HEALTH ECONOMICS
Health Econ. **10**: 325–339 (2001)
DOI: 10.1002/hec.602

PHYSICIAN BEHAVIOUR

PROVIDER PAYMENT REFORM IN CHINA: THE CASE OF HOSPITAL REIMBURSEMENT IN HAINAN PROVINCE

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SUMMARY

This paper develops a simple model of payment incentives and empirically evaluates provider payment reform in Hainan Province, China. We use a pre-post study design with a control group to analyse two years of claims data to assess the impact of a January 1997 change to prospective payment for a sub-sample of the hospitals. This difference-in-difference empirical strategy allows us to isolate the supply-side payment reform effects from demand-side changes, in contrast with previous studies of China's reforms. Our results validate the theory that Chinese providers' behavioural response to payment incentives is similar to that reported in the literature derived from the experience of industrialized countries. We find that prepayment is associated with a slower rate of growth of overall expenditures, programme spending and patient co-payments per inpatient admission, compared to fee-for-service (FFS). These findings suggest cautious optimism regarding the effectiveness of prospective payment for controlling costs and should be encouraging for policymakers in developing and transitional economies considering replacement of FFS with more aggregated forms of provider payment. Copyright © 2001 John Wiley & Sons, Ltd.

KEY WORDS — China; hospital reimbursement; pre-post control study design; prospective payment; urban health reform

INTRODUCTION

Health care providers often respond to financial incentives embedded in payment policies, as documented in numerous theoretically and empirically rigorous studies in industrialized countries. Do providers in developing and transitional economies respond similarly? Policy advisors have assumed that they do, yet the evidence is predominantly anecdotal. This paper seeks to contribute to filling this gap in the literature by focusing on a natural experiment in Hainan Province, China. We develop a simple, institutionally appropriate model of payment incentives, and empirically analyse Hainan's hospital payment reform of 1997.

Urban health care providers have traditionally been paid on a fee-for-service (FFS) basis in China. A FFS payment system has been shown to be associated with higher health expenditures than alternative payment systems in OECD countries [1]. China's FFS system, combining little cost-sharing on the demand-side, has contributed to

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Received 4 August 1999
Accepted 16 January 2001
Published online 18 May 2001

double-digit health cost inflation since the mid 1980s. This trend continued in the 1990s at a time when overall economy inflation rates shifted from double-digit to moderate levels (from 17.1% consumer price index (CPI) year-on-year inflation in 1995 to 8.3% in 1996 and 2.8% in 1997 [2]), raising concerns of affordability of health care for the Chinese. A recent report by the World Bank recommends that China move away from FFS payment toward negotiated prepayment for more aggregated products to control excessive health expenditure growth [3]. Payment reforms in that spirit have already been implemented in pilot areas in China, but there has been virtually no systematic analysis of their impact. Moreover, most analyses look at reform as a whole and are unable to disentangle the effects of demand-side insurance reforms and supply-side payment reforms, largely because both kinds of reforms have been implemented simultaneously and without any control groups.

One of the advantages of focusing on the Hainan experience is that demand-side reforms were initiated a year and a half prior to payment reform, so that the effects of the latter can be separated from the former. Moreover, there is a natural, albeit imperfect, 'control group' created by the implementation of payment reform only for a selected subset of hospitals. Prior to January 1997, all hospitals in Hainan were reimbursed on a FFS basis. In January 1997, this system was changed to prospective payment for six hospitals. By using a difference-in-difference (DD) empirical strategy we are able to isolate the effects of supply-side payment reform from demand-side changes, and from other factors in the environment that were changing at the time of payment reform yet cannot be controlled for. In a rapidly changing environment such as China's, there are many such confounding factors. Unprecedented economic growth, downward trend in economy-wide inflation rates, combined with systemic transformation from a centrally planned to a market-based economy all influence demand and supply of health care, along with more sector-specific trends such as technology diffusion and medical-specific cost inflation, shift from inpatient to outpatient services, coverage and benefit package changes (such as ability to choose between hospitals), etc. Our analysis finds that Hainan providers responded to the payment change as theory would predict. Prepayment is associated with a slower rate of growth of overall expenditures and programme spending per inpatient admission, compared to the control group.

Policymakers from many other Chinese areas show active interest in the 'Hainan model', which covered 123479 individuals as of September 1997 (over 70% of the then-eligible population). However, few abroad are aware of Hainan's reforms, and its experience has been largely overlooked in analyses of China's health care reforms (e.g. [3]). Our evaluation of the reforms should be policy relevant given the relative dearth of empirical analysis to guide the current expansion of health system reform into dozens of other areas covering millions of people in China. In fact, health insurance reforms have been singled out as one of the top national policy initiatives in the 1999–2002 period [4].

The paper is organized as follows. A simple theoretical model of payment incentives that captures the primary features of the Hainan system is presented in the next section. The data and our empirical methodology are then described in the third section. The results and limitations are then discussed in the fourth section.

A SIMPLE MODEL

Consider a hospital that seeks to maximize net revenue. In treating patients in a given period (month or year), the hospital incurs total costs **C**. A payer, such as the social insurance fund (SIF) in Hainan, pays the hospital a combination of a fixed budget **B** and reimbursement for the fraction $(1-\mathbf{s})$ of costs. (Although **B** is fixed in one period, we will discuss endogenous setting of **B** in a two-period model below.) The fraction s represents 'supply-side cost sharing' [5]: the proportion of costs that the payer does not reimburse and therefore the supplier—the hospital—must 'share'. Thus, the hospital's net revenue is prepayment **B** less cost **C** plus cost reimbursement $(1-\mathbf{s})\mathbf{C}$:

$$\pi = \mathbf{B} - \mathbf{C} + (1-\mathbf{s})\mathbf{C}$$

or

$$\pi = \mathbf{B} - \mathbf{sC}. \tag{1}$$

Prospective payment involves prepayment of a fixed budget $\mathbf{B} > 0$ and making the hospital responsible for a significant share of costs, $\mathbf{s} > 0$

(e.g. $\mathbf{s} = 1$ implies $\pi = \mathbf{B} - \mathbf{C}$). Pure cost reimbursement combines no prepayment, $\mathbf{B} = 0$, with exact reimbursement of costs, $\mathbf{s} = 0$ (implying that the hospital neither retains net revenues nor incurs cost overruns: $\pi = 0$). FFS also features no prepayment, $\mathbf{B} = 0$, but reimburses the hospital full costs plus a profit margin, $\mathbf{s} < 0$ (e.g. $\mathbf{s} = -0.1$ implies that $\pi = 0.1 \cdot \mathbf{C}$).

The higher the level of supply-side cost sharing $\mathbf{s}$, the greater the hospital's incentive to reduce costs. We can see this more clearly by considering an action that the hospital can take to reduce costs. Let $\mathbf{e}$ denote provider cost control effort that results in efficiency improvements reducing $\mathbf{C}$ at a decreasing rate: $\mathbf{C}'(\mathbf{e}) < 0$; $\mathbf{C}''(\mathbf{e}) > 0$. The effort cost of efficiency improvements is denoted $\gamma(\mathbf{e})$ and is strictly convex in $\mathbf{e}$ [6]. Net revenues are thus given by

$$\pi(\mathbf{e}) = \mathbf{B} - \mathbf{s} \cdot \mathbf{C}(\mathbf{e}) - \gamma(\mathbf{e}). \tag{2}$$

Let the first order condition be sufficient for definition of a unique revenue-maximizing choice of cost-reducing effort, $\mathbf{e}^*$:

$$-\mathbf{s} \cdot \mathbf{C}'(\mathbf{e}^*) = \gamma'(\mathbf{e}^*). \tag{3}$$

The marginal benefit of cost-reducing effort—the left-hand side of (3)—is increasing in $\mathbf{s}$. Under FFS or pure cost reimbursement ($\mathbf{s} \leq 0$), there is no benefit to the hospital from cost reduction and therefore $\mathbf{e}^* = 0$. In contrast, purely prospective payment ($\mathbf{s} = 1$) gives the largest incentive to reduce costs. These incentives are summarized in the following proposition.

Proposition 1

$$\frac{d\mathbf{e}^*}{d\mathbf{s}} > 0.$$

The optimal level of cost-reducing effort, $\mathbf{e}^*$, increases with the degree of supply-side cost sharing, $\mathbf{s}$.

Proof: see Appendix A.

This result is quite intuitive: payment reform that replaces FFS with prospective payment increases a hospital's incentive to control costs.

Hainan's prepayment contract

The Hainan Social Protection Bureau applied this logic when designing its 1997 payment reform. Prior to January 1997, all hospitals in Hainan were reimbursed on a FFS basis, with *ex post* approval/auditing beginning in July 1995 when demand-side insurance reforms took effect. The 1995 insurance reforms instituted city-wide risk pooling in the provincial capital of Haikou for urban employees in the formal sector, covering approximately 50% of the urban population or 20% of the total population. The insurance scheme is financed by an 11% payroll tax. These funds flow into the SIF to cover catastrophic hospitalization expenses and into individual medical savings accounts to cover patient co-payments. Beginning in January 1997, the insurance scheme replaced FFS with prospective payment for six hospitals. The reformers chose these hospitals because in 1996 they together represented 83% SIF expenditures and 75% of SIF inpatient admissions [7].

Each of the six chosen hospitals receives prospectively each month 90% of what the SIF reimbursed that hospital during the corresponding month the previous year. The balance 10% of the budget is reimbursed at the end of the year if the hospital passes a quality assurance review. There is also an adjustment at the end of the year based on 'the primary reasonable factors influencing health care costs' [8, p. 22], such as inflation or unanticipated increases in admissions.

Hainan's prepayment system is not case-based (such as the Prospective Payment System of Diagnosis Related Group payment in the US). Rather, Hainan's payment system is more akin to a global budget or a cost-and-volume contract. The hospital can only retain residual savings from the prospective payment if two conditions are met. First, the number of cases $\mathbf{N}$ must be at least 90% of the previous year's. Second, the total spending $\mathbf{C}$ must be at least 90% of the budget. In designing this payment structure, the Social Protection Bureau aimed 'to assure that hospitals do not go so far as to harm patients' interests in order to come in under budget' [8, p. 25].

Moreover, Hainan's reform hospitals face a nonlinear schedule of supply-side cost sharing. If the reimbursable expenditures of the hospital exceed the prospective payment, the hospital bears an increasing percentage of the cost overrun: if total expenditures exceed the prospective payment by 10% or less, the hospital must pay 30% and the SIF will reimburse 70%; for cost overruns over 10% but less than 20%, the hospital must pay

50%; and for cost overruns over 20%, the hospital must pay 100% of the cost overrun. This cost-sharing for budget overruns was designed 'to avoid adversely impacting patients' medical treatment from target rates being set too rigidly' [8, p. 25]. Since payment depends on both cost and volume, the contract gives hospitals some insurance against unforeseen contingencies; this allows the payer to command a lower price by reducing the risk premium for participation [9], although it also introduces potential for gaming the nonlinear features of the contract (such as distorted incentives around the 'break points').

In sum, under Hainan's prepayment contract, assuming an acceptable quality assurance review, a hospital's net revenue π is given by:

$$\pi = \mathbf{B} - \mathbf{sC}$$

with

$$\mathbf{s} = 1 \text{ if } \mathbf{B} \geq \mathbf{C} \geq 0.9\mathbf{B} \text{ and } \mathbf{N} \geq 0.9\mathbf{N}_0;$$

$$\mathbf{s} = 0.3 \text{ if } 1.1\mathbf{B} \geq \mathbf{C} > \mathbf{B};$$

$$\mathbf{s} = 0.5 \text{ if } 1.2\mathbf{B} \geq \mathbf{C} > 1.1\mathbf{B};$$

$$\mathbf{s} = 1 \text{ if } \mathbf{C} > 1.2\mathbf{B};$$

$$\text{otherwise } \mathbf{s} = 0. \tag{1'}$$

The ratchet effect

The dynamic properties of the contract also shape cost-reduction incentives. To reduce programme spending, there must be a mechanism for cost reductions to decrease payment, not merely increased hospital net revenue. In Hainan this is achieved by using period 1 reported costs to set period 2 prospective budgets. When hospitals reduce the rate of growth of claims expenditures, the SIF benefits from a lower rate of growth of prospective budget spending. Yet this budget-setting rule also reduces hospitals' incentives to control costs through the well-known 'ratchet effect' [10,11].

The ratchet effect can be illustrated with the following simple two-period model. A hospital seeks to maximize net revenue over two periods, discounting second period net revenue by the factor δ $(1 > \delta \geq 0)$. Total net revenue is given by

$$\pi = \mathbf{B}_0 - \mathbf{s}\cdot\mathbf{C}(\mathbf{e}_0) - \gamma(\mathbf{e}_0) + \delta[\mathbf{B}_1 - \mathbf{s}\cdot\mathbf{C}(\mathbf{e}_1) - \gamma(\mathbf{e}_1)]. \tag{4}$$

Suppose that $\mathbf{s} = 1$ and that the payer sets the hospital's second period budget to be equal to the first period's reported costs: $\mathbf{B}_1 = \mathbf{C}(\mathbf{e}_0)$. (Typically there would be an adjustment for inflation, etc., but let us ignore these factors for now.) This budget-setting rule introduces a 'ratchet effect' whereby cost reduction achieved in the first period increases first period net revenue but 'ratchets down' the budget and net revenue in the second period. Substituting the budget-setting rule into (4) and solving for optimal $\mathbf{e}_0$, we see that the provider will choose a level of cost-reducing effort in the first period that balances the benefit of cost reduction against both direct effort cost and the opportunity cost of a reduced second period budget:

$$-\mathbf{C}' = \gamma' - \delta\mathbf{C}'. \tag{5}$$

Proposition 2

$$\frac{\mathrm{d}\mathbf{e}_0^*}{\mathrm{d}\delta} < 0.$$

First period cost-reducing effort is decreasing in the discount rate on period two net revenue (the ratchet effect).

Proof: see Appendix A.

The second term on the right-hand side of (5) is the ratchet effect. Note that if the hospital were myopic and placed no value on second period net revenue ($\delta = 0$), then the ratchet effect would disappear. (In that case, (5) would be the same as (3) with $\mathbf{s} = 1$.) As the value placed on the future increases, the ratchet effect increases the marginal cost of first-period effort. The ratchet effect present in the Hainan payment scheme therefore counteracts to some extent the incentive created by supply-side cost sharing to exert effort to reduce costs.

This simple theoretical model reveals that Hainan's prepayment contract for the six major hospitals gives incentives for cost reduction, bounded by the 90% cost and volume requirement, modified by the non-linear cost sharing, and mitigated by the ratchet effect. We will refer to the six prospectively paid hospitals as 'reform hospitals' in recognition of the multiple incentive effects, which counteract each other. *A priori*, it is unclear to what extent providers will respond to these incentives, and which incentive dominates.

The overall impact of payment reform is an empirical question.

To isolate the separate effects of the various incentives (prepayment, 90% cost and volume requirement, non-linear cost-sharing, and ratchet effect) implicit in Hainan's prepayment contract would be an extremely stimulating research endeavour. However, it also requires extensive, detailed data. Unfortunately, such data is not available. We instead seek to identify the overall, net effect of the prepayment contract on hospital behaviour. Will the reform hospitals change practices so as to decrease expenditures, or will inertia and the potential ratchet effect lead to little if any change?

EMPIRICAL ANALYSIS

Data

Our analysis of the net impact of payment reform focuses on expenditure per admission rather than total number of admissions (N) or total expenditures (**C**) because we only have 14 hospitals, which would not allow us sufficient degrees of freedom for statistical analysis. The data used are from inpatient claims data submitted to the Department of Health Insurance of the Hainan Social Protection Bureau. Since Hainan's insurance programme covers only catastrophic (inpatient) expenditures, the data cover all programme spending and relevant copayment, but not total health spending (since we lack information on outpatient expenditures).

The study period spans two years, from the initiation of the insurance reforms in July 1995–June 1997. The data therefore includes half a year of claims after the payment system reforms began in January 1997.

Beginning with a data set of 5171 inpatient admissions, elimination of observations with incomplete or incorrectly coded records, Hadi multivariate expenditure outliers ($p = 0.05$) and hospitals with exceptionally low *insured* patients admissions, resulted in a final sample of 4213 inpatient admissions in 14 hospitals. The sample included all six reform-hospitals and eight FFS hospitals that are comparable to the reform hospitals in terms of scale and scope of service provision. The means and standard deviations of variables are listed in Table 1. Average total inpatient expenditure is 6016 RMB yuan and average length of stay (LOS) is 27.5 days. The latter is almost three times the OECD median LOS, but not unrepresentative of many developing and Asian countries (Japan's ALOS was 43 days in 1997) [12].

'Expenditure' refers to reported medical claims data, not actual costs. Total expenditure has two primary components: programme (SIF) spending and patient co-payments.

$$\text{Total Inpatient Expenditure} = \text{Program Expenditure} + \text{Patient Co-payments} + \text{Disallowed Expenditure}. \quad (6)$$

A third component is disallowed expenditures (i.e. expenditures deemed un-reimbursable after claims auditing), which averaged about 3% and 9% of total expenditures for FFS and reform hospitals, respectively (3.6% and 11.3% in the pre-reform 1995–1996 period).

Empirical specification

Our analysis uses a DD methodology, or a pre-post design with control group [13,14]. This method represents an improvement over pre-post comparison without a control group. Most analyses of reforms in China to date have adopted the intuitive pre-post comparison approach. A problem with that methodology is that if other factors in the environment are changing at the same time as the payment change yet cannot be controlled for statistically, then the analysis incorrectly attributes their effect to the payment change. In a rapidly changing environment such as China's, there are many such confounding factors, as discussed in the 'Introduction'.

One solution is to find a control group that experiences similar changes in the environment but does not experience the payment change. For our study, eight FFS hospitals that are comparable to the reform hospitals in terms of scale and scope of service provision, and also treated a non-trivial share of insured patients represent this control group. Their insured patients were covered by the same benefit package, their services subject to similar economic factors, etc.

To analyse the impact of the payment system reform on (the natural log of) expenditures per admission, we use a DD approach. This methodology is based on intuitive comparisons—before and after the policy change, for the treatment and

Table 1. Variables and mean values ($N = 4213$)

Variable name	Definition	Mean	S.D.
Expen	Total expenditures per admission (RMB)	6015.5	7961.68
Programx	Programme expenditures per admission (RMB)	4114.84	5470.10
Patientx	Patient co-payments per admission (RMB)	1382.27	3349.22
LOS	Length of stay (days)	27.50	31.15
Reform	Dummy variable = 1 if hospitalized in a reform hospital (in any year)	0.91	0.28
Policy	Dummy variable = 1 if hospitalized in 1997	0.23	0.42
Reform * Policy	Dummy variable = 1 if hospitalized in 1997 in a reform hospital	0.20	0.40
Age	Patient age in years	51.25	14.12
Age^2	Patient age in years squared	2826.30	1428.04
Retired	Dummy variable = 1 if patient is retired	0.38	0.48
Male	Dummy variable = 1 if male, 0 if female	0.68	0.47
Infect	Dummy variable = 1 if patient diagnosed with an infectious disease	0.07	0.25
Tumour	Dummy variable = 1 if patient diagnosed with a tumour	0.16	0.37
Circu	Dummy variable = 1 if patient diagnosed with a circulatory system condition	0.22	0.42
Resp	Dummy variable = 1 if patient diagnosed with a respiratory system condition	0.10	0.30
Digest	Dummy variable = 1 if patient diagnosed with a digestive system condition	0.14	0.35
Urolrep	Dummy variable = 1 if patient diagnosed with urology and/or reproductive system condition(s)	0.10	0.30
Tertref	Dummy variable = 1 if patient hospitalized in a tertiary reform hospital (in any year)	0.76	0.43
Ntertref	Dummy variable = 1 if patient hospitalized in a non-tertiary reform hospital (in any year)	0.15	0.36

control groups—controlling for other relevant factors. We operationalize this method with the following empirical specification (see Table 2):

$$\begin{aligned}\ln(\text{expen}_i) = {} & \beta_0 + \beta_1\text{Reform}_i + \beta_2\text{Policy}_i \\ & + \beta_3\text{Reform}_i * \text{Policy}_i + \beta_4\text{Age}_i + \beta_5(\text{Age}_i)^2 \\ & + \beta_6\text{Retired}_i + \beta_7\text{Male}_i + \beta_8[\text{Diagnosis}_i] \\ & + \beta_9[\text{Year}_i] + \beta_{10}[\text{Month}_i] + \varepsilon. \end{aligned} \tag{7}$$

Reform_i is a dummy variable equal to 1 if patient i is treated in one of the six reform hospitals. β_1 thus captures all time-independent differences in 'treatment' versus 'control' hospitals. The reform hospitals include the most sophisticated facilities available in the province, so their case mix is likely to be different from that of the hospitals that were paid on a FFS basis throughout the 2-year period: we expect $\beta_1 > 0$. Policy_i is a dummy variable equal to 1 if patient i was hospitalized in 1997, the year that the policy change was implemented. β_2 captures the difference in 'before' and 'after' the policy was implemented. Given increasing input costs of care, we expect $\beta_2 > 0$ as a crude measure of time trend factors, which are also controlled for by other

Table 2. The DD methodology

	Reform hospitals (treatment group)	FFS hospitals (control group)
Before (July 1995–December 1996; Policy = 0)	$\beta_0 + \beta_1$	β_0
After (January 1997–June 1997; Policy = 1)	$\beta_0 + \beta_1 + \beta_2 + \beta_3$	$\beta_0 + \beta_2$
Difference (After–Before)	$\beta_2 + \beta_3$	β_2
DD ($\text{Diff}_{\text{Reform}} - \text{Diff}_{\text{FFS}}$)	$\langle\beta_3\rangle$	

year and month dummy variables ($Year_i$ and $Month_i$). The DD estimate of the impact of payment reform is captured by the coefficient β_3 on the interaction term $Reform_i * Policy_i$ (equal to 1 if patient i is hospitalized in a reform hospital in 1997). Since demand-side factors are similar for all hospitals and trends (β_2) are differenced out, this methodology allows isolation of supply-side effects (β_3).

We control for patients' age (Age and Age^2, to account for nonlinear effects), gender (Male), retiree status (Retiree) and diagnosis category (see Table 1). Similar regressions were used to analyse the impact of reform on the primary components of expenditures, programme spending and patient co-payments, as well as length of stay (LOS).

RESULTS

Consistent with theoretical predictions, total expenditure and its two primary components showed sizable DD cost reductions associated with prospective payment (see Table 3). Average total expenditure per admission in the reform hospitals fell by 1688 RMB yuan after the reform, while that of FFS hospitals grew by 1790 RMB yuan, leading to a DD estimate of the impact of payment reform of -3478 RMB yuan. This suggests that prepayment was associated with a 54% reduction in expenditure per admission for this sample of hospitals. This contrasts with the 12% growth in expenditure per admission between 1995 and 1996 (before payment reform) for all Haikou inpatient admissions [15].

Reform hospitals recorded a 556 RMB yuan decrease in programme spending per admission in 1997, compared with a 1614 RMB yuan increase for the FFS hospitals. Recall that programme expenditures refer to expenditure from the social insurance fund, corresponding to the total bill less patient cost sharing and expenditures disallowed after auditing. This result suggests that prepayment led to slightly more than a 50% reduction in programme spending per admission relative to what would likely have occurred in the absence of reform.

Patients also benefited from the cost reduction incentives of prepayment. Co-payments per admission for reform hospitals declined by 420 RMB yuan, while those for comparable FFS hospitals increased by 162 RMB yuan, suggesting that prepayment was associated with about a two-fifths reduction in co-payments.

Average LOS decreased across all hospitals. This reveals the importance of a control group; the seven-day decline in reform hospitals' LOS—a 25% decrease—could easily have been attributed to the payment reform, had the almost 8-day (20%) decline in FFS hospital LOS not revealed that LOS would probably have declined to a similar extent even in the absence of payment reform. This across-the-board decline in average LOS is consistent with, although larger in magnitude than, the national trend of about 5% annual decline in average LOS in the latter half of the 1990s.

Table 4 shows the results of multivariate regressions on different categories of expenditures following specification (7). The coefficient estimates largely conform to expectations. The DD variable (Reform * Policy) is negative and statistically significant at the 1% level in all but the LOS regression, showing that payment reform is associated with a relative decrease in expenditures at the reform hospitals. Those hospitals (Reform = 1) have statistically significantly higher total, programme total, and patient co-payment expenditures, but shorter LOS than FFS hospitals. The positive and statistically significant coefficients for the Policy variable indicate that the trend of increasing expenditures continued in 1997 across all hospitals.

Results for the other variables are largely consistent with expectations. Expenditures and LOS increase with age at a decreasing rate. Patient co-payments are significantly less for retirees, as dictated by the benefits package. Although the overall regressions are all statistically significant, the adjusted r^2 are quite low. However, this is not uncommon for medical expenditures regression analyses.

The main result is that the change to prospective payment did significantly reduce inpatient expenditure growth for patients treated at the reform hospitals, relative to the FFS control group. Both the insurer (SIF) and the patient benefited from this cost control. We focus on inpatient spending rather than overall spending because we only have access to inpatient claims data and therefore cannot analyse the extent to which there may have been substitution from inpatient to outpatient expenditure for treating an episode of illness. In separate work, we also find that prepayment led to a significant reduction in growth of spending on expensive drugs and high technology procedures [16]. Overall, the significant DD impact of

Table 3. Impact of payment reform: average DD estimates

	Reform hospitals			FFS hospitals			DD	DD as % of reform before
	Before	After	Diff	Before	After	Diff		
Average expenditure per admission	6428.50 [8264.8]	4740.27 [6254.2]	−1688.23 [304.06] {−5.55}	5138.26 [7927.9]	6927.81 [10233.1]	1789.55 [995.21] {1.80}	−3477.78 [962.74] {−3.61}	−54.10
Average program expenditure per admission	4231.49 [5362.5]	3675.71 [4966.1]	−555.78 [204.12] {−2.72}	3732.76 [6727.3]	5346.80 [8052.4]	1614.04 [820.49] {1.97}	−2169.82 [663.12] {−3.27}	−51.28
Average patient copayments per admission	1482.85 [3819.2]	1062.81 [1659.3]	−420.04 [133.67] {−3.14}	1268.15 [1498.6]	1429.84 [2530.9]	161.69 [213.25] {0.76}	−581.73 [406.15] {−1.43}	−39.23
Average length of stay per admission	28.10 [30.9]	20.95 [19.3]	−7.15 [1.11] {−6.43}	40.13 [50.1]	32.28 [40.6]	−7.85 [5.47] {−1.43}	0.70 [3.74] {0.19}	2.49

'Before' is 1995–1996; 'After' is 1997; Diff is after minus before; DD is diff for reform hospitals minus diff for FFS hospitals. The number of observations is 2983 in 1995–1996 and 861 in 1997 for reform hospitals, and 263 in 1995–1996 and 106 in 1997 for FFS hospitals. S.D. are in square brackets and t-statistics are in braces.

Table 4. Multivariate regression DD estimates of the impact of payment reform

Variable	Total expenditures per admission (natural log)	Programme expenditures per admission (natural log)	Patient co-payments per admission (natural log)	Length of stay (days) (natural log)
Reform * policy	−0.5283**	−0.4257**	−0.4444**	−0.0507
	(0.0997)	(0.1220)	(0.0868)	(0.1082)
Reform	0.3008**	0.2424**	0.2039**	−0.1741**
	(0.0531)	(0.0650)	(0.0461)	(0.0576)
Policy	0.4431**	0.5753**	0.2131*	0.0053
	(0.1047)	(0.1282)	(0.0911)	(0.1136)
Age	0.0250**	0.0323**	0.0175**	0.0424**
	(0.0059)	(0.0073)	(0.0052)	(0.0064)
Age^2	−0.0002**	−0.0002**	−0.0001**	−0.0004**
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Retired	−0.0632	0.1118*	−0.5293**	0.0338
	(0.0422)	(0.0517)	(0.0367)	(0.0458)
Male	0.0636*	0.0926**	0.0232	0.0724*
	(0.0291)	(0.0356)	(0.0252)	(0.0316)
Infectious	0.1929**	0.1967**	0.2179**	0.3218**
	(0.0576)	(0.0705)	(0.0500)	(0.0625)
Tumour	0.2702**	0.3106**	0.1189**	0.0438
	(0.0425)	(0.0521)	(0.0370)	(0.0462)
Circulatory	0.2108**	0.1964**	0.1696**	−0.0381
	(0.0404)	(0.0494)	(0.0351)	(0.0438)
Respiratory	0.0711	0.0694	0.0684	−0.1556**
	(0.0493)	(0.0603)	(0.0428)	(0.0535)
Digestive	−0.1252**	−0.2076**	−0.0198	−0.4051**
	(0.0441)	(0.0540)	(0.0383)	(0.0478)
Urol_Repr	−0.0177	−0.0213	0.0590	−0.1329*
	(0.0488)	(0.0597)	(0.0424)	(0.0529)
Constant	7.4852**	6.7974**	6.2467**	1.7890**
	(0.1728)	(0.2115)	(0.1431)	(0.1875)
N	4213	4213	4210	4213
Adjusted r^2	0.0844	0.0789	0.1591	0.0802
Prob > F	0.0000	0.0000	0.0000	0.0000
Root MSE	0.8157	0.9987	0.7082	0.8852

Standard errors in parentheses.
* Statistically significant at the 5% level; ** statistically significant at the 1% level; all regressions also include year and month dummy variables.

prepayment on expenditures suggests that supply-side cost sharing can be powerful in helping to control costs.

The validity of the DD methodology

For the DD methodology to be valid, two assumptions need to be satisfied. First, the trends in uncontrolled factors should be similar for the FFS and reform hospitals across the period of policy intervention. Otherwise, the analysis cannot separate the impact of the intervention—the payment reform—from that of the uncontrolled factor(s). Fortunately in Hainan's case, this first assumption is well satisfied, since the primary factors that would confound measurement of the impact of reform—in particular, demand-side policies, technological change, and area-wide economic factors—affect all the hospitals in the study to a similar extent.

A second assumption is that the experiment—payment reform—is exogenous. In other words, the treatment group—reform hospitals—should be randomly assigned, and there should not be any systematic relationship that is unobservable or uncontrolled for between the reform/control hospitals and the growth of the dependent

variables of interest (e.g. inpatient expenditures per admission). We examined the extent to which this assumption is satisfied.

In Hainan, the hospitals chosen for prospective payment represent the majority of SIF inpatient admissions. They are also more technologically and managerially sophisticated than the hospitals that continued to be paid on a FFS basis. Table 5 compares the two groups of hospitals (prior to payment reform). On average, the reform hospitals are more 'expensive', in terms of total expenditure per admission, programme spending and patient co-payments. The FFS hospitals in the comparison group, although representing a relatively small share of total SIF admissions, are by no means cottage hospitals; they include, for example, a municipal (as opposed to provincial) People's Hospital and a military hospital. Unfortunately we do not have data on hospital characteristics such as bed size, managerial capacity, etc. Since there might be factors specific to individual hospitals that affect behaviour, we conducted sensitivity analysis by estimating the same models with hospital fixed effects to capture such hospital-specific effects. As shown in Table 6, the results were robust.

We also examined the *trends* in expenditures for the two groups of hospitals in the pre-intervention period to see if there existed any systematic differences between the reform and control groups, since *differences* in trends would not be captured by a DD model. We compared the growth in average expenditure per admission during the period prior to the payment policy change (with 2-month moving averages, excluding the months immediately preceding the change) and found that the pre-reform trends were similar. In particular, a t-test of the difference between the reform and FFS hospitals' average pre-1997 expenditure growth rates of 3.3% and 4.4%, respectively, confirms that there is no statistically significant difference ($t = -0.241$, $p < 0.4070$, one-tail test). This result is reassuring, since it indicates that the second assumption underlying the validity of the DD methodology is adequately satisfied, even though the members of the two groups are not identical in their baseline expenditure levels.

On balance, we believe that the DD estimates are indicative of the impact of prospective payment, although the specific coefficient magnitudes should be interpreted with caution.

Table 5. Characteristics of reform and FFS hospitals (based on data for 1995–1996, prior to payment reform)

Characteristic	Mean for reform hospitals	Mean for FFS hospitals	t-statistic for difference in means
Patient characteristics			
Age	50.90	50.56	−0.3770
Percentage male	0.67**	0.76	3.0698
Percentage retired	0.36	0.37	0.1754
Average length of stay	28.10**	40.13	5.6826
Average expenditures			
Expenditure per admission	6428.50**	5138.26	−2.4349
Patient co-payment expenditure	1482.85	1268.15	−0.9054
Programme expenditure	4231.49	3732.76	−1.4135
Patient co-payments per day	83.47**	62.98	−3.1173
Programme expenditure per day	184.39**	141.78	−3.0468
Frequency of cases by diagnosis			
Infectious diseases	0.06**	0.11	2.6852
Tumours	0.17**	0.08	−3.6669
Circulatory system disorders	0.23	0.21	−0.6143
Respiratory system disorders	0.10*	0.06	−1.7920
Digestive system disorders	0.14	0.14	−0.0350
Urology and reproductive system disorders	0.11**	0.04	−3.7782
Other diagnosis	0.19**	0.36	6.5445

* (**) Indicates that the difference in the two mean values is statistically significant at the 5% (1%) level, one-tail test.

Table 6. Fixed effect regression DD estimates of the impact of payment reform

Variable	Total expenditures per admission (natural log)	Programme expenditures per admission (natural log)	Patient co-payments per admission (natural log)	Length of stay (days) (natural log)
Reform * Policy	−0.5324**	−0.4073**	−0.3828**	−0.2120
	(0.1053)	(0.1278)	(0.0921)	(0.1114)
Policy	0.4530**	0.5747**	0.1296	0.2152
	(0.1106)	(0.1342)	(0.0968)	(0.1170)
Age	0.0238**	0.0300**	0.0176**	0.0396**
	(0.0059)	(0.0072)	(0.0052)	(0.0063)
Age^2	−0.0002**	−0.0002**	−0.0001**	−0.0003**
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Retired	−0.0659	0.1088*	−0.5219**	−0.0102
	(0.0421)	(0.0511)	(0.0367)	(0.0446)
Male	0.0649*	0.0906**	0.0253	0.0668*
	(0.0288)	(0.0350)	(0.0251)	(0.0305)
Infectious	0.2423**	0.2754**	0.2201**	0.4119**
	(0.0578)	(0.0702)	(0.0504)	(0.0612)
Tumour	0.2936**	0.3659**	0.0987**	0.1340**
	(0.0429)	(0.0521)	(0.0374)	(0.0454)
Circulatory	0.2254**	0.2303**	0.1518**	−0.0034
	(0.0417)	(0.0506)	(0.0363)	(0.0441)
Respiratory	0.0881	0.0940	0.0749	−0.1266*
	(0.0495)	(0.0601)	(0.0431)	(0.0524)
Digestive	−0.0838	−0.1303*	−0.0310	−0.2972**
	(0.0445)	(0.0540)	(0.0387)	(0.0471)
Urol_Repr	0.0057	0.0375	0.0312	−0.0339
	(0.0489)	(0.0594)	(0.0427)	(0.0518)
Constant	7.3220**	6.4704**	6.6960**	1.6280**
	(0.1543)	(0.1873)	(0.1610)	(0.1633)
N	4213	4213	4210	4213
Prob > F	0.0000	0.0000	0.0000	0.0000

Standard errors in parentheses.
* Statistically significant at the 5% level; ** statistically significant at the 1% level. All regressions also include year and month dummy variables. With hospital fixed effects, the Reform variable is dropped.

Cost shifting, underprovision and selection

The results for Hainan suggest that prepayment can be an effective instrument for controlling expenditure growth. Nevertheless, caution is warranted because the payment change may have led to unmeasured reductions in quality of care, cost shifting to the uninsured and unwanted risk selection.

One of the potential adverse impacts of prospective payment is the financial reward that accrues to providers that underprovide beneficial services or decrease quality of care. In Hainan's case, there is some anecdotal but little systematic evidence about possible underprovision. Through complaints and appeals, a small survey of patient satisfaction, patient focus group discussions, and patient chart auditing for quality assurance, the Social Protection Bureau assembled evidence of some gaming of the system and quality problems for certain hospitals (particularly the Chinese medicine hospital) and levied fines accordingly [7]. Overall the administrators nevertheless felt that prepayment was successful in controlling programme costs without undue adverse impact on quality of care.

Another concern associated with prepayment for specific insured beneficiaries is the potential for providers to shift costs to other payers (in this case, the uninsured which represents 50% and 100% of the urban and rural population, respectively). Since social insurance in China only covers about half of the urban population, and uninsured urban residents as well as rural

residents access urban hospitals for inpatient care, most Chinese urban hospitals treat a large percentage of uninsured patients. As Table 7 shows, in Hainan there is considerable scope for reform hospitals to recoup part or all of their revenue losses by shifting costs to such uninsured patients. SIF beneficiaries constituted a minority of total admissions for all of the reform hospitals. Programme spending constituted a slightly higher but still small percentage of overall hospital revenues, ranging from 11% for the Provincial People's Hospital (the single most important site of care for beneficiaries) to 51% for the Provincial Chinese Medicine Hospital. Efforts to shift costs to self-pay patients would nevertheless be constrained by those patients' limited ability to pay. Unfortunately, without any relevant data for the uninsured population we cannot analyse the extent to which cost shifting was associated with prepayment in Hainan. This would be a fruitful area for future research.

A third important concern is that prospective payment creates an incentive for hospitals to refer expensive patients to other providers, a behaviour known as risk selection. For example, after the official reform city of Zhenjiang implemented fixed payment for all hospitals in 1995, the Zhenjiang Insurance Bureau became aware of patient dissatisfaction regarding selection in terms of turning away unprofitable patients (and other gaming of the system) and began to monitor more closely patient transfers between hospitals and re-admissions [17]. 'Administrators of a primary hospital openly admitted that they refused admission to patients who were seriously ill and referred them to secondary and tertiary hospitals' [18, p. 249].

The scope for this kind of risk selection behaviour was narrowed in Hainan by two factors. The first is the design of the payment method. The hospital can only retain residual savings from prospective payment if the number of cases is at least 90% that of the previous year and total spending is at least 90% of the budget. There is also an adjustment at the end of the year for unanticipated increases in admissions. A second factor mitigating selection is the type of hospital selected for reform. Since only the most sophisticated hospitals were pre-paid (including all three of the province's 'A grade' tertiary hospitals), Hainan's reform designers not only targeted providers more likely to be able to bear the risk and internally manage the incentives, but also limited the scope for referring severely ill patients to alternative providers. If in contrast, prospective payment had been implemented at primary and secondary hospitals, there would have been a strong incentive for those providers to increase referrals of the most severely ill patients to tertiary hospitals in order to decrease their own costs. Short of referring patients outside the province for highly specialized services (an extremely rare occurrence), the largest hospitals did not have an option of referring expensive-to-treat patients to alternative providers.

To explore the extent to which risk selection may exist among the reform hospitals, we performed the multivariate regression analyses with separate DD interaction terms for the three tertiary ($\text{Tert\_Reform}_i * \text{Policy}_i$) and three non-tertiary ($\text{Nontert\_Reform}_i * \text{Policy}_i$) reform hospitals. If risk selection were an important factor, the non-tertiary reform hospitals should have been able to achieve a greater reduction in expenditures than the tertiary reform hospitals by referring more expensive cases to the latter. As shown in Table 8, the results suggest that such risk selection is unlikely to have been a major factor,

Table 7. Potential room for cost shifting: program beneficiaries as a percentage of reform hospitals' total admissions and total revenues, 1997

Hospital	Beneficiaries as percentage of total admissions	Beneficiaries as percentage of total revenues
Provincial People's Hospital (Renmin)	8	11
Hainan Medical University Attached Hospital (Haiyi)	14	23
Provincial Chinese Medicine Hospital (Zhongyi)	35	51
Haikou Municipal People's Hospital (Haikou)	15	21

Source: Hainan Social Protection Bureau. Answers to a few questions about payment reform. Written communication to authors, June 1998.

Table 8. The differential impact of payment reform on tertiary and non-tertiary reform hospitals

Hospital fixed effects?	Variable	Total expenditure per admission (natural log)	Programme expenditure per admission (natural log)	Patient co-payments per admission (natural log)	Length of stay (days) (natural log)
Without fixed effects	Tert_Reform * Policy	−0.5586**	−0.4330**	−0.5201**	−0.0420
		(0.1007)	(0.1233)	(0.0873)	(0.1093)
	Nontert_Reform * Policy	−0.4118**	−0.3977**	−0.1529	−0.0841
		(0.1139)	(0.1395)	(0.0987)	(0.1237)
With fixed effects	Tert_Reform * Policy	−0.6055**	−0.4753**	−0.4642**	−0.2838**
		(0.1062)	(0.1291)	(0.0928)	(0.1125)
	Nontert_Reform * Policy	−0.2379*	−0.1337	−0.0554	0.0773
		(0.1229)	(0.1494)	(0.1073)	(0.1302)

Standard errors in parentheses.
* Statistically significant at the 5% level; ** statistically significant at the 1% level.

since the DD effect of prepayment is more significant for the tertiary rather than non-tertiary reform hospitals (with and without fixed effects).

Unfortunately, without more detailed data on utilization patterns for the uninsured, outpatient expenditures, referrals, etc., the ultimate impact of payment reform on society-wide health care expenditures and quality of care remains unclear. We hope that in the future data can be collected to examine these important aspects of Hainan's reform.

CONCLUSION

In this paper we develop a model of payment incentives and empirically assess provider payment reform in Hainan province. We employ a DD identification strategy to estimate the impact of the payment system reform on expenditures per admission in reform hospitals (relative to before the payment change and relative to trends in the 'control' FFS hospitals). This methodology enables us to isolate supply-side payment reform effects from demand-side changes. We find that relative to FFS, prospective payment is associated with a slower rate of growth of overall expenditures and of its two primary components, programme spending and patient co-payments.

Although our pre-post design with a control group represents a methodological improvement over most analyses of payment reforms in China and other developing countries, there are nevertheless several limitations. For example, the long-term impact of payment reform may be under- or over-estimated based on only the first half year of implementation. In addition, to the extent strong financial incentives of prospective payment may induce adverse consequences such as under-provision, cost shifting and risk selection, there is need for careful evaluation of the broader social impact of payment reform. Unfortunately it is very difficult to obtain sufficient data to draw conclusions about social welfare; instead, we focus on inpatient programme spending and related patient co-payments. There may have been some cost shifting to the uninsured population (such as other patients treated in the same hospital); such a behavioural response would suggest that reductions in programme spending are offset by an increased burden on the uninsured. Additional complications arise from the lack of good controls for case mix or severity of illness. Although this limits our ability to analyse whether reform hospitals acted upon the incentive to refer expensive-to-treat patients to alternative providers, an examination of the differential impact of prepayment on tertiary and non-tertiary hospitals suggests that such risk selection behaviour was probably not a major concern. Quality assurance review materials from the Social Protection Bureau offer concrete albeit largely anecdotal evidence of quality reductions at least in some

reform hospitals. On the other hand, there is considerable evidence of inefficiency in the pre-reform era (such as overuse of high technology and expensive drugs [3]), suggesting that payment reform has the potential to reduce wasteful expenditures without damaging—or even improving—quality of care.

Many developing countries and transitional economies that currently use the FFS payment method for hospital services face problems of cost escalation and inefficiency similar to those of China. However, they often lack the technical and management capacity to implement more sophisticated payment methods that aim to control cost inflation but simultaneously putting checks on under-provision and quality skimming. Our main finding, that the introduction of prospective payment did significantly reduce inpatient expenditure growth suggests cautious optimism regarding the effectiveness of prospective payment for moderating growth in health expenditures. A prospective payment method tied to performance, like the one in Hainan, offers an intermediate solution to reduce overall expenditure and LOS by ameliorating incentives to over-prescribe expensive procedures and rapidly adopt less cost-effective hi-tech equipment. As policymakers collect more data and information on costs and quality, they can consider moving toward payment based on more comprehensive performance indicators that include measures of quality adjusted for differences in diagnosis and severity.

ACKNOWLEDGEMENTS

The authors are grateful to the Social Protection Bureau of Hainan Province for cooperation that made this paper possible. We also wish to thank William Hsiao for his invaluable comments, two anonymous referees for their constructive advice, and Blenda Wong for capable research assistance.

APPENDIX A

Proposition 1
The optimal level of cost-reducing effort increases with the degree of supply-side cost sharing.

Proof
The optimal level of cost-reducing effort, $\mathbf{e}^*$, is defined by the first-order condition (3). Total differentiation of (3) yields

$$\frac{\mathrm{d}\mathbf{e}^*}{\mathrm{d}\mathbf{s}} = \frac{-\mathbf{C}'}{\mathbf{s}\cdot\mathbf{C}'' + \gamma''} > 0. \tag{A1}$$

Proposition 2
In the two-period model when the second period budget is set to equal first period reported cost, first period cost-reducing effort is decreasing in the discount rate on period two net revenue (the ratchet effect).

Proof
The optimal level of first period cost-reducing effort is defined by the first-order condition (5). Total differentiation of (5) yields

$$\frac{\mathrm{d}e_0^*}{\mathrm{d}\delta} = \frac{\mathbf{C}'}{\mathbf{C}''\cdot(1-\delta) + \gamma''} < 0. \tag{A2}$$

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