Hospital response to reimbursements: the role of physician behaviour and compensation arrangement

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1. Introduction

In Taiwan a hospital-based physician works as an employee of the hospital and is the major agent in the management of the various inputs producing health services. The penalties/revenues structure embodied in the hospital-physician interaction is therefore of critical importance for the effectiveness and efficiency of the reimbursement mechanism in Taiwan. This paper investigates empirically how the financial incentives facing the physician influence hospital performance, considering hospital performance as the aggregate of individual physicians' decision about admission and treatment. The financial incentives capture the hospital's strategies of regulating physician behaviour and its response to incentives in reimbursements, and therefore determine the extent to which hospital performance is driven by the reimbursements.

There have been voluminous empirical studies on the effects of the reimbursement changes on physician behaviour. Most of their work centred on the estimation of the fee differentials and the volume/intensity of physician services, and concluded that the fee level is a relevant factor in explaining changes in the service utilization (Rice, 1983; Christensen, 1992; Wedig et al., 1989; Hurley et al., 1990; Escarce, 1993; Rochaix, 1993; Mitchell and Cromwell, 1995; Gruber and Owings, 1996; Mitchell and Hadley, 1997; Nguyen and Derrick, 1997; Zuckerman et al., 1998; Tai-Seale et al., 1998; Yip, 1998; Gruber et al., 1999; Rice et al., 1999; Mitchell et al., 2000; Currie and Gruber, 2001). The question is whether or not these results can necessarily be carried over to the case of hospital-based physicians. We would argue that they may

not be applicable. Since hospital-based physicians do not bear the operating costs and grip all the profits directly, they may not have the same incentives as those independent practitioners do. In such a circumstance, the compensation mechanism, especially the performance pay, is regarded as an effective measure to regulate their behaviour, so as to create a connection between their performance and reimbursement policy. Thus modelling hospital-based physician behaviour requires a framework incorporating the compensation mechanism.

We investigate this issue within the context of a particular example, physician's decision to apply laparoscope into performing oophorectomy. Laparoscope is a technique that brings about patients better prognosis, shorter length of stay and less bleeding, which naturally presents a better choice for patients, but also together with greater expense and longer operation time. In order to promote the use of this technology, the National Health Insurance (NHI) in Taiwan increased the reimbursement rate for laparoscopic-assisted oophorectomy relative to oophorectomy when the prospective payment system was implemented for these procedures in 1997. With the fact that there are great variations across hospitals in the way they compensate the physician-employees, physician's procedure choice and intensity decision in response to the reimbursement change thus serve as a natural experiment to examine how the financial incentives within the hospital affect physician behaviour. In this paper we address the following questions: does the physician respond to NHI reimbursement change in terms of procedure choice and intensity decision; does a higher revenue share of any oophorectomy in physician's practice matter in determining the odds of performing laparoscopic-assisted oophorectomy; is there evidence that hospital incentive mechanism affects physician's reaction.

In particular, we use individual level of discharge expenditure data from nine hospitals over the period 1996-2000 to model the effect of the reimbursement

differential on substitution towards laparoscopic-assisted procedure. The findings suggest that physicians do respond to the fee differentials, share of the diagnoses for which oophorectomy is served and the hospital compensation mechanism. While the value is quite small, there is a positive effect of their interaction on the laparoscopic-assisted oophorectomy rates and a negative effect on the length of stay.

The paper proceeds as follows. Second 2 describes the institutional background, including the reimbursement policy and the compensation mechanism within the hospital. Section 3 introduces the theoretical framework of this paper. Section 4 introduces the empirical model. Section 5 presents the data and variable specification. Our results are presented in section 6. Section 7 is the discussion.

2 Institutional background

2.1. The Prospective Payment System (PPS) in Taiwan

Since National Health Insurance (NHI) in 1995, although inpatient services are mainly paid retrospectively, a prospective payment scheme, named as the case payment system, has been established as part of the reimbursement policy for chosen procedures, in which a fixed price is paid for all the services provided in a discharge. Regarded as a simplified version of the DRG-based prospective payment system in United States, the factors featuring the case payment system may have important financial implication to physician-employees. First of all, the system is simply carried out on the procedure/diagnosis basis. As long as the International Classification of Disease, Ninth Revision, Clinical Modification (ICD 9CM) reported in the principal or secondary diagnosis/procedure of a claim is correspondent with the designated code, a prospective price will be paid.

Second, the prospective price for the chosen procedures is set up by adding another ten percent to the average expense of the inpatient claims of related diagnoses and procedures, and then adjusted according to hospitals' accreditation. However,

patients' age, sex, severity and discharge status are not taken into account in this system. For example, while hospitals of higher accreditation will be reimbursed by a greater payment for a procedure, they cannot claim for a higher price for treating a more serious patient.

Third, regarding the outliers that incur expenses more than the case payment system indicates, the excess part will be fully reimbursed only on two conditions. For instance, for a procedure the number of the outliers is not allowed to exceed a percentage of all the cases performed at hospital in a month, which is set between 0 to 100 percent, varying with the procedures but not necessarily with the accreditation. If this quantity exceeds the limitation, hospitals may select the cases, usually based on the amount of their expense, as the outlier payment. On the other hand, the cases outside this rate will be paid simply the prospective price, regardless of the expense hospitals claim for.

Moreover, there is a threshold for reimbursing these outliers. Namely, hospitals cannot claim for the outlier expense higher than the allowed amount of money. A larger threshold is available to the hospitals of higher accreditation. Nevertheless, no regulation is put on procedures with the laparoscope in the department of gynaecology yet because of the lack of the information on the costs.

2.2. The compensation mechanism at hospital

In Taiwan, hospitals are the subject that the insurer reimburses inpatient services. The pricing of physician inputs, such as diagnosing, examining and treating patients and operating the surgery, has not been identified separately in each payment, either before or after the NHI. Because under the close-staff hospital system physicians who provide inpatient services are the employees of a hospital, the return to their inputs depends entirely on the compensation mechanism arranged in each hospital.

Before 1970s, the flat salary paid simply based on physicians' position and seniority

was the major system in Taiwan hospital industry. This arrangement that pays the same salary to physicians of different productivity is considered to be short of incentives inducing physicians' efficiency and profit making, and thereby leads to poor quality of health care. In contrast to flat salary, a performance-based payment, the Private Physician Fee (PPF), was initiated in the outpatient department in a Christian hospital in 1971 and became popular thereafter in order to improve the aforementioned incentive problem. PPF is an additional charge for designating the physician patients prefer and will be forwarded to this physician. That is to say, how many payment physicians can receive in addition to their salary relies on the volume of patients they treat. Physicians thus pay more attention on diagnosing and treating patients whereby attract more patients to visit.

Generally, the compensation mechanism at hospital may be classified as the physician fee, the flat salary and salary plus physician fee. The physician fee refers to the zero-based physician fee, in which physicians' income depends simply on the physician fee. On the other hand, the flat salary is the arrangement without taking physicians' performance into account besides their seniority, position and degree. In reality, there are few hospitals employing only the salary as the compensation for their physician-employees. Most of the hospitals, either public or private, have chosen the physician fee as a means to improve physicians' productivity, whatever the extent is.

3. Basic theoretical framework

The conceptual foundation for the analysis of physician's procedure choice and intensity decision closely follows the model of McGuire and Pauly (1991). In their model, if any exogenous market change associated with a service/insurer leads to a significantly negative impact on physician's income, the physician will increase the supply of this service. This is the income effect. Instead, the physician will be subject to the standard substitution effect between the labour and leisure, in which the volume

and the intensity always rise when the profitability of a service rises, and fall when its profitability falls. Taken together, McGuire and Pauly suggest that the amount of inducement is limited to the interaction between the income effect and the substitution effect.

However, there are some important distinctions. As the argument set forth earlier, to what extent the physician will react to the reimbursement changes depends on the compensation mechanism at hospital. Thus the physician is more likely to respond to fee reduction with increased quantity and intensity for services of larger share when the hospital employs the performance pay. On the contrary, a salary-paid physician may not be interested in the fee differentials among substitute procedures. Given these facts, the correlation between reimbursements and physician procedure choice is more likely to be built on the interaction of three elements: fee differentials, the share of patients for whom oophorectomy is performed in a physician's practice and the compensation mechanism.

Furthermore, oophorectomy is usually performed by the gynaecologist whose income largely relies on practicing the birth delivery. In this context it is therefore possible that the substitution effect dominates. According to our data, on average oophorectomy only constitutes around 7% of gynaecologist's caseload. This smaller fraction may not suggest a significant income effect, but a positive relationship between the fee differential of two procedures and the probability of performing the better paid. As a result, when the NHI increases the price for laparoscopic-assisted oophorectomy relative to traditional oophorectomy, the probability of choosing laparoscopic-assisted procedure will be higher.

Yet laparoscope is a relatively sophisticated and expensive technology introduced after late 1980s. While this technology may result in better prognosis, less bleeding and shorter length of stay, the underlying costs of laparoscopic-assisted procedure are

considered to be very high in terms of physician time, required equipment and medical assistants. Both physicians and medical assistants need to spend extra time on learning this new technology in the first place. In addition, the duration of performing laparoscope is longer than the traditional abdominal and vaginal approach does, which is likely to reduce the amount of patients a physician can treat in a period. Such costs may restrain the physician from performing this procedure regardless of the higher reimbursement rate since the physician may not think this fee suffices for the increased inputs. Therefore, without empirical estimation considering all these factors, it would be difficult to predict in priori whether and how the gynaecologists' choice of oophorectomy and thereby the intensity decision are affected by the increased reimbursement rates.

4. Empirical estimation

To estimate the probability of applying laparoscope into oophorectomy and thereby its effect on the intensity, we run the regression of the form:

$$LAPA_{ijkt} = f(\beta_1 Inc_{jkt-1} + \beta_2 Pat_i + \beta_3 Doc_j + \beta_4 Hos_k + \beta_4 Time_t)$$

$$\ln LOS_{ijkt} = f(\beta_1 Inc_{jkt-1} + \beta_2 Pat_i + \beta_3 Doc_j + \beta_4 Hos_k + \beta_4 Time_t),$$

where i indexes individual patients, j indexes individual physicians, k indexes hospitals and t indexes the time the patient receives treatment. $LAPA$ is a dummy variable that equals one if the patient receives a laparoscopic-assisted oophorectomy; $\ln LOS$ is the logarithm of the length of stay; Inc is a set of variables that affect physician's income; Pat is a set of patient characteristics; Doc is a set of physician characteristics; Hos is a set of hospital characteristics; $Time$ is a complete set of variables related to time the physician treats patients.

In this model, we estimate the effect of variables that affect physician income on the odds of laparoscopic-assisted oophorectomy and on the length of stay of any

oophorectomy patients. Following the conceptual framework presented in Section 3, this effect is analysed in the light of three variables: fee differentials for laparoscopic-assisted oophorectomy relative to traditional oophorectomy, the share of the diagnoses for which any oophorectomy is performed in a physician's total revenue and the compensation mechanism at hospital. Based on this specification, we estimate this effect in three ways. First, we simply measure the individual influence of these variables. Second, we reestimate the model by incorporating the interactive variables between revenue share and fee differentials and between revenue share and compensation mechanism. Finally, the influence of the interaction of all these three variables will be taken into account.

Because the unit of observation is the procedure and treatment intensity provided by a physician to individual patients, it is likely that the error term of the procedure choice equation is correlated to the error term in the length of stay equation. In other words, the procedure choice may be endogenous, and correlated with unobservable latent factors that also affect the length of stay decision. For instance, if the physician with greater intention to perform laparoscopic-assisted oophorectomy is more likely to reduce the length of stay, then failure to control for this correlation will yield an estimated effect of income-related variables on the intensity decision that is biased upwards. Treatment effects model is therefore used for estimation in order to account for correlations between a binary variable and a continuous variable[1].

5. Data and variables

The primary data source for this study is the Detailed Inpatient Medical Expenses file abstracted from the National Health Insurance Research Database (NHIRD), which is managed by the National Health Research Institute (NHRI) in Taiwan. This database incorporates all the medical claims of medical care institutions contracted with

[1] We used STATA Version 7 to estimate this model.

National Health Insurance (NHI) between 1996 and 2000, providing individual patient level information about age, diagnosis, treatment, specialty, length of stay, co-payment, the expense of treatments and examinations, total (claimed) expense and physician code. Because over ninety-six percent of the population and over ninety-one percent of providers are members of NHI, this provides empirical researchers with a good database for studying how patients and the providers use medical resources in Taiwan.

Six general hospitals, which are two public hospitals, three private general hospitals and a Christian hospital, are chosen because of their different weight on nonperformance-related factors distributing the physician fee, and then labelled as A to F respectively. By the progressively decreasing order, A indicates the hospital with the mechanism of the least performance pay, while F is the hospital of the lowest weight on the nonperformance factors[23]. Because we estimate the model at the level of the individual patient/physician, based on hospital identifiers, the measures of financial incentives facing individual physicians were created. In addition, with the reasoning that physicians may make the procedure choice and intensity decision contingent on previous experience, the revenue share information was calculated on the basis of physician performance in the year $t-1$[4]. Therefore, the sample includes all the gynaecologists who performed any oophorectomy at least once in the selected hospitals in the period 1997-2000, resulting in a sample of 135 physicians and 14261 cases.

Fee differentials were computed by subtracting the price of oophorectomy from that of laparoscopic-assisted oophorectomy. Because the NHI implemented the

[2] This ranking does not necessary have a cardinal or scalar interpretation with respect to their compensation arrangement.

[3] Hospital B has three divisions in northern, central and southern Taiwan (BN, BC, BS), while hospital F has divisions in northern and southern Taiwan (FN, FS).

[4] This measure would include the actual response otherwise (Hadley et al., 1989).

prospective payment system for oophorectomy, hysterectomy and metacyesis treatment since October 1997, the calculation basis is different before and after the PPS was effective. Rather than simply using the indicated price for procedures performed after 1998, the price facing individual physicians in 1997 is constructed by averaging the total expense of the study procedures they performed in 1996 respectively[5]. As noted above, measuring the effect of fee differentials on procedure choice and intensity decision without controlling for the sophistication difference leads to biased estimates. We use the price ratio as the proxy since no standard indicator serves the purpose of reflecting the relative sophistication between two procedures. The reason is that not only the returns to the service, the procedure price also indicates the required inputs to perform a procedure and a more sophisticated technology is usually related to higher price. Hence this ratio variable is reasonable to capture physician's intention to substitute their time out of difficult procedure into relatively "easier" one. In addition, we also control the capability to produce profits that potentially determines the procedure choice by creating a payment difference variable with the measurement defined as the difference between actual payment and claimed expense[6].

The share variable is measured based on the fraction of the revenue attributed to the patients for whom any oophorectomy is performed in each physician's practice[7]. Moreover, that laparoscope is applicable to other procedures performed in the gynaecological department may give the physician stronger incentives to choose this

[5] For those did not have cases to perform either procedure in 1996, we use the hospital-level information instead. The same method was applied to the measurement of payment difference.

[6] To an extent this variable may also be related to the case mix facing individual physicians.

[7] However, this variable may be measured with error. The hospital-based physician in Taiwan not only provides the inpatient services, but also the outpatient services. In other words, the outpatient service may also constitute a significant part of physician income that affect physician's medical decision. Without incorporating this information, the estimation of the effect of share appears to be imprecise. Even so, the NHIRD does not contain sufficient information to compute physician's revenue produced in the outpatient department.

technology for the scale economy reason. We estimate this effect by computing the revenue share explained by patients who received any hysterectomy and any metacyesis treatment[8]. However, the anecdotal evidence also indicates that physicians may suggest the women over certain age to remove the ovary for the prevention reason[9] even if the nidus only occurs in the uterus, and vice versa. If this were the case, the physician would appear to report the more highly reimbursed as the principal treatment, the hysterectomy in this analysis. In such circumstance the competition effect may dominate the promotion effect[10][11].

With respect to compensation mechanism, nonetheless, there is no standard survey or inside information about the detailed revenue distribution mechanism at study hospitals. We use the hospital dummy as the proxy although it may also capture the management strategy, supporting equipment and medical staff within the hospital in tandem[12]. Other hospital characteristics, including dummies for the ownership (public and private), dummies for the hospital location (northern; central; southern), number of beds and department size (number of physicians in gynaecological department), may to some extent be related to above effects and market competition either[13].

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[8] Nonetheless, there is reason to believe that laparoscope can be applied to procedures of other diagnoses. We only included these two procedures since they are the only procedure also available in the PPS list.

[9] For example, they may say uterus and ovary are of no use after the child-bearing age but full of risk like bleeding and tumour.

[10] Alternative explanation is that physician time and the amount of the equipment and supporting staff are limited. When the hysterectomy patients account for a larger share of physician's caseload, the physician may prefer the less time consuming approach to perform oophorectomy since hysterectomy has taken much of above resources.

[11] Our data shows that the metacyesis treatment only accounts for a trivial proportion of physician revenue. Therefore it is quite likely to interpret the coefficient of the second revenue share variable as the interaction of promotion and competition effect.

[12] One reason to choose hospital as the proxy is the likelihood that the response to the compensation mechanism may be observed in the response to fee differential or to the procedure share in the different hospital context. In particular, there may be latent factors relating physicians' choice of hospital to practice (according to its compensation mechanism) to their medical decision. Hence the physician who prefers income to the leisure may work for the hospital with performance pay policy and thereby respond to the fee differential more significantly. However, the data in this study does not contain the information to test this hypothesis

[13] More specifically, the location dummy is to control the area specific effect, such as difference in population, income and practice pattern by area. The number of beds may be a reasonable indicator of

As for other covariates, data on physician characteristics does not contain sufficient information for us to identify when the physician joined the hospital whereby to estimate seniority[14]. Hence, age variable is used as the proxy to reflect physician's willingness to learn and to employ the new technology in terms of either financial reason or practice pattern. Physician sex is not taken into account because the overwhelming majority of the physicians in this study are male. In addition, we include a vector of characteristics of patients in order to control the potential diagnostic nature that may affect physician's decision: dummies for age groups (20-; 20-29; 30-39; 40-49; 50-59; 60-69; 70+); co-payment and number of diagnoses in an episode. A full set of year dummies (97; 98; 99; 00) and the month difference between the date the procedure was performed and the date the prospective price was effective are also included for controlling the secular differences in the rate of using laparoscope and physician's adaptation to the prospective payment policy respectively[15].

6 Results

The summary statistics on prices, volume, length of stay and revenue share for both oophorectomy and laparoscopic-assisted oophorectomy are presented in Table 1 and 2. On average, the revenue derived from any oophorectomy accounts for roughly 7% of physician's total practice revenue. The price for laparoscopic-assisted oophorectomy has been significantly increased by a larger scale after the prospective payment system as compared to that for oophorectomy. In response to this fee change, there is a clear increase pattern in the volume of laparoscopic-assisted oophorectomy between

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hospital capacity/willingness to introduce a new technology. Department size is related to the scale economy of introducing a new technology. For instance, the hospital will be more likely to purchase expensive equipment if there are more users/physicians in this department.

[14] As aforementioned, seniority is considered to be an important factor since it is about the distribution of physician fee.

[15] That is, the physician may make the decision in response to the underlying cost incentive of the prospective payment policy, particularly with respect to the treatment intensity.

1997 and 2000, though in a different rate across hospitals. On the contrary, the length of stay of patients of both procedures declines in this period.

Table 1

Revenue share of any oophorectomy in physician's practice by hospital (%)

	A	BN	BC	BS	C	D	E	FN	FS
1996	3.67	7.18	7.14	5.57	5.32	3.68	3.44	6.71	7.35
1997	5.05	6.86	3.67	6.91	4.89	4.34	4.23	7.06	7.85
1998	7.48	9.85	10.63	6.45	6.01	7.52	6.53	10.43	12.39
1999	8.37	8.03	8.77	6.92	6.76	6.38	5.58	10.71	10.60
2000	7.61	8.70	8.67	6.87	6.60	6.83	6.79	11.54	8.42

6.1. The effect of variables that affect physician income

The findings are shown in Table 3A and 3B, which present the estimation of the effect of the income-related variables on the procedure choice[16]. The estimated coefficients of fee differentials and share variable are significant across the procedure choice equation and the length of stay equation, but with opposite effect. The probability of employing laparoscopic-assisted oophorectomy increases with the fee differential and share. Although only two hospitals have statistically significant coefficients, the odds of performing laparoscopic-assisted oophorectomy increases with the hospital order, which may suggest that the higher proportion of performance pay encourages the physician to perform the highly reimbursed procedure. Similar increase movement can be also observed in the length of stay equation. One reason is that, conditional on all other factors, the physician whose income relies more on performance pay may have stronger incentive to keep the patient longer whereby raise the bed occupancy. The likelihood ratio test (LR test) rejects the null hypothesis that the two error terms are uncorrelated at the 99% confidence level, supporting that physician decision on procedure and length of stay is significantly and negatively correlated.

6.1.1. Relative sophistication

[16] For simplicity reason, in the following we mainly describe the results from the choice equation.

There seems to be evidence that the relative sophistication is also important in determining the procedure and treatment intensity. The estimated coefficients show that the greater complexity of laparoscopic-assisted oophorectomy not only significantly increases the treatment days, but also has a negative effect on physician choice for this procedure. Nonetheless, this effect may be mitigated by fee differential and with share variable, but augmented by its interaction with share variable in the length of stay equation.

6.1.2. Growth of other laparoscope-applicable diagnoses

We find that the laparoscopic-assisted oophorectomy rates decreases with the growth of other laparoscope-applicable diagnoses, particularly those which hysterectomy is performed for. Our results therefore imply that there exists competitive relation between two procedures[17]. On the other hand, the estimated coefficient of the interactive variable between own-share and others share exhibits a positive sign, indicating another promotion effect on the choice of this laparoscopic-assited procedure.

6.1.3. Payment difference

Surprisingly, the payment differences derived from procedures, either with or without laparoscope, have a positive effect on the choice of laparoscopic-assisted oophorectomy. One reason may be that those who are more capable of producing profits tend to perform the more sophisticated and higher reimbursed procedure. It is also likely that within a given level of diagnosis share and sophistication the physician who gains profits in the previous year may choose the better-paid procedure to maintain their income[18].

[17] In the other part of this research shows a positive effect of the other share variable, which implies more "oophorectomy cases" may promote the use of hysterectomy, which also strengthens the notion.
[18] This explanation is made based on the observation of the other procedure, hysterectomy, in which the estimated coefficients are significantly negative.

6.2. The interactive variables

The results of the second and the third approach are reported in column (2)-(4), in which the share variable is weighted by hospital dummy and fee differential respectively. The column (2) shows that there is no consistent pattern of physician medical decision in response to revenue share across hospitals in both equations: only two coefficients have expected positive sign in the procedure choice equation and all are positive in the length of stay equation. One would expect that this result may be attributed to various management policy and the limited supporting equipment that is also involved in the hospital variable[19]. To capture the interactive effect of compensation mechanism and share variable more precisely, we reestimate the model by adding the performance pay weight to the share variable, in which 1 refers to the flat salary paid in hospital A and in turn 6 refers to the full performance pay in hospital F. The estimated coefficients indicate that the greater part of physician income resulted from the performance pay, the larger opportunity the patient will receive laparoscopic-assisted oophorectomy and lower length of stay, though insignificant in the length of stay equation.

The column (3) shows the result of the interaction between fee differential and share. Although the magnitude is quite small, there is a statistically significant positive effect of this interactive variable on both equations: physicians that experienced increased revenue impact may have augmented incentives to choose laparoscope but have mitigated intention to reduce the length of stay.

Finally, as noted in the section of theoretical framework, physician income should be determined by the interaction of all above three variables. The estimation results in

[19] That is to say, independent of the influence of compensation mechanism, the hospital that either introduces the laparoscope earlier than others or has purchased larger amount of equipment may encourage the physician to use this technology. On the other hand, the hospital with the negative sign may suggest that the time consuming and expense characteristics of laparoscope may deterred physicians of some hospital from applying it into oophorectomy.

column (5) and (6) show that there is significantly positive effect observed in most of hospitals, but with a rather small scale. Given the sign of coefficients, the magnitude of the influence, however, does not increase with the hospital order either. We also test this model by including the interaction between fee differential, share and compensation weight. While the magnitude is still quite small, there is a significant pattern that the probability and the intensity are increased with the value of this variable.

6.3. Other covariates

The control variables are generally significant. We find a strong pattern of decreasing laparoscopic-assisted oophorectomy rates with physician age. Increased copayment exhibits positive coefficients on both procedure and intensity equations. Laparoscopic-assisted oophorectomy rates are highest for the age group 20-29 and lower with patients' age over this group, possibly reflecting that the older patients may be unable to endure a time consuming operation. Similar pattern can be observed in the estimated coefficients for the number of diagnoses. That patients of more diagnoses reported are less likely to receive laparoscope may indicate this procedure is more suitable for those with simpler syndrome. Laparoscopic-assisted oophorectomy rates are higher at private hospitals relative to public hospitals, and at hospital in central Taiwan as compared with those of other areas. They are also higher with the size of the department, while the number of bed has no significant effect. We also find a clear increasing pattern of laparoscopic-assisted oophorectomy rates over year, which implies that the use of laparoscope has become the norm of the profession for performing oophorectomy. On the other hand, the odds increase as the reimbursement policy was coming onto PPS but declines over time after the PPS was effective. Similar effect can be observed in the LOS equation, which is consistent with the findings of a number of papers.

7 Discussion

Since McGuire and Pauly (1991) develop a general model that emphasizes the relative strength of the income effect and the substitution effect is the decisive factor to determine physician response to reimbursement changes, there has been a number of empirical research with the focus on estimating this effect. This paper further adds the elements by incorporating the compensation mechanism feature of the hospital industry in Taiwan. With the fact that oophorectomy only explains a smaller share of a physician's caseload, while the magnitude is quite small, the empirical results support the hypothesis that there exists a positive relationship of this total effect with the rate of laparoscopic-assisted oophorectomy, and a negative relationship with the length of stay. This result also suggests that physicians will perform the more sophisticated procedure that bring about better health outcome only if their inputs are reimbursed adequately.

While it is likely that physicians will react in the similar way as long as there is some performance pay feature in the compensation mechanism, several limitations of this study may lead to the result of smaller scale. First, this analysis is restricted to six medical centres, in which academic research and teaching are expected to be their main purpose. Second, the lack of the exact information about the distribution rule at hospital and physician's seniority makes the measurement of the financial incentives with error. Furthermore, because the hospital-based physicians also provide health services in the outpatient department, without incorporating the revenue information in this department may fail to estimate the income effect facing individual physicians sufficiently, leading to the measurement bias. Finally, the date of laparoscope being introduced may be different across hospitals, which may influence physician's procedure choice either.

Table 2A Price information

Price for oophorectomy (H) and laparoscopic-assisted oophorectomy (I) by hospital in 1997*					PPS price of each procedure by year				
Hospital	(H)	(I)	Price ratio (I/H)	Fee differential (I-H)	Year	(H)	(I)	Price ratio (I/H)	Fee differential (I-H)
A	41532.11	28416.84	0.68	-13115.27	1997	31000(40390)			
BN	51456.15	34400.59	0.67	-17055.56	1998	31000(40390)/31690(40390)**	49100/49790	1.58/1.57	18100
BC	34702.47	24316.09	0.70	-10386.39	1999	31690(40390)	49790	1.57	18100
BS	43951.98	33409.10	0.76	-10542.88	2000	31690(40390)	49790	1.57	18100
C	31871.06	29362.94	0.92	-2508.13					
D	32730.87	26796.77	0.82	-5934.10					
E	28788.65	24567.32	0.85	-4221.33					
FN	37867.19	29481.16	0.78	-8386.03					
FS	29242.95	24934.27	0.85	-4308.68					

* This price is computed based on the average expense of study procedure performed in 1996

** The price in the parenthese is for the outliers and the PPS price was changed on July 1998 once.

Table 2B Total volume of oophorectomy (H) and laparoscopic-assisted oophorectomy (I) by hospital

	Hospital A		Hospital BN		Hospital BC		Hospital BS		Hospital C		Hospital D		Hospital E		Hospital FN		Hospital FS	
	H	I	H	I	H	I	H	I	H	I	H	I	H	I	H	I	H	I
1996	115	31	183	73	110	82	123	10	366	31	93	13	77	56	611	363	365	49
1997	171	48	249	103	76	32	159	30	365	39	136	28	90	84	573	463	470	39
1998	208	90	169	246	39	247	184	51	269	150	110	86	51	133	433	795	310	296
1999	248	102	107	317	32	213	181	71	248	221	86	62	35	113	328	825	210	302
2000	254	102	103	369	48	208	140	81	208	203	64	86	37	127	349	831	167	220

Table 2C Average length of stay of oophorectomy (H) and laparoscopic-assisted oophorectomy (I) by hospital

	Hospital A		Hospital BN		Hospital BC		Hospital BS		Hospital C		Hospital D		Hospital E		Hospital FN		Hospital FS	
	H	I	H	I	H	I	H	I	H	I	H	I	H	I	H	I	H	I
1996	7.66	2.68	9.76	5.30	4.74	2.10	9.57	5.90	6.74	4.97	5.73	3.46	5.32	3.66	6.75	4.26	5.73	3.84
1997	7.66	2.79	8.82	4.23	5.78	1.97	9.03	3.83	6.42	4.49	5.07	3.14	4.91	4.01	6.65	3.83	5.79	3.26
1998	7.67	2.71	8.15	3.63	6.18	2.83	5.05	2.41	5.23	2.39	5.67	3.15	6.10	4.02	7.22	3.54	6.37	3.07
1999	8.40	2.53	5.84	3.35	5.53	2.81	5.47	2.46	5.04	2.31	5.71	3.18	6.17	3.87	7.16	3.46	5.20	3.05
2000	7.25	2.45	6.10	3.38	6.00	2.87	5.32	2.84	5.16	2.42	6.56	3.57	8.27	3.73	7.18	3.33	5.49	3.09

Table 3A Procedure choice results

	(1)	(2)	(3)	(4)	(5)	(6)
	Model I	Model II	Model II	Model II	Model III	Model III
Physician age	-0.1778(0.0225)***	-0.1601(0.0227)***	-0.1685(0.0225)***	-0.1752(0.0225)***	-0.1665(0.0226)***	-0.1747(0.0224)***
Physician age^2	0.0018(0.0003)***	0.0016(0.0003)***	0.0016(0.0003)***	0.0017(0.0003)***	0.0016(0.0003)***	0.0017(0.0003)***
Fee differential	0.00005(7.56e-06)***	0.00005(7.64e-06)***	0.00005(7.63e-06)***	0.00004(7.92e-06)***	0.00003(7.77e-06)***	0.00004(7.39e-06)***
Share*HospitalB	-	-0.0055(0.0075)	-	-	-	-
Share*HospitalC	-	-0.0311(0.0138)**	-	-	-	-
Share*HospitalD	-	0.0378(0.0166)**	-	-	-	-
Share*HospitalE	-	-0.0572(0.0164)***	-	-	-	-
Share*HospitalF	-	0.0210(0.0069)***	-	-	-	-
Share*Compensation weight	-	-	0.0055(0.0011)***	-	-	-
Fee differential*Share	-	-	-	8.52e-07(2.43e-07)***	-	-
Share*HospitalB*Fee differential	-	-	-	-	6.28e-07(2.49e-07)**	-
Share*HospitalC*Fee differential	-	-	-	-	1.37e-06(4.96e-07)***	-
Share*HospitalD*Fee differential	-	-	-	-	1.47e-06(6.69e-07)**	-
Share*HospitalE*Fee differential	-	-	-	-	-1.60e-06(6.41e-07)**	-
Share*HospitalF*Fee differential	-	-	-	-	1.10e-06(2.04e-07)***	-
Fee differential*Share*Compensation weight	-	-	-	-	-	1.66e-07(3.31e-08)***
Relative sophistication	-1.6680(0.3658)***	-1.5945(0.3696)***	-1.7128(0.3685)***	-1.5097(0.3620)***	-1.1892(0.3630)***	-1.4926(0.3555)***
Payment difference H	4.40e-06(1.68e-06)***	4.79e-06(1.69e-06)***	4.63e-06(1.69e-06)***	5.17e-06(1.70e-06)***	5.17e-06(1.17e-06)***	5.08e-06(1.70e-06)***
Payment difference I	1.28e-06(1.56e-07)***	1.47e-06(1.59e-07)***	1.43e-06(1.59e-07)***	1.34e-06(1.57e-07)***	1.44e-06(1.59e-07)***	1.42e-06(1.59e-07)***
Share	0.0568(0.0027)***	0.0791(0.0063)***	0.0341(0.0050)***	0.0459(0.0044)***	0.0475(0.0035)***	0.0481(0.0032)***
Share of other diagnoses	-0.0080(0.0015)***	-0.0086(0.0015)***	-0.0082(0.0015)***	-0.0077(0.0015)***	-0.0079(0.0015)***	-0.0082(0.0015)***
Copayment	0.0003(8.06e-06)***	0.0003(8.11e-06)***	0.0003(8.08e-06)***	0.0003(8.06e-06)***	0.0003(8.13e-06)***	0.0003(8.08e-06)***
Patient age 20-	-0.3206(0.0617)***	-0.3243(0.0618)***	-0.3198(0.0619)***	0.3230(0.0617)***	-0.3263(0.0618)***	-0.3237(0.0617)***
Patient age 20-29	-	-	-	-	-	-
Patient age 30-39	-0.0097(0.0299)	-0.0095(0.0300)	-0.0110(0.0300)	-0.0121(0.0299)	-0.0168(0.0300)	-0.0153(0.0299)
Patient age 40-49	-0.2014(0.0361)***	-0.2038(0.0362)***	-0.2025(0.0362)***	-0.2051(0.0362)***	-0.2115(0.0363)***	-0.2074(0.0362)***
Patient age 50-59	-0.5353(0.0685)***	-0.5244(0.0687)***	-0.5269(0.0686)***	-0.5380(0.0685)***	-0.5350(0.0687)***	-0.5319(0.0685)***
Patient age 60-69	-1.0322(0.0992)***	-1.0237(0.0997)***	-1.0361(0.0996)***	-1.0297(0.0992)***	-1.0301(0.0995)***	-1.0342(0.0994)***
Patient age 70+	-1.7615(0.1469)***	-1.7462(0.1466)***	-1.7500(0.1463)***	-1.7721(0.1475)***	-1.7742(0.1474)***	-1.7725(0.1468)***
Number of diagnosis	-0.1995(0.0135)***	-0.2023(0.0135)***	-0.2017(0.0135)***	-0.2014(0.0135)***	-0.2036(0.0136)***	-0.2040(0.0135)***
Hospital B	0.6185(0.1018)***	0.7229(0.1268)***	0.5934(0.1016)***	0.6441(0.1022)***	0.5571(0.1064)***	0.6178(0.1017)***
Hospital C	0.7239(0.4666)	0.8536(0.4730)*	0.0318(0.1148)	0.6850(0.4677)	0.0293(0.1418)	0.6238(0.4691)
Hospital D	0.7580(0.5598)	0.3689(0.5756)	-	0.6959(0.5614)	-	0.5968(0.5635)
Hospital E	1.3311(0.5539)**	1.5234(0.5625)***	0.5414(0.0785)***	1.2604(0.5554)***	0.8307(0.1095)***	1.1485(0.5577)**
Hospital F	-	-	-0.6921(0.5617)	-	-0.5180(0.5734)	-
Number of beds	0.00007(0.00005)	0.00003(0.00005)	0.00005(0.00005)	0.00007(0.00005)	0.00006(0.00005)	0.00006(0.00005)
Department size	0.0296(0.0134)**	0.0229(0.0135)*	0.0261(0.0134)*	0.0283(0.0134)**	0.0240(0.0136)*	0.0245(0.0135)*
Central Taiwan	0.7309(0.2412)***	0.5920(0.2431)**	0.6433(0.2424)***	0.6976(0.2418)***	0.6357(0.2443)***	0.6271(0.2428)***
Southern Taiwan	0.0862(0.2800)	-0.0899(0.2824)	-0.0206(0.2817)	0.0543(0.2808)	-0.0262(0.2837)	-0.1741(0.2821)
Private	0.3941(0.2669)	0.3381(0.2751)	0.8986(0.3132)***	0.4335(0.2677)	0.8551(0.3245)***	0.3765(0.2678)
Year 1998	1.8524(0.1277)***	1.8309(0.1284)***	1.8583(0.1280)***	1.8234(0.1261)***	1.6838(0.1268)***	1.7752(0.1265)***
Year 1999	3.3883(0.1488)***	3.3394(0.1495)***	3.3778(0.1492)***	3.3537(0.1476)***	3.2083(0.1485)***	3.2991(0.1479)***
Year 2000	4.8763(0.1801)***	4.8455(0.1809)***	4.8725(0.1806)***	4.8519(0.1790)***	4.7174(0.1797)***	4.8062(0.1790)***
PPS time	-0.1206(0.0038)***	-0.1197(0.0038)***	-0.1202(0.0038)***	-0.1211(0.0038)***	-0.1205(0.0038)***	-0.1209(0.0038)***

Table 3B Intensity decision results

	(1)	(2)	(3)	(4)	(5)	(6)
	Model I	Model II	Model II	Model II	Model III	Model III
Physician age	0.02816(0.0065)***	0.0251(0.0065)***	0.0271(0.0065)***	0.0284(0.0065)***	0.0281(0.0065)***	0.0294(0.0065)***
Physician age^2	-0.0002(0.00007)***	-0.0002(0.00007)***	-0.0002(0.00007)***	-0.0002(0.00007)***	-0.0002(0.00007)***	-0.0003(0.00007)***
Fee differential	-0.00002(2.16e-06)***	-0.00002(2.16e-06)***	-0.00002(2.15e-06)***	-0.00003(2.29e-06)***	-0.00002(2.25e-06)***	-0.00002(2.17e-06)***
Share*HospitalB	-	0.0061(0.0018)***	-	-	-	-
Share*HospitalC	-	0.0117(0.004)***	-	-	-	-
Share*HospitalD	-	0.0043(0.0048)	-	-	-	-
Share*HospitalE	-	0.0278(0.0048)***	-	-	-	-
Share*HospitalF	-	0.0022(0.0018)	-	-	-	-
Share*Compensation weight	-	-	-0.0003(0.0003)	-	-	-
Fee differential*Share	-	-	-	2.58e-07(7.54e-08)***	-	-
Share*HospitalB*Fee differential	-	-	-	-	1.53e-07(6.41e-08)**	-
Share*HospitalC*Fee differential	-	-	-	-	-8.25e-07(1.49e-07)***	-
Share*HospitalD*Fee differential	-	-	-	-	8.20e-07(1.98e-07)***	-
Share*HospitalE*Fee differential	-	-	-	-	1.26e-06(1.94e-07)***	-
Share*HospitalF*Fee differential	-	-	-	-	2.16e-07(5.78e-08)***	-
Fee differential*Share*Compensation weight	-	-	-	-	-	3.66e-08(9.33e-09)***
Relative sophistication	0.8314(0.1030)***	0.7855(0.1032)***	0.8294(0.1029)***	0.8587(0.1033)***	0.7499(0.1042)***	0.8460(0.1029)***
Payment difference H	-1.49e-06(4.46e-07)***	-1.58e-06(4.45e-07)***	-1.50e-06(4.45e-07)***	-1.37e-06(4.47e-07)***	-1.22e-06(4.45e-07)***	-1.37e-06(4.46e-07)***
Payment difference I	-1.56e-07(3.60e-08)***	-1.81e-07(3.71e-08)***	-1.65e-07(3.71e-08)***	-1.49e-07(3.60e-08)***	-1.33e-07(3.67e-08)***	-1.27e-07(3.67e-08)***
Share	-0.0076(0.0007)***	-0.0117(0.0017)***	-0.0063(0.0011)***	-0.0118(0.0014)***	-0.0103(0.001)***	-0.0097(0.0009)***
Share of other diagnoses	0.0023(0.0004)***	0.0024(0.0004)***	0.0024(0.0004)***	0.0025(0.0004)***	0.0023(0.0004)***	0.0022(0.0004)***
Copayment	0.00002(2.88e-06)***	0.00002(2.87e-06)***	0.00002(2.88e-06)***	0.00002(2.88e-06)***	0.00001(2.87e-06)***	0.00002(2.88e-06)***
Patient age 20-	0.0938(0.0181)***	0.0940(0.0180)***	0.0935(0.0180)***	0.0935(0.0181)***	0.0917(0.0180)***	0.0927(0.018)***
Patient age 20-29	-	-	-	-	-	-
Patient age 30-39	0.0054(0.0087)	0.0049(0.0086)	0.0055(0.0087)	0.0051(0.0087)	0.0047(0.0086)	0.0048(0.0087)
Patient age 40-49	0.0936(0.0105)***	0.0933(0.0104)***	0.0932(0.0105)***	0.0931(0.0105)***	0.0944(0.0104)***	0.0933(0.0105)***
Patient age 50-59	0.2390(0.0193)***	0.2353(0.0193)***	0.2377(0.0193)***	0.2389(0.0193)***	0.2380(0.0192)***	0.2403(0.0193)***
Patient age 60-69	0.4613(0.0261)***	0.4561(0.0260)***	0.4596(0.0260)***	0.4605(0.0261)***	0.4584(0.0259)***	0.4616(0.0260)***
Patient age 70+	0.5432(0.0318)***	0.5382(0.0317)***	0.5410(0.0318)***	0.5431(0.0318)***	0.5410(0.0316)***	0.5441(0.0318)***
Number of diagnosis	0.0917(0.0038)***	0.0919(0.0038)***	0.0917(0.0038)***	0.0916(0.0038)***	0.0903(0.0038)***	0.0908(0.0038)***
Hospital B	-0.1031(0.0287)***	-0.1710(0.0341)***	-0.1017(0.0286)***	-0.0968(0.0287)***	-0.0981(0.03)***	-0.0980(0.0287)***
Hospital C	-0.0423(0.1353)	-0.0755(0.1362)	-0.2372(0.0336)***	-0.0514(0.1353)	-0.0493(0.0414)	-0.0702(0.1352)
Hospital D	0.1906(0.1624)	0.2124(0.1658)	-	0.1760(0.1625)	-	0.1488(0.1625)
Hospital E	0.2263(0.1608)	0.1078(0.1626)	0.0391(0.0244)	0.2124(0.1609)	0.0059(0.0347)***	0.1820(0.1610)
Hospital F	-	-	-0.1955(0.1621)	-	0.0189(0.1645)	-
Number of beds	0.00002(0.00001)	0.00002(0.00001)	0.00002(0.00001)	0.00001(0.00001)	3.11e-06(0.00001)	0.00001(0.00001)
Department size	0.0050(0.0039)	0.0058(0.0039)	0.0053(0.0039)	0.0049(0.0039)	0.0016(0.0039)*	0.0039(0.0039)
Central Taiwan	-0.1122(0.0695)	-0.1019(0.0695)	-0.1078(0.0694)	-0.1201(0.0695)*	-0.1783(0.0696)***	-0.1310(0.0695)*
Southern Taiwan	0.0221(0.0811)	0.0446(0.0811)	0.0285(0.0811)	0.0150(0.0811)	-0.0534(0.0813)	-0.0048(0.0812)
Private	-0.2084(0.0769)***	-0.2514(0.0782)***	-0.0007(0.0901)	-0.1987(0.0770)***	-0.1847(0.0931)***	-0.2086(0.0768)***
Year 1998	-0.3949(0.0368)***	-0.3809(0.0368)***	-0.3908(0.0367)***	-0.3981(0.0367)***	-0.3582(0.0369)***	-0.4053(0.0368)***
Year 1999	-0.6220(0.0436)***	0.6038(0.0436)***	-0.6146(0.0436)***	-0.6273(0.0436)***	-0.5844(0.0437)***	-0.6335(0.0436)***
Year 2000	-0.8070(0.0533)***	-0.7869(0.0532)***	-0.7970(0.0532)***	-0.8120(0.0532)***	-0.7599(0.0532)***	-0.8160(0.0532)***
PPS time	0.0141(0.0011)***	0.0138(0.0011)***	0.0139(0.0011)***	0.0141(0.0011)***	0.0139(0.0011)***	0.0140(0.0011)***
LAPA	-0.2271(0.0151)***	-0.2306(0.0152)***	-0.2320(0.0153)***	-0.2261(0.0150)***	-0.2334(0.0151)***	-0.2307(0.0151)***

Standard errors in parentheses. * Statistically significant at 10% level, ** statistically significant at 5% level, ***statistically significant at 1% level