service
OLS	Ordinary Least Squares
OOP	Out-of-pocket
OOP1	Statutory copayment
OOP2	Non-covered medical expenses fully borne by the patient
PET	Positron Emission Tomography
SD	Standard Deviation
SID	Supplier-induced demand
USD	United States dollar
VIF	Variance Inflation Factor

Declarations

Ethics / Approval and consent to participate This study utilized secondary data from the Survey on the Benefit Coverage Rate of National Health Insurance, which contains de-identified facility-level data and aggregated facility-level information with no individually identifiable data. Accordingly, institutional review board approval was not required.

Consent for publication Not applicable.

Competing interests R.M., Y.L., and N.S. are employed by the National Health Insurance Service, which produces the data used in this study. The authors declare that this affiliation did not influence the study design, data collection, analysis, interpretation, or reporting of findings.

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Authors' contributions R.M. conceptualized the study, conducted the statistical analysis, interpreted results and drafted the manuscript. Y.L. contributed to data curation and construction of the analytical dataset. N.S. contributed to critical revision of the manuscript. All authors read and approved the final manuscript.

Data availability The data used in this study are not publicly available due to data governance restrictions of the National Health Insurance Service of Korea. The survey data are collected and held by the National Health Insurance Service and are accessible only through internal institutional procedures. Summary statistics on non-covered service ratios and expenditure amounts are publicly accessible through annual reports and press releases published by the National Health Insurance Service of Korea (https://www.nhis.or.kr). Further information on data access conditions may be obtained from the corresponding author upon reasonable request.

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Appendix

Table A1: Year-Specific Coefficients from Repeated Cross-Sectional Regression: NHI Benefit Payment

	Year									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Intercept	-150.0	-156.0	-24.6	-194.0	-226.0	-243.0	-255.0	-210.0	-110.0	-68.6
	(0.008)	(0.030)	(0.796)	(0.013)	(0.007)	(0.01)	(0.123)	(0.01)	(0.221)	(0.500)
Seoul	-73.0	-10.4	-78.3	-8.56	31.8	124.8	43.34	-10.6	30.9	36.5
	(0.180)	(0.859)	(0.314)	(0.899)	(0.654)	(0.104)	(0.722)	(0.862)	(0.678)	(0.657)
Metro	13.1	62.4	10.7	109.2	14.2	150.0	2.2	-39.9	38.8	-41.0
	(0.720)	(0.132)	(0.855)	(0.024)	(0.777)	(0.008)	(0.981)	(0.366)	(0.432)	(0.485)
Private	79.5	3.4	7.6	35.8	92.4	181.4	278.4	176.5	37.6	184.9
	(0.029)	(0.940)	(0.896)	(0.475)	(0.065)	(0.001)	(0.004)	(<.001)	(0.488)	(0.004)
Density	-91.4	-75.3	-115.0	41.9	45.4	-18.1	-387.0	23.3	105.1	-28.3
	(0.366)	(0.486)	(0.389)	(0.663)	(0.645)	(0.875)	(0.073)	(0.818)	(0.357)	(0.834)
Bed	1.2	1.6	0.5	1.1	2.1	1.4	2.6	1.9	2.4	1.1
	(<.001)	(<.001)	(0.352)	(0.010)	(<.001)	(0.014)	(0.002)	(<.001)	(<.001)	(0.080)
Equipment	9.5	-37.6	-16.6	-22.4	-18.0	24.7	-51.0	-7.2	-49.6	-47.0
	(0.574)	(0.006)	(0.301)	(0.156)	(0.324)	(0.179)	(0.068)	(0.623)	(0.002)	(0.009)
Physician	37.5	47.0	47.9	52.4	53.2	40.3	58.1	53.8	45.9	48.9
	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)
Nurse	6.6	4.9	7.8	7.2	6.7	8.9	8.8	7.5	10.8	12.4
	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)
Elderly	1.6	3.0	3.0	2.6	1.2	2.7	6.2	2.1	1.2	1.7
	(0.081)	(0.008)	(0.047)	(0.030)	(0.286)	(0.036)	(0.003)	(0.039)	(0.275)	(0.179)
Cancer	0.5	0.7	-2.0	-0.8	-0.4	-4.5	-7.1	-2.2	-3.9	-3.2
	(0.660)	(0.712)	(0.468)	(0.703)	(0.823)	(0.180)	(0.262)	(0.118)	(0.009)	(0.121)
Ortho/Neuro	1.3	2.0	0.1	1.3	0.6	-2.0	-1.7	-1.2	-1.1	-2.0
	(0.040)	(0.005)	(0.901)	(0.120)	(0.552)	(0.046)	(0.269)	(0.121)	(0.242)	(0.053)
N	214	205	209	234	246	256	258	281	291	322
F-statistic	71.2	79.1	54.9	86.8	83.7	67.0	33.0	104.8	103.5	85.9
	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)
R^2	0.784	0.808	0.740	0.802	0.788	0.740	0.578	0.803	0.796	0.744

Note: ( ): p-value; The reference group for *Seoul* and *Metro* is other regions; The reference group for *Private* is public or corporate ownership; *Density*: number of hospitals per 10,000 population in the same district(Si/Gun/Gu); *Bed*: number of beds; *Equipment*: number of high-cost medical equipment (e.g., MRI, CT, PET, C-Arm, robot surgical devices); *Physician* and *Nurse*: number of physicians and nurses, respectively; *Elderly*, *Cancer*, and *Ortho/Neuro*: share of medical expenditure attributed to elderly patients, cancer, and orthopedic & neurosurgery departments, respectively(%).

Table A2: Year-Specific Coefficients from Repeated Cross-Sectional Regression: OOP1

	Year									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Intercept	-54.7	-59.1	-83.6	-93.9	-117.0	-109.0	-67.4	-56.7	-12.6	-21.5
	(0.023)	(0.129)	(0.049)	(0.018)	(0.001)	(<.001)	(0.093)	(0.061)	(0.684)	(0.534)
Seoul	-43.4	37.1	35.6	61.4	52.0	49.9	33.9	6.8	23.8	45.9
	(0.063)	(0.246)	(0.303)	(0.073)	(0.090)	(0.056)	(0.252)	(0.763)	(0.356)	(0.102)
Metro	-1.9	27.7	3.9	17.4	5.1	42.7	-0.5	-1.2	6.0	-2.5
	(0.902)	(0.217)	(0.881)	(0.473)	(0.814)	(0.025)	(0.983)	(0.944)	(0.728)	(0.900)
Private	32.8	8.3	21.4	7.4	31.5	28.2	40.6	31.2	-18.2	19.5
	(0.035)	(0.738)	(0.409)	(0.771)	(0.145)	(0.132)	(0.079)	(0.071)	(0.331)	(0.366)
Density	-60.2	-71.3	-52.5	-19.1	-21.9	31.3	-41.8	69.7	76.9	57.4
	(0.164)	(0.225)	(0.376)	(0.694)	(0.606)	(0.424)	(0.423)	(0.065)	(0.052)	(0.213)
Bed	0.3	0.2	0.0	0.0	0.2	-0.1	-0.2	-0.5	-0.1	-0.3
	(0.021)	(0.486)	(0.966)	(0.879)	(0.397)	(0.789)	(0.386)	(0.001)	(0.746)	(0.101)
Equipment	14.2	13.0	7.4	14.2	24.4	25.4	7.9	26.7	13.1	13.8
	(0.050)	(0.076)	(0.302)	(0.076)	(0.002)	(<.001)	(0.242)	(<.001)	(0.016)	(0.023)
Physician	16.7	19.5	20.6	21.6	24.6	22.8	28.9	25.1	23.0	23.8
	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)
Nurse	1.6	1.8	2.2	2.3	1.2	1.9	2.1	2.3	2.6	2.7
	(0.006)	(0.002)	(<.001)	(<.001)	(0.021)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)
Elderly	0.6	1.1	1.8	1.4	1.3	0.8	1.1	0.6	-0.3	0.1
	(0.152)	(0.069)	(0.007)	(0.018)	(0.012)	(0.075)	(0.024)	(0.099)	(0.386)	(0.839)
Cancer	-0.4	-1.0	-1.7	-1.4	-0.6	-1.1	-2.3	-0.4	-1.0	-1.0
	(0.455)	(0.295)	(0.176)	(0.182)	(0.431)	(0.332)	(0.135)	(0.47)	(0.055)	(0.161)
Ortho/Neuro	0.9	0.9	0.9	1.0	0.5	0.1	0.0	-0.4	0.0	-0.3
	(0.001)	(0.021)	(0.027)	(0.016)	(0.240)	(0.877)	(0.999)	(0.222)	(0.888)	(0.479)
N	214	205	209	234	246	256	258	281	291	322
F-statistic	57.0	44.4	42.7	55.4	72.8	85.7	82.0	121.9	188.4	103.3
	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)
R^2	0.743	0.700	0.688	0.720	0.763	0.785	0.776	0.826	0.817	0.778

Note: ( ): p-value; The reference group for *Seoul* and *Metro* is other regions; The reference group for *Private* is public or corporate ownership; *Density*: number of hospitals per 10,000 population in the same district(Si/Gun/Gu); *Bed*: number of beds; *Equipment*: number of high-cost medical equipment (e.g., MRI, CT, PET, C-Arm, robot surgical devices); *Physician* and *Nurse*: number of physicians and nurses, respectively; *Elderly*, *Cancer*, and *Ortho/Neuro*: share of medical expenditure attributed to elderly patients, cancer, and orthopedic & neurosurgery departments, respectively(%).

Table A3: Year-Specific Coefficients from Repeated Cross-Sectional Regression: OOP2

	Year									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Intercept	-35.9	24.1	-169.0	-1.9	99.4	0.2	-48.5	95.2	157.3	158.7
	(0.626)	(0.775)	(0.13)	(0.985)	(0.283)	(0.999)	(0.633)	(0.291)	(0.09)	(0.120)
Seoul	159.8	36.6	312.7	158.4	138.2	132.8	181.0	191.3	230.0	271.6
	(0.026)	(0.597)	(<.001)	(0.068)	(0.081)	(0.143)	(0.017)	(0.005)	(0.003)	(0.001)
Metro	103.6	133.2	126.9	154.7	56.0	156.6	50.2	49.1	48.9	47.0
	(0.032)	(0.007)	(0.064)	(0.013)	(0.315)	(0.018)	(0.369)	(0.316)	(0.338)	(0.425)
Private	29.8	31.8	111.3	45.9	75.6	131.2	76.2	65.8	29.2	-6.0
	(0.533)	(0.553)	(0.102)	(0.475)	(0.175)	(0.044)	(0.194)	(0.201)	(0.602)	(0.925)
Density	145.1	18.3	356.8	64.5	115.7	111.1	136.0	41.3	-14.5	111.4
	(0.276)	(0.885)	(0.023)	(0.601)	(0.293)	(0.414)	(0.306)	(0.713)	(0.902)	(0.413)
Bed	-1.5	-1.5	-2.2	-1.6	-2.6	-2.8	-2.2	-2.5	-2.4	-3.7
	(<.001)	(0.001)	(<.001)	(0.004)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)
Equipment	136.7	114.3	138.8	127.8	132.4	158.2	165.9	167.7	159.4	213.3
	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)
Physician	13.8	22.3	18.1	18.3	15.3	16.4	13.8	4.1	6.6	4.8
	(0.03)	(<.001)	(0.001)	(<.001)	(0.001)	(0.008)	(0.002)	(0.310)	(0.077)	(0.284)
Nurse	6.9	4.8	7.3	5.7	5.6	4.6	6.5	7.6	7.5	9.0
	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(0.003)	(<.001)	(<.001)	(<.001)	(<.001)
Elderly	-4.4	-5.4	-3.2	-4.5	-4.2	-3.4	-3.8	-4.6	-5.6	-5.1
	(<.001)	(<.001)	(0.065)	(0.003)	(0.001)	(0.026)	(0.003)	(<.001)	(<.001)	(<.001)
Cancer	1.6	2.6	-1.0	2.2	1.6	-1.0	-2.4	1.3	2.5	1.9
	(0.299)	(0.231)	(0.763)	(0.395)	(0.427)	(0.809)	(0.537)	(0.416)	(0.112)	(0.348)
Ortho/Neuro	0.9	1.5	0.4	2.9	0.1	-0.1	-0.2	-1.1	-0.6	-1.8
	(0.281)	(0.064)	(0.711)	(0.006)	(0.893)	(0.923)	(0.798)	(0.219)	(0.542)	(0.090)
N	214	205	209	234	246	256	258	281	291	322
F-statistic	26.85	30.72	32.03	33.80	29.67	26.38	46.93	43.63	49.16	60.57
	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)
R^2	0.572	0.616	0.621	0.608	0.563	0.523	0.663	0.626	0.646	0.671

Note: ( ): p-value; The reference group for *Seoul* and *Metro* is other regions; The reference group for *Private* is public or corporate ownership; *Density*: number of hospitals per 10,000 population in the same district(Si/Gun/Gu); *Bed*: number of beds; *Equipment*: number of high-cost medical equipment (e.g., MRI, CT, PET, C-Arm, robot surgical devices); *Physician* and *Nurse*: number of physicians and nurses, respectively; *Elderly*, *Cancer*, and *Ortho/Neuro*: share of medical expenditure attributed to elderly patients, cancer, and orthopedic & neurosurgery departments, respectively(%).

Table A4: Year-Specific Coefficients from Repeated Cross-Sectional Regression: OOP2 Rate

	Year									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Intercept	20.7	20.3	20.4	24.3	29.4	25.4	30.8	31.8	31.5	34.0
	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)
Seoul	14.86	6.65	13.60	5.73	5.03	5.04	6.95	6.36	9.13	5.58
	(<.001)	(0.015)	(<.001)	(0.024)	(0.036)	(0.025)	(<.001)	(0.001)	(<.001)	(0.002)
Metro	1.59	1.93	4.27	3.70	0.82	3.36	2.00	1.14	0.79	1.42
	(0.466)	(0.312)	(0.031)	(0.040)	(0.624)	(0.040)	(0.164)	(0.417)	(0.557)	(0.270)
Private	3.07	1.75	2.22	2.74	0.98	2.78	0.71	0.63	1.05	-0.57
	(0.157)	(0.406)	(0.258)	(0.145)	(0.558)	(0.084)	(0.639)	(0.668)	(0.474)	(0.680)
Density	12.99	11.12	14.80	1.74	3.16	-0.77	0.54	-2.66	-1.97	-2.98
	(0.032)	(0.027)	(0.001)	(0.630)	(0.341)	(0.818)	(0.874)	(0.410)	(0.526)	(0.315)
Bed	-0.07	-0.05	-0.03	-0.05	-0.07	-0.05	-0.07	-0.06	-0.07	-0.08
	(<.001)	(0.005)	(0.066)	(0.001)	(<.001)	(0.002)	(<.001)	(<.001)	(<.001)	(<.001)
Equipment	3.95	2.89	2.19	2.81	2.03	2.17	2.20	2.45	2.07	2.62
	(<.001)	(<.001)	(<.001)	(<.001)	(0.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)
Physician	-0.11	0.23	0.06	0.04	-0.16	-0.17	-0.39	-0.46	-0.36	-0.37
	(0.697)	(0.156)	(0.700)	(0.774)	(0.239)	(0.269)	(<.001)	(<.001)	(<.001)	(<.001)
Nurse	0.14	0.02	0.00	0.02	0.07	0.03	0.06	0.08	0.06	0.04
	(0.080)	(0.647)	(0.926)	(0.649)	(0.087)	(0.416)	(0.086)	(0.009)	(0.048)	(0.200)
Elderly	-0.43	-0.39	-0.34	-0.31	-0.34	-0.30	-0.29	-0.32	-0.28	-0.26
	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)
Cancer	0.37	0.30	0.03	0.24	0.26	0.41	0.12	0.45	0.47	0.41
	(<.001)	(<.001)	(0.787)	(0.002)	(<.001)	(<.001)	(0.241)	(<.001)	(<.001)	(<.001)
Ortho/Neuro	0.11	0.18	0.17	0.18	0.16	0.19	0.19	0.15	0.18	0.19
	(0.004)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)
N	214	205	209	234	246	256	258	281	291	322
F-statistic	23.5	24.6	29.6	32.1	25.5	34.3	46.4	43.5	56.3	66.1
	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)
R^2	0.538	0.560	0.602	0.595	0.524	0.590	0.660	0.626	0.677	0.691

Note: ( ): p-value; The reference group for *Seoul* and *Metro* is other regions; The reference group for *Private* is public or corporate ownership; *Density*: number of hospitals per 10,000 population in the same district(Si/Gun/Gu); *Bed*: number of beds; *Equipment*: number of high-cost medical equipment (e.g., MRI, CT, PET, C-Arm, robot surgical devices); *Physician* and *Nurse*: number of physicians and nurses, respectively; *Elderly*, *Cancer*, and *Ortho/Neuro*: share of medical expenditure attributed to elderly patients, cancer, and orthopedic & neurosurgery departments, respectively(%).