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Economic evaluation of the impact of physician-hospital integration and physician boards on hospital expenditure per patient

A 5-year longitudinal study

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Abstract

Background: This study aims to contribute to the ongoing policy and scholarly debate on physician-hospital integration (INT) and health care cost by providing evidence for the role of physician boards in mitigating hospital expenditure associated with INT.

Methods: We conducted our study of the relationship between INT, physician boards, and hospital expenditure using data on hospitals in California. We obtained data from the Centers for Medicare and Medicaid Services, American Hospital Association, and California Office of Statewide Health Planning and Development from 2002 to 2006. A hospital fixed-effect ordinary least square (OLS) regression analysis was used.

Results: Hospital expenditure was higher in a hospital with an integrated arrangement (e.g., a hospital that adopted an integrated salary model) than under other independent arrangements between physicians and hospitals, and the proportion of physician members on hospital boards negatively moderated the effect of integration on hospital expenditure.

Conclusions: Physician boards may provide a context that affords benefits that can reduce hospital expenditures under INT. This finding highlights the importance to having a supportive organizational design when implementing INT.

Abbreviations: HHI = Herfindahl index, INT = physician-hospital integration, OLS = Ordinary Least Square, PHY BOARD = Physician Boards.

Keywords: hospital expenditure, physician boards, physician-hospital integration, public health

1. Introduction

Containing health care costs has long been considered a critical issue for policy makers and researchers, especially in the United States. Physician-hospital integration (INT) has often been thought as a viable alternative to independent practice associations through which soaring costs associated with health care delivery might be curtailed. INT began to occur in the US from the 1990s when physicians migrated in large numbers from independent practices to integrated medical groups[1] and hospitals started to purchase independent physician practices and recruit physicians as in-house employees. With the enactment of Patient Protection and Affordable Care Act in March 2010, INT started to gain more momentum. According to the American Hospital Association Hospital Statistics Report (2012), there has been a 32% increase in hospital employment of physicians since 2000 and almost half of physicians are now employed by hospitals.[1] Despite the optimism surrounding INT, its superiority over the IPA-based model in reducing the cost of medical care remains controversial.

Transaction cost economic theory predicts that cost of care under the integrated system will be considerably less compared to that under independent practice associations in which physicians must interact independently with hospital systems. Transaction cost economics scholars claim that employing physicians in-house can help hospitals to reduce expenditure by facilitating coordination and communication among health care practitioners.[2,3] It is also suggested that cost-saving can be derived from more effective use of health-care information technology, better adherence to clinical guidelines by physician-employees, and abolition of unnecessary procedures at hospitals.[1–7]

Contrary to such expectations, a growing body of research has documented 3 types of costs—namely, monitoring (costs that arise from tracking physician behavior and evaluating performance), coordination (costs that arise from processing information and undertaking a joint task), and cooperation cost (costs that result from strong social ties)—that are likely to incur when implementing INT.[8] Several studies suggest that costs of monitoring, coordination, and cooperation occur when inadequate incentive measures are in place in integrated hospitals: offering low-powered incentives induce health care employees to slack off and to withhold important information from other decision makers, especially when it serves their interests to do so.[8–11] Relatedly, other studies found that patients of salaried

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physicians tend to receive excessive treatment compared to those of independent physician practices.[12–14] One possible explanation behind this is that employee-physicians might be under strong pressure to run excessive tests and order unnecessarily expensive treatments in hospitals which are concerned more about their overall financial conditions.[12–13] Further, recent research reveals that INT led to increased price of hospital treatment without cost savings, as physician-employing hospitals typically have stronger bargaining power over insurers.[12–16] Taken together, these studies imply that INT does not always result in efficiency gains and cost savings because integration costs can outweigh its expected cost benefits. This might explain the degraded financial performance experienced by a number of physician groups and hospitals post-integration.

Given this, in recent years researchers have started to examine the organizational conditions under which INT may yield benefits that can help reduce costs incurred. One study examines how integration arrangement is moderated by the membership in a multihospital system, considering more managerial knowledge and resources can be provided under a large system.[17] Other study shows that integrated arrangements provide more benefits for rural hospitals than urban hospitals.[18] The present study extends this promising, albeit limited in volume, stream of research, assessing the possible mitigating effect of physician boards in the relationship between INT and hospital expenditures.

In particular, focusing on understudied costs incurred in INT that might explain the frequent failure of hospital and physician group integration during the 1990s, we first propose that hospital expenditures will be higher under INT than under independent arrangements between physicians and hospitals. We also propose that this increase may be moderated by physicians' participation on boards.

In general, physician board membership providing a shared identity context is expected to motivate employees to afford clinical perspective and appreciation for financial decisions of the administration,[17] work more actively towards organizational goals,[19] and facilitate timely coordination of actions.[20–21] Prior literature thus associates with physician involvement in hospital governance boards a number of benefits including quality improvement and cost containment.[17,22–23] Because this effect can, however, be offset by physicians who exploit board membership to expend resources on clinical functions and thereby increase expenditures,[17] we refrain from a definitive prediction regarding the main effect of physician board membership.

We nevertheless maintain that physician board membership is expected to foster organizational identification, particularly when physicians and hospitals share financial considerations via INT. It is widely accepted that individuals who identify with an organization will value more highly, and typically require less reward to pursue, desired organizational outcomes,[19] and thereby moderate organizational costs. In particular, hospital-employed physicians actively involved in administrative decisions as board members are expected to be more cooperative and become more cost conscious, while un-employed physicians whose financial incentives are not as aligned as those of employed physicians are less likely to make efforts to contain costs or improve quality. Thus, we propose the hypothesis that proportion of non-physician boards will negatively moderate the relationship between INT and hospital expenditures.

Our hypotheses are tested using data on hospitals in California and their operations and finances that we obtained from multiple sources including the Centers for Medicare and Medicaid Services, the California Health and Human Services Agency's Office of Statewide Health Planning and Development, among other sources. Overall, this study aims to contribute to the ongoing policy and scholarly debate on physician-hospital integration and health care cost by providing evidence for the role of physician boards in mitigating hospital expenditure associated with INT.

2. Methods

2.1. Data sources

We compiled data on hospitals in California during 2002~2006 from multiple sources, all of which are publicly available. First, we obtained information about total hospital expenditures, number of patients, multihospital system, and hospital type (e.g., short-term versus long-term) from cost reports of California hospitals from Centers for Medicare and Medicaid Services (downloadable from www.cms.gov). Medicare reimbursable facilities including hospitals are required to complete and submit a cost report on a yearly basis to Centers for medicare and medicaid services. Although cost reports cover 92% of all hospitals in the US, we had to restrict our sample to the hospitals residing in California due to limited availability of other data. This will be discussed further in the limitation section. Second, information about physician-hospital arrangements (e.g., hospital employment of physicians) is obtained from American Hospital Association. We hand-coded this information from annually published "American Hospital Association Hospital Directory". Third, we used annual financial data that include information about the proportion of physician members on hospital boards and case mix index from the California Office of Statewide Health Planning and Development (downloadable from www.oshpd.ca.gov). As all data are publicly available and does not contain any identifiable patient information, the ethical approval was not necessary. Our final sample consists of 468 hospital-year observations with 154 hospitals in California.

2.2. Variables

2.2.1. Dependent variable.

Our outcome variable is hospital expenditure per patient. During our study period, total hospital cost emerged as the basis for compensation (e.g., pay-for-performance) for health care practitioners and there was more emphasis on the total cost rather than cost for particular service.[24] Accordingly, we chose the total hospital expenditure divided by patient number as our dependent variable. Specifically, we computed total hospital expenditure including buildings and equipment, administrative expenses, and education programs for all departments at a given hospital. All costs are in 2006 dollars as we use medical care consumer price index (available from the US Bureau of Labor Statistics) to adjust hospital expenditures for inflation.

2.2.2. Independent variables.

INT is measured as hospital employment of physicians, which is a binary indicator of whether a hospital has adopted the tightest form of integration between physicians and hospitals. This variable takes the value of 1 if a hospital adopts an integrated salary or foundation model and 0 otherwise (other physician-hospital arrangements such as independent practice associations or open physician-hospital organizations).

The other key explanatory variable, proportion of physician board (PHY BOARD), identifies the proportion of physician board members. Using California Office of Statewide Health

Planning and Development financial data, we calculate this variable by dividing the number of physicians on the board by the total number of board members. PHY BOARD is also our moderating variable. The test of the moderating effect is performed by multiplying "physician-hospital integration" and "physician board members" (INT * PHY BOARD).

As a robustness check, we use an alternative measure of INT. We replaced our key explanatory variable, INT, with an ordinal variable (i.e., a variable with ordered or ranked categories), Level of Integration. This variable takes the value of 0, 1, 2, 3, and 4 if the hospital has no physician-hospital arrangement, independent practice associations, open physician-hospital organizations, closed physician-hospital organizations, and fully integrated organizations (i.e., integrated salary or foundation model), respectively. No physician-hospital arrangement shows the loosest form of integration while the fully integration organizations shows the tightest form of integration.[16] When using this alternative measure, the test of moderating effect is performed by including "Level of integration" and "physician board members" (Level of Integration * PHY BOARD).

2.2.3. Control variables. We included as well a number of control variables following previous studies.[16–17] We first controlled for hospital Case Mix Index. Case mix index reflects the morbidity of the patients. Thus, the higher the index (e.g., patients with more chronic conditions), the more resources are required to treat these patients in a given group, increasing hospital expenditure per patient. We also controlled for market concentration by including the Herfindahl index (HHI) based on number of patients.[17] The HHI is the sum of the square of market share of each hospital in a given county. The smaller the index, the more perfect being competition. We thus expect a positive association between HHI and cost per patient, which will be higher in a market close to monopoly than under perfect competition via collusion. Other control variables include chain dummy and hospital type. Multihospital system is a binary variable that takes the value of 1 if a hospital is part of the multihospital systems and 0 otherwise.[17] The affiliation with the multihospital system is expected to result in efficient allocation of capital, staffing, and other resources, which leads to the negative effect of the system affiliation on hospital expenditure per patient. Hospital Type is a categorical variable, which takes the value of 0, 1, 2, and 3 if the hospital is general short-term, general long-term, rehabilitation, and children, respectively. We expect resource consumption and thus hospital expenditure to be higher for specialized than for general hospitals, and a positive association is thus expected between hospital type variable and hospital expenditure per patient. Lastly, we include both firm and year fixed effects. Thus, hospital characteristics that are constant over our sample period, such as ownership type (for-profit, not-for-profit, and government), Kaiser Permanente affiliate, and teaching status, are subsumed within he fixed effect.

2.3. Specification

The following specification was used to estimate hospital expenditures per patient against INT and physician board membership.

$$\begin{aligned}&\text{Hospital expenditure per patient}_{it}\\&\quad=\beta_0+\beta_1\text{INT}_{it}+\beta_2\text{PHY BOARD}_{it}+\beta_3\boxtimes(\text{INT}_{it}\times\text{ PHY BOARD}_{it})\\&\quad+\beta_4\text{Case Mix Index}_{it}+\beta_5\text{HHI}_{it}+\beta_6\text{Multihospital System}_{it}\\&\quad+\beta_7\text{Hospital Type}_{it}+Hospital_i+\text{Year}_t+\varepsilon_{it}\end{aligned}$$

We used a hospital fixed-effect ordinary least square (OLS) regression analysis. It is well known that a random-effect model is based on the assumption that individual effects are not correlated with any regressors. If this assumption does not hold, a random-effect approach can generate inconsistent estimates in the presence of endogeneity problems (i.e., explanatory variables not being exogenous). Thus, we decided to use a hospital fixed-effect panel data model in estimating the effect of INT and physician board membership on hospital expenditure.

3. Results

Table 1 reports descriptive statistics for the variables for 468 hospital-year observations in California. As several variables have skewness and kurtosis, we normalize our variables, except 2 dummy variables (INT and multihospital system) and 2 categorical variables (hospital type and level of integration). The mean value of the binary variable of INT, 0.28, indicates that 28% of hospital-year observations (129 hospitals = 0.2756 × 468 hospitals) adopted either an integrated salary or a foundation model. Multihospital system binary variable's mean value of 0.86 indicates that roughly 86% of hospital-year observations (401 hospitals = 0.8568 ×469 hospitals) are part of multihospital systems. The hospital type categorial variable's mean value was of 0.06. In our sample, 98% of hospital-year observations were general short-term hospitals (457 hospitals); 0.2% of hospitals were general long-term hospitals (1 hospital); 0.2% hospitals were rehabilitation hospital (1 hospital); 2% of hospitals were cancer hospitals (9 hospitals). The other categorical variable, level of integration, has mean value was 0.06. In our sample, there are 191 observations that had no physician-hospital arrangement, 126 observations that had independent practice organizations, 13 observations that had open physician-hospital organizations, 9 observations that had closed physician-hospital organizations, and 129 observations that had fully integrated organizations, respectively.

Table 2 presents the correlation matrix. The strength of association between the independent variables is not particularly strong. The correlation between the INT and Level of Integration, (0.93*) is supposed to be very high, as Level of Integration is an alternative measure for INT. The variance inflation factors test confirms that multicollinearity problem does not exist among our right-hand side variables.

Table 3 compares the mean values for key variables depending on the INT status, respectively. A few key differences can be observed from the table. First, hospitals that employ physicians spent more than hospitals that do not employee physicians. Second, proportion of physician board was higher for non-integrated hospitals than integrated hospitals. Third, hospitals that employ physicians tend to be in multihospital system than those that do not employee physicians. We controlled for these differences in our regressions.

Table 4 and Table 5 report the results of our fixed-effect OLS regressions analyses. As mentioned above, a random-effect approach yields inconsistent estimation with the presence of the correlation between individual effects and any regressors. Hausman test also suggests that fixed-effect models are preferred than random-effect models with our data. Thus, we performed the fixed-effect analyses.

Looking across the columns (1)–(4) of Table 4, the coefficients on the control variables were as expected, while both HHI and multihospital system dummy variable were insignificant but had the positive sign as theorized.

Table 1

Summary statistics.

	Definition	Mean	SD	Min	Max
(1) Hospital Expenditure Per Patient	(Normalized) Total hospital expenditure including buildings and equipment, administrative expenses, and education programs for all departments at a given hospital / Total number of patients for all departments at a given hospital	0	1	−2.40	5.08
(2) Physician-Hospital Integration (0,1)	A dummy variable; 1 for a hospital that has adopted the integrated salary model (hospital employment of physicians) or foundation model, and 0 otherwise	0.28	0.45	0	1
(3) Proportion of Physician Board	(Normalized) Number of physicians on the board divided by total number of board members	0	1	−1.14	4.20
(4) Case Mix Index	(Normalized) A relative value assigned to a diagnosis-related group of patients in a medical care environment	0	1	−4.79	3.78
(5) Herfindal Index	(Normalized) Herfindahl-Hirschman index based on number of patients	0	1	−0.95	2.38
(6) Multihospital System (0,1)	A dummy variable; 1 if a hospital is part of the multihospital systems, and 0 otherwise	0.86	0.35	0	1
(7) Hospital Type (0,1, 2 and 3)	A categorical variable; 0 if a hospital is a general shot-term hospital, 1 if a general long-term hospital, 2 if a rehabilitation, and 3 if a children hospital, respectively.	0.06	0.42	0	3
(8) Level of Integration (0,1, 2, 3 and 4)	A categorical variable; 0 if the hospital has no physician-hospital arrangement, 1 if independent practice associations, 2 if open physician-hospital organizations, 3 if closed physician-hospital organizations, and 4 if fully integrated organizations (i.e., integrated salary or foundation model), respectively.	0.06	0.42	0	3

Notes: The sample contains 468 hospital-year observations during 2002 to 2006. We normalize our variables, except 2 dummy variables (physician-hospital integration and multihospital system) and 2 categorical variables (hospital type and level of integration). In our sample, 28% of hospital-year observations (129 hospitals = 0.2756 × 468 hospitals) adopted either an integrated salary or a foundation model. 86% of hospital-year observations (401 hospitals = 0.8568 × 469 hospitals) are part of multihospital systems. Also, 98% of hospital-year observations were general short-term hospitals (457 hospitals); 0.2% of hospitals were general long-term hospitals (1 hospital); 0.2% hospitals were rehabilitation hospital (1 hospital); 2% of hospitals were cancer hospitals (9 hospitals). Lastly, there are 191 observations that had no physician-hospital arrangement, 126 observations that had independent practice organizations, 13 observations that had open physician-hospital organizations, 9 observations that had closed physician-hospital organizations, and 129 observations that had fully integrated organizations, respectively. SD = standard deviation.

As expected, the coefficient on INT, the INT variable, was positive and statistically significant in all columns. Especially, when we added our moderating variable in column (4), the main effect of INT stayed positive and statistically significant ($P = .03$). This indicates that INT indeed increases hospital expenditures.

The coefficient on PHY BOARD, the proportion of physician board members, was positive but failed to reach the significant level in column (2) ($P = .16$). In column (4), however, the main effect of PHY BOARD became significant only at the 0.1 level ($P = .93$). This reflects the fact that the previous studies emphasized both benefits and costs that physician boards provide.[17,22,23]

As expected, the coefficient on the interaction between INT and the proportion of physician membership on boards (INT X PHY BOARD) was negative and significant ($P = .03$) in column (4), implying that the positive association between INT and hospital expenditures was weakened with increased physician representation on boards. This highlights the necessity of conjoint financial and cultural integration. Our finding suggests that employing physicians itself is costly as physicians do not commit themselves to a hospital but just enjoy low-powered incentives. It also suggests that cultivating a conjunct physician-management culture via board membership is 1 way to reduce hospital expenditures arising from INT.

Table 2

Correlation matrix.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Hospital Expenditure Per Patient	1							
(2) Physician-Hospital Integration (0,1)	0.09*	1						
(3) Proportion of Physician Board	−0.14*	−0.14*	1					
(4) Case Mix Index	0.28*	0.02	−0.04	1				
(5) Herfindal Index	0.38*	−0.07	−0.09	−0.06	1			
(6) Multihospital System (0,1)	0.14*	0.13*	−0.01	0.11*	0.09*	1		
(7) Hospital Type (0, 1, 2, and 3)	0.04	−0.07	−0.06	−0.05	−0.04	−0.13*	1	
(8) Level of Integration (0,1,2,3, and 4)	0.03	0.93*	−0.11*	−0.00	−0.11*	0.09	−0.02	1

* $P < .05$.

Notes: The dependent variable is hospital expenditure per patient. Physician-hospital integration, is a dummy variable, which takes the value of 1 if a hospital adopts an integrated salary or foundation model, and 0 otherwise. Proportion of Physician Board is the number of physicians on the board divided by the total number of board members. Case Mix Index indicates the morbidity of the patients. The Herfindal Index is the sum of the square of market share of each hospital in a given county. Multihospital system is a dummy variable that takes the value of 1 if a hospital is part of the multihospital systems, and 0 otherwise. Hospital type is a categorical variable, which takes the value of 0, 1, 2, and 3 if the hospital is general short-term, general long-term, rehabilitation, and children, respectively. Level of Integration is an ordinal variable with 5 ranked categories; 0 if the hospital has no physician-hospital arrangement, 1 if independent practice associations, 2 if open physician-hospital organizations, 3 if closed physician-hospital organizations, and 4 if fully integrated organizations (i.e., integrated salary or foundation model), respectively. The sample contains 468 hospital-year observations with 154 hospitals during 2002 to 2006. We normalize our variables, except 2 dummy variables (physician-hospital integration and multihospital system) and 2 categorical variables (hospital type and level of integration).

Table 3

Mean comparison between non-integrated versus integrated hospitals.

		Non-integrated hospitals	Integrated hospitals	Difference
(1)	Hospital Expenditure Per Patient	−0.06	0.15	−2.11*
(2)	Physician-Hospital Integration (0,1)	0	1	—
(3)	Proportion of Physician Board	0.09	−0.23	0.32*
(4)	Case Mix Index	−0.01	0.04	−0.05
(5)	Herfindal Index	0.05	−0.12	0.17
(6)	Multihospital System (0,1)	0.83	0.93	−0.10*
(7)	Hospital Type (0,1,2, and 3)	0.08	0.02	0.07
(8)	Level of Integration (0,1,2,3, and 4)	0.53	4	−3.47*

* $P < .05$.

Notes: The dependent variable is hospital expenditure per patient. Hospital Employment of Physicians, a proxy for physician-hospital integration, is a dummy variable, which takes the value of 1 if a hospital adopts an integrated salary or foundation model, and 0 otherwise. Proportion of Physician Board is the number of physicians on the board divided by the total number of board members. Case Mix Index indicates the morbidity of the patients. The Herfindal Index is the sum of the square of market share of each hospital in a given county. Multihospital system is a dummy variable that takes the value of 1 if a hospital is part of the multihospital systems, and 0 otherwise. Hospital type is a categorical variable, which takes the value of 0, 1, 2, and 3 if the hospital is general short-term, general long-term, rehabilitation, and children, respectively. Level of Integration is an ordinal variable with 5 ranked categories; 0 if the hospital has no physician-hospital arrangement, 1 if independent practice associations, 2 if open physician-hospital organizations, 3 if closed physician-hospital organizations, and 4 if fully integrated organizations (i.e., integrated salary or foundation model), respectively. The sample contains 468 hospital-year observations with 154 hospitals during 2002 to 2006. We normalize our variables, except 2 dummy variables (physician-hospital integration and multihospital system) and 2 categorical variables (hospital type and level of integration).

Table 5 shows the results of using the alternative measure of INT, Level of Integration. The estimates in columns (1)–(4) of Table 5 are similar to those in Table 4. Importantly, column (4) of Table 5 shows that the signs and significance of the baseline results remain largely unchanged, indicating that the results are robust to the choice of measure of physician-hospital integration. The downside of using this alternative measure of INT is that we treated this variable as continuous based on the assumption that the ordinal categories are equally spaced. We thus conducted the sub-sample analysis to check whether the coefficient of PHY BOARD varies with the alternative measure of INT (Table 6). Due to the small number of observations, we aggregated observations of the 3 groups (intendent practice associations (Level of Integration = 1), open physician-hospital organizations (Level of Integration = 2), and closed physician-hospital organizations (Level of Integration = 3). The sub-sample analysis (loose, medium and tight form of INT) confirms that physician boards reduce hospital expenditures when physicians and hospitals are tightly integrated. In other words, the results of the sub-sample analysis, like our other results, suggest that physician boards provide a context that affords benefits that can reduce hospital expenditures under INT.

Table 4

The effect of integration and physician board on hospital expenditure.

DV = hospital expenditure per patient	(1)	(2)	(3)	(4)
Physician-Hospital Integration (0,1)		0.16*	0.15*	0.16*
		[0.07]	[0.07]	[0.08]
Proportion of Physician Board (PHY BOARD)			0.08	0.10+
			[0.05]	[0.06]
INT * PHY BOARD				−0.13*
				[0.06]
Case Mix Index	0.26**	0.25**	0.26**	0.26**
	[0.09]	[0.09]	[0.09]	[0.09]
Herfindal Index	0.10	0.12	0.12	0.14
	[0.13]	[0.13]	[0.13]	[0.14]
Multihospital System (0,1)	−0.02	−0.04	−0.05	−0.04
	[0.10]	[0.09]	[0.09]	[0.10]
Hospital Type (0,1, 2, and 3)	0.09**	0.07**	0.07**	0.10**
	[0.03]	[0.03]	[0.03]	[0.03]
Constant	−0.47**	−0.48**	−0.49**	−0.50**
	[0.09]	[0.08]	[0.08]	[0.09]
R-squared	0.47	0.48	0.48	0.49

Standard errors in brackets.
* $P < .05$,
+ $P < .1$.
** $P < .01$.

Notes: Both Hospital and Year-fixed effect are included in all models. The dependent variable is hospital expenditure per patient. Physician-hospital integration is a dummy variable, which takes the value of 1 if a hospital adopts an integrated salary or foundation model, and 0 otherwise. Proportion of Physician Board is the number of physicians on the board divided by the total number of board members. Case Mix Index indicates the morbidity of the patients. The Herfindal Index is the sum of the square of market share of each hospital in a given county. Multihospital system is a dummy variable that takes the value of 1 if a hospital is part of the multihospital systems, and 0 otherwise. Hospital type is a categorical variable, which takes the value of 0, 1, 2, and 3 if the hospital is general short-term, general long-term, rehabilitation, and children, respectively. The sample contains 468 hospital-year observations with 154 hospitals during 2002 to 2006. We normalize our variables, except 2 dummy variables (physician-hospital integration and multihospital system) and a categorical variable (hospital type).

INT = Physician-hospital Integration; PHY BOARD = Physician Boards.

Table 5

The effect of integration and physician board on hospital expenditure.

DV = hospital expenditure per patient	(1)	(2)	(3)	(4)
Level of Integration (0, 1, 2, 3, and 4)		0.04+	0.04+	0.04+
		[0.02]	[0.02]	[0.02]
Proportion of Physician Board			0.07	0.10+
			[0.05]	[0.06]
Level of Integration * PHY BOARD				−0.02+
				[0.01]
Case Mix Index	0.26**	0.26**	0.26**	0.26**
	[0.09]	[0.10]	[0.09]	[0.09]
Herfindal Index	0.10	0.11	0.12	0.13
	[0.13]	[0.13]	[0.13]	[0.14]
Multihospital System (0,1)	−0.02	−0.05	−0.06	−0.04
	[0.10]	[0.09]	[0.09]	[0.09]
Hospital Type (0,1, 2 and 3)	0.09**	0.07**	0.07**	0.09**
	[0.03]	[0.03]	[0.03]	[0.03]
Constant	−0.47**	−0.49**	−0.49**	−0.50**
	[0.09]	[0.08]	[0.08]	[0.09]
R-squared	0.47	0.48	0.48	0.48

Standard errors in brackets.
** $P < .01$.
* $P < .05$.
+ $P < .1$.
Notes: Both Hospital and Year-fixed effect are included in all models. The dependent variable is hospital expenditure per patient. Level of Integration is an ordinal variable with 5 ranked categories; 0 if the hospital has no physician-hospital arrangement, 1 if independent practice associations, 2 if open physician-hospital organizations, 3 if closed physician-hospital organizations, and 4 if fully integrated organizations (i.e., integrated salary or foundation model), respectively. Proportion of Physician Board is the number of physicians on the board divided by the total number of board members. Case Mix Index indicates the morbidity of the patients. The Herfindal Index is the sum of the square of market share of each hospital in a given county. Multihospital system is a dummy variable that takes the value of 1 if a hospital is part of the multihospital systems, and 0 otherwise. Hospital type is a categorical variable, which takes the value of 0, 1, 2, and 3 if the hospital is general short-term, general long-term, rehabilitation, and children, respectively. The sample contains 468 hospital-year observations with 154 hospitals during 2002 to 2006. We normalize our variables, except a dummy variable (multihospital system) and 2 categorical variables (hospital type and level of integration).
PHY BOARD = Physician Boards.

Table 6

The sub-sample analysis.

DV = hospital expenditure per patient	Loose form of physician-hospital integration (level of integration = 0)	Medium form of physician-hospital integration (level of integration = 1,2, or 3)	Tight form of physician-hospital integration (level of integration = 4)
Proportion of Physician Board	0.02	0.30	−0.10*
	[0.04]	[0.21]	[0.06]
Case Mix Index	0.12	0.27+	0.90*
	[0.09]	[0.14]	[0.46]
Herfindal Index	0.04	0.15	0.32
	[0.16]	[0.28]	[0.22]
Multihospital System (0,1)	−0.15	−0.05	−0.27
	[0.17]	[0.28]	[0.32]
Hospital Type (0,1, 2 and 3)	—	—	−0.03
			[0.04]
Constant	−0.30**	−0.64*	0.02
	[0.10]	[0.25]	[0.35]
Observations	191	148	129
Number of Hospitals	82	61	54
R-squared	0.39	0.38	0.53

Standard errors in brackets.
** $P < 0.01$.
* $P < 0.05$.
+ $P < 0.1$.
Notes: Both Hospital and Year-fixed effect are included in all models. The dependent variable is hospital expenditure per patient. Level of Integration is an ordinal variable with 5 ranked categories; 0 if the hospital has no physician-hospital arrangement, 1 if independent practice associations, 2 if open physician-hospital organizations, 3 if closed physician-hospital organizations, and 4 if fully integrated organizations (i.e., integrated salary or foundation model), respectively. Proportion of Physician Board is the number of physicians on the board divided by the total number of board members. Case Mix Index indicates the morbidity of the patients. The Herfindal Index is the sum of the square of market share of each hospital in a given county. Multihospital system is a dummy variable that takes the value of 1 if a hospital is part of the multihospital systems, and 0 otherwise. Hospital type is a categorical variable, which takes the value of 0, 1, 2, and 3 if the hospital is general short-term, general long-term, rehabilitation, and children, respectively. We normalize our variables, except a dummy variable (multihospital system) and 2 categorical variables (hospital type and level of integration).
PHY BOARD = Physician Boards.

Table 7

Summary statistics (using un-transformed raw data).

	Definition	Mean	SD	Min	Max
(1) Hospital Expenditure Per Patient	Total hospital expenditure including buildings and equipment, administrative expenses, and education programs for all departments at a given hospital / Total number of patients for all departments at a given hospital	3226.32	1118.80	546.44	8912.97
(2) Physician-Hospital Integration (0,1)	A dummy variable; 1 for a hospital that has adopted the integrated salary model (hospital employment of physicians) or foundation model, and 0 otherwise	0.28	0.45	0	1
(3) Proportion of Physician Board	Number of physicians on the board divided by total number of board members	0.21	0.19	0	1
(4) Case Mix Index	A relative value assigned to a diagnosis-related group of patients in a medical care environment	1.13	0.27	0	2.03
(5) Herfindal Index	Herfindahl-Hirschman index based on number of patients	0.30	0.29	0.03	1
(6) Multihospital System (0,1)	A dummy variable; 1 if a hospital is part of the multihospital systems, and 0 otherwise	0.86	0.35	0	1
(7) Hospital Type (0,1, 2 and 3)	A categorical variable; 0 if a hospital is a general shot-term hospital, 1 if a general long-term hospital, 2 if a rehabilitation, and 3 if a children hospital, respectively.	0.06	0.42	0	3

Notes: The sample contains 468 hospital-year observations during 2002 to 2006. In our sample, 28% of hospital-year observations (129 hospitals = 0.2756 × 468 hospitals) adopted either an integrated salary or a foundation model. 86% of hospital-year observations (401 hospitals = 0.8568 × 469 hospitals) are part of multihospital systems. Also, 98% of hospital-year observations were general short-term hospitals (457 hospitals); 0.2% of hospitals were general long-term hospitals (1 hospital); 0.2% hospitals were rehabilitation hospital (1 hospital); 2% of hospitals were cancer hospitals (9 hospitals). Please note that none of the variables are normalized.

As robustness checks, we added Table 7 and Table 8 to report descriptive statistics of the un-transformed variables and check whether the results change without normalizing variables with skewness and kurtosis. The results in Table 4 are similar to those in Table 8, suggesting that normalization of the variables has no important effect.

4. Discussion

Results of the present study have implications for research, policy, and practice. Previous studies have paid little attention to context-related variation in the effects of INT. Hospitals can reduce the costs of INT only in the presence of corresponding revisions in structure, incentives, control systems, and other organizational elements. Specifically, we found that a positive correlation between INT and hospital expenditure is weakened with increased physician representation on boards. This suggests that revisions to supporting organizational structures, in the present study, physician boards, significantly reduce hospital expenditures incurred in integration.

The results of our study can also inform policymakers' efforts to bring costs under control. Policymakers believe integrated care

Table 8

The effect of integration and physician board on hospital expenditure (using un-transformed raw data).

DV = hospital expenditure per patient	(1)	(2)	(3)	(4)
Physician-Hospital Integration (0,1)		174.19*	166.68**	339.57*
		[82.06]	[82.93]	[132.07]
Proportion of Physician Board (PHY BOARD)			450.32	575.92+
			[317.42]	[340.93]
INT * PHY BOARD				−748.52*
				[345.54]
Case Mix Index	1212.54**	1204.32**	1216.03**	1225.34**
	[444.83]	[447.82]	[436.53]	[433.66]
Herfindal Index	396.48	450.58	478.87	526.70
	[482.45]	[491.96]	[513.98]	[533.15]
Multihospital System (0,1)	−20.36	−45.98	−52.08	−48.58
	[111.14]	[102.95]	[103.29]	[108.00]
Hospital Type (0,1, 2 and 3)	103.13**	81.98**	77.60**	106.50**
	[29.99]	[28.72]	[29.15]	[30.05]
Constant	1208.50*	1181.65*	1061.10+	997.06+
	[542.08]	[543.70]	[546.62]	[547.64]
R-squared	0.47	0.48	0.48	0.49

Standard errors in brackets.

** $P < .01$.

* $P < .05$.

+ $P < .1$.

Notes: Both Hospital and Year-fixed effect are included in all models. The dependent variable is hospital expenditure per patient. Physician-hospital integration is a dummy variable, which takes the value of 1 if a hospital adopts an integrated salary or foundation model, and 0 otherwise. Proportion of Physician Board is the number of physicians on the board divided by the total number of board members. Case Mix Index indicates the morbidity of the patients. The Herfindal Index is the sum of the square of market share of each hospital in a given county. Multihospital system is a dummy variable that takes the value of 1 if a hospital is part of the multihospital systems, and 0 otherwise. Hospital type is a categorical variable, which takes the value of 0, 1, 2 and 3 if the hospital is general short-term, general long-term, rehabilitation, and children, respectively. The sample contains 468 hospital-year observations with 154 hospitals during 2002 to 2006. Please note that none of the variables are normalized.

INT = Physician-hospital Integration; PHY BOARD = Physician Boards.

to be an important building block in a new health care system that can contain costs and improve quality of care. Our study of how INT affects costs, and contextual conditions under which its effects may differ, suggests that these goals be pursued with an element of caution.

Lastly, the findings of the present study are especially important for practitioners. It has been reported that hospitals lose $150,000 to $250,000 per year during the first 3 years of employing physicians.[3] The current research can provide guidelines for practitioners who have already acquired physician practices, or plan to do so, by emphasizing that appropriate organizational component (in this case, physician boards) and accompanying incentive alignment can result in more effective implementation of physician-hospital integration.

4.1. Limitations

Our study admits the following limitations. We restricted our sample to California because data on the proportion of physician board members, an important variable in the present study, is publicly available, to the best of our knowledge, only in that state. We believe the consequent reduction in sample size to be offset by the present study's implications for revising previous studies' negative assessments of INT through concerted efforts to cultivate complementary supporting organizational elements.

Another limitation regards the time frame of our study. Our dataset ranges from 2002 to 2006. A large number of hospitals had integrated with physician groups during this sample period, and most physicians are now employed by hospitals.[1] Although not including more recent data could be a limitation, hospitals that had been integrated with physician groups early might exploit efficiency gains or absorb integration costs differently from those integrated more recently. We thus believe that the effect of INT can be better examined in our sample period.

Third, the present study lacks specific information about how physician behavior changes with adjustments to the physician-hospital arrangement or increases in the proportion of physician board members, that might better explain changes in expenditure. Future studies could enhance understanding of these effects through detailed examination of information about how physicians treat patients (e.g., patient referrals or number of tests) and respond to changes in level of integration or composition of hospital boards.

Further, although our results suggest that having physician boards helps to reduce hospital expenditures that arise from INT, physician board membership does not fully offset the costs incurred. Future studies could examine other organizational elements (e.g., physician stock ownership or payment arrangement) that might help to reduce the costs that result from INT, when such data become available.

5. Conclusion

Our study extends the previous literature by confirming that the main effect of INT on hospital expenditure may be non-negative and identifying a context in which benefits may help reduce costs of INT. Specifically, we found preliminarily negative perceived effects of INT to be weakened by attention to revisions to the design of supportive organizational elements.

Author contributions

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