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Hospital Competition under Regulated Prices: Application to Urban Health Sector Reforms in China

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Abstract

We develop a model of public-private hospital competition under regulated prices, recognizing that hospitals are multi-service firms and that equilibria depend on the interactions of patients, hospital administrators, and physicians. We then use data from China to calibrate a simulation model of the impact of China's recent payment and organizational reforms on cost, quality and access. Both the analytic and simulation results show how providing implicit insurance through distorted prices leads to over/under use of services by profitability, which in turn fuels cost escalation and reduces access for those who cannot afford to self-pay for care. Hospital competition for patients will improve social welfare only if policymakers pay careful attention to payment incentives and regulation.

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Abstract. We develop a model of public-private hospital competition under regulated prices, recognizing that hospitals are multi-service firms and that equilibria depend on the interactions of patients, hospital administrators, and physicians. We then use data from China to calibrate a simulation model of the impact of China's recent payment and organizational reforms on cost, quality and access. Both the analytic and simulation results show how providing implicit insurance through distorted prices leads to over/under use of services by profitability, which in turn fuels cost escalation and reduces access for those who cannot afford to self-pay for care. Hospital competition for patients will improve social welfare only if policymakers pay careful attention to payment incentives and regulation.

1 Introduction

Many countries, particularly developing and transitional economies, are experimenting with market forces and privatization in their health sectors. Existing models of competition and regulated prices (e.g., Norman and Thisse 2000) are not appropriate for assessing the impact of such reforms, because they are not tailored to the institutional features of the health sector: pervasive uncertainty, acute asymmetry of information, health care provider market power, moral hazard induced by insurance coverage, and difficulty in measuring quality and outcomes. On the supply side in health care, hospital administrators and physicians, who may have different objectives and relate to patients differently, both critically shape available treatment. Moreover, a hospital is a multi-service firm, and policies with different incentives across services will impact hospitals' overall portfolio of investments and offerings.

The central aims of our paper are twofold. First, we develop a model of hospital - physician behavior under regulated prices, broadly applicable to the health sectors in developing and transitional economies (as well as many established market economies). The primary contribution is capturing multiple layers of decision-making on the suppy side with a reasonably parsimonious model.[1] Second, we simulate the impact of the latest Chinese pricing and payment reforms on cost control and patient access. The focus is urban China, both because financing and institutional constraints differ significantly between urban and rural areas, and because the challenges facing urban China more closely resemble those of other transitional economies.

We develop a model of public-private hospital competition under regulated prices, recognizing that hospitals are multi-service firms. Three kinds of agents interact in the model: patients, doctors, and hospital administrators. On the demand side, patients have limited choices. Unlike for many other goods or services, the patient often lacks the time, information, and/or acumen to choose optimally between competing suppliers with various prices and qualities of service. In particular, the patient frequently cannot discern what treatment options are necessary or desirable for his or her specific medical condition, and how the quality of any given hospital or physician compares to that of others. Providers derive considerable power over patients from this asymmetry of information and from the fact that medical care is a non-tradeable service (see discussion in McGuire 2000). Nevertheless, consumers do have margins

[1]Previous theoretical work on public-private provision in the health sector (e.g., Barros and Martinez-Giralt 2000, Ma forthcoming) focus on different institutional and research questions than those posited here, and do not model hospitals as multi-service firms.

of choice, even in the setting of China's urban health sector. The patient can choose self-care rather than formal treatment (especially for mild conditions), and typically can choose between hospitals. This is the primary margin of choice that we include in the model. Once at the hospital, the consumer has limited voice in the treatment decisions, except to the extent that physicians take account of the patient's needs and ability to pay.

On the supply side, we use a shadow-price approach to capture hospital and physician behavior. We interpret the hospital-set shadow price as a kind of 'reduced form' for a hospital-physician contract that includes service-specific spending caps and payment incentives such as cost sharing between the hospital administration and doctor(s). For a discussion of this approach, see Frank, Glazer and McGuire (2000; hereafter FGM) and Eggleston (2002). Doctors allocate the available resources across patients according to patients' needs, possibly influenced by the doctor's own financial incentives. Hospital administrators decide on hospital strategies such as investment in high-tech equipment and the availability of staff and equipment for various services. They also choose compensation systems for doctors. For example, the hospital administrator may set a budget limit for spending on unprofitable services, but encourage use of profitable services by giving doctors bonus payments according to utilization of those services.

We use our model to derive analytic results and to calibrate a simulation model of China's pricing policies and organizational reforms that will introduce public-private competition more directly into the urban hospital sector. Both the analytic and simulation results show how providing implicit insurance through distorted prices leads to over/under use of services by profitability, which in turn fuels cost escalation and reduces access for those who cannot afford to self-pay for care.

The paper is organized as follows. Section 2 provides background on China's urban health sector and administered pricing. Section 3 develops the model and the analytic results. The remaining sections describe the simulation model, analyze the results, and discuss policy implications.

2 China's Urban Health Sector and Recent Reforms

The recent epidemic of Severe Acute Respiratory Syndrome focused an international spotlight on health and health care in the PRC. Despite China's unprecedented economic growth and success in lifting millions out of poverty, an important component of the social protection system – health care – suffers from benign neglect. For example, although the majority of Chinese had health insurance as early as the 1970s, the majority lost such coverage during the decades of economic reform. Decollectivization of agriculture removed the community financing mechanism in rural areas, and social health insurance for formal-sector employees in urban areas covers only half of urban residents (see Hsiao 1995; Henderson et al. 1995; World Bank 1997; Liu, Hsiao and Eggleston 1999; Liu 2002; and Yip, Eggleston and Meng 2003).

China's strategy for providing social protection for urban residents includes city-based Social Health Insurance (SHI) for government employees and employees of state and private enterprises. Coverage is financed with a payroll tax, nominally divided between employer (6% of wages) and employee (2% of wages). The insurance structure borrows from the Singaporean model of individual Medical Savings Accounts (MSAs), combined with a Social Risk Pooling Fund for catastrophic expenditures. Funding for outpatient services comes primarily from MSAs and out-of-pocket payments. The Social Risk Pooling Fund finances inpatient care, usually after the employee pays a deductible equal to 10% of his or her annual wage. Patients are also responsible for coinsurance, with rates that are graded and often feature caps set by local government. The benefit package varies based on local economic conditions. The majority of those not covered by SHI self-pay for health services. This half of urban residents includes the dependents of workers, those who are self-employed, migrant workers, and those who work in the informal sector. Since these residents typically have lower incomes than employees in the formal sector, there is a positive correlation between income and insurance coverage.

Delivery of medical services relies heavily on hospitals, which usually have large outpatient clinics. Government-owned hospitals form the backbone of the urban delivery system, accounting for about 50% of inpatient beds. They were historically financed by government budgets, but in recent years rely increasingly on user charges and profits from sales of pharmaceuticals to cover operating expenses. State-owned enterprises (SOEs), particularly the larger ones, often operate their own hospitals, accounting for approximately 40% of inpatient beds. The remaining ten percent are in private hospitals, owned by physicians or nonstate firms.

Pricing and payment is predominantly on a fee-for-service (FFS) basis, with a government-regulated fee schedule. The salient feature of these administered prices is their distortion from average costs, intentionally designed to provide implicit insurance to poor patients. Prices for basic services often do not cover even marginal cost. To compensate providers for lost revenue, some other services–primarily high-technology diagnostic procedures and most pharmaceuticals–are priced well above average cost. For example, the Price Bureau allows hospital pharmacies to charge a 15 percent markup on the wholesale price of drugs. This pricing scheme clearly gives hospitals incentive to encourage overuse of profitable services and skimp on provision of basic (unprofitable) services. Recognizing these distortions, several social health insurance bureaus have experimented with aggregate forms of payment, such as case-based payments or fixed budgets with bonuses and with-holds tied to performance. In addition, China shares with many transition economies the widespread prevalence of under-the-table payments for medical care.

To illustrate how this system affects hospital finances and behavior, we examined a small sample of longitudinal hospital-level data collected from 38 government hospitals in different municipalities over the past two decades of reform (see Yip, Eggleston and Meng 2003). The average percentage of hospital income from government sources declined from 17% in 1985 to 7% in 1999. This illustrates the significant reliance of government-owned hospitals on non-state revenues–primarily user fees–to cover operating expenses. In the sample hospitals over this period, an increasing percentage of income came from user fees (26 to 37%) and sales of drugs (39% to 50%). Consistent with the incentives of the distorted fee schedule, hospitals increased investment in high-technology equipment: high-value equipment as a percentage of fixed assets grew from 17% in 1985 to 36% in 1999. Government subsidies (as a percentage of hospital income) are negatively correlated with (1) drug income (-0.54), and (2) CT and MRI patient volume (-0.41 and –0.11, respectively). These correlations suggest a pattern of substitution toward high-margin services as government subsidies became a less and less significant source of financing.

Salaries decreased as a percentage of total compensation (from 60% in 1985 to 33% in 1999), while "other" compensation–presumably bonuses–increased. This pattern corroborates other survey and anecdotal evidence that bonuses, and other forms of incentives for doctors and administrators, are increasingly significant, as they seem to be for most urban Chinese workers (although much of the evidence comes from industrial rather than service sectors).[2] In 1999, median hospital net revenue was 3.6% – a respectable number given the deficit-ridden plight of many Chinese SOEs.[3]

Current problems and challenges confronting China's urban health

[2]See, for example, the discussion of efficiency wages, wage-payment schemes and productivity in Fleisher and Wang (2001).

[3]In the sample, 82% of hospitals had positive net revenue, with median revenue conditional on positive net revenue of about 5%, and the largest 30%. Median net revenue among lossmakers was –27.7%. This raises the question of how hospitals running deficits cover their expenses. Although budget constraints are ostensibly hard, there have been no known bankruptcies of government-owned hospitals to date.

sector include significant and probably unsustainable cost escalation, with overuse of high-technology diagnostic procedures and an excessive proportion of spending (over 50% of total health spending) on pharmaceuticals. These problems contribute to limitations on access, particularly for the uninsured and poor. Those who cannot afford to pay often do not get timely care, or care at all.

Table 1 about here

Chinese policymakers plan to adjust regulated to better reflect actual resource costs, and encourage aggregated forms of payment. In addition, organizational reform will more clearly differentiate provider ownership and tax obligations. As illustrated in Table 1, 'public' hospitals and other healthcare providers will be divided into those that receive government subsidies (government hospitals) and those that do not (private nonprofit hospitals). Both will continue to operate under regulated prices and be tax exempt. Private for-profit providers will be required to pay taxes and can set their own prices. We assume, consistent with current evidence, that these providers cater to a different clientele and will largely price services not to be in direct competition with the larger government and private non-profit hospitals.

Will the reforms yield the desired results? Since the majority of China's urban hospitals remain nonprofit, our model of reforms focuses on them.

3 The Model

Three kinds of agents interact in the model: doctors, hospital administrators, and patients. To capture nonuniversal coverage, we assume two kinds of patients: $i = H$ are the high-income, insured patients, while $i = L$ are low-income, uninsured patients. A hospital hires a representative physician to provide various health care services indexed by j. Throughout our simulation we will assume that there are two services, where $j = 1$ represents profitable services (e.g., high technology services and drugs), while $j = 2$ represents services priced below marginal cost (e.g., basic services). Let m_j^i represent the resource use for health service j provided to patient i. Let $v_j^i\left(m_j^i\right)$ represent the increasing and concave benefit (i.e., money-metric utility) that patient i derives from spending m_j^i. Total service-related utility from obtaining treatment is $v^i\left(m^i\right) = \sum_j v_j^i\left(m_j^i\right)$.

Without loss of generality we define price P_j as the ratio of administrative price to marginal cost, so that $P = 1$ represents a price that exactly covers cost. Patients must pay a a fraction C_0^i of the price, where

$0 \leq C_0^i \leq 1$. A typical insured urban resident often pays 35% of medical bills, so that in the benchmark simulation $C_0^H = 0.35$. For the uninsured, by definition $C_0^L = 1$.

Simulations of the two-service, two-patient-type model build upon the functional forms of Keeler, Carter and Newhouse (1998). Specifically, consumer utility exhibits linear marginal benefit, taking the form

$$v^i = \sum_{j=1}^{2} \left[a_j m_j^i - \frac{b_j}{2} \left(m_j^i \right)^2 \right] - C_0^i P_j m_j^i. \tag{1}$$

We discuss the behavior of the three agents – doctors, hospital administrators, and patients – each in turn.

3.1 Physician Behavior

Physicians are primary decision-makers for medical care. The model assumes that physicians decide which patients received how much of which services, thus defining spending m_j^i for each patient i for each service j. How are these clinical decisions made? Physicians by profession serve the interests of their patients. However, considerable empirical evidence suggests that physicians may also be influenced by the financial incentives of their compensation arrangements (see, for example, Newhouse 2002). Physicians thus act as "dual agents," influenced both by their professional opinion of what is in the best interest of the patient, on the one hand, and financial incentives on the other. In China, physicians treating patients at hospitals are almost without exception employees of the hospital. The physician's financial incentives therefore originate with the hospital administrator.[4]

We focus on a representative physician and assume a simple linear compensation contract: the doctor receives a fixed payment per patient (e.g., a volume-dependent salary), R, plus reimbursement $(1 - S_j)\, m_j^i$ for each service j , with $S_j \leq 1$. In other words, the physician is responsible for the fraction S of patient treatment costs. For hospital physicians compensated exclusively by salary (as was typical in China until recently), $S = 0$. Bonuses that increase with patient utilization arises when $S < 0$. For example, $S = -0.05$ would mean the provider is reimbursed $(1 - [-0.05])\, m_j^i = 1.05 m_j^i$, that is, a 5% profit margin above treatment cost m_j^i. Full capitation (which is rare to nonexistent for Chinese hospital-based physicians) would pay a positive R per pa-

[4]For a physician to agree to work at a hospital, the hospital's compensation package must meet the physician's participation constraint (i.e., reservation utility). For simplicity we assume the hospital meets this constraint exactly; in other words, the market for physician services is reasonably competitive.

tient and leave the physician fully liable for costs of care, i.e., $S_j = 1$ for every service j. A mixed payment system features $0 < S < 1$. Pure cost reimbursement corresponds to $S = 0$.

Given this linear compensation scheme, the physician's net income from treating patient i is $\pi^i = R - S_1 m_1^i - S_2 m_2^i$ $(i = H, L)$. The utility U of a representative physician features a constant marginal rate of substitution $\beta \geq 0$ between patient benefit and physician income. In other words, the physician puts weight β on net revenue and weight 1 on patient benefit, when deciding on how to treat patients, where β Q 1. The physician's utility function is thus

$$U = \sum_i n^i \left[v^i + \beta \pi^i \right]. \tag{2}$$

The higher is β, the more financial incentives influence clinical decisions. We assume the physician takes demand (n^i) as given. In other words, doctors allocate available resources across an existing panel of patients, ignoring how current spending choices may affect future demand.

The physician's clinical decisions also must respect resource constraints: only a limited amount of equipment, supplies, and ancillary staff are available. To capture such constraints tractably, we assume that the hospital administrator may set a specific budget limit B on how much can be spent on a given service. For example, unprofitable service $j = 2$ may have a restrictive budget of B_2; the physician must allocate this budget across heterogenous patients while adhering to the overall budget constraint on spending for service 2. Specifically, she chooses spending per H patient, m_2^H, and spending per L patient, m_2^L, such that $n^H m_2^H + n^L m_2^L \leq B_2$. For the profitable service, B_1 may be set so high that this budget constraint is not binding.

Given these incentives and constraints, a representative physician in the two-service, two-patient-type model chooses a vector allocation of spending $m = \left(m_1^H, m_2^H, m_1^L, m_2^L \right)$ to maximize

$$\begin{gathered} U = n^H \left[v^H + \beta \pi^H \right] + n^L \left[v^L + \beta \pi^L \right], \\ \text{subject to } \; n^H m_1^H + n^L m_1^L \leq B_1, \\ \text{and } \; n^H m_2^H + n^L m_2^L \leq B_2, \end{gathered} \tag{3}$$

where $\pi^H = R^H - S_1 m_1^H - S_2 m_2^H$ and $\pi^L = R^L - S_1 m_1^L - S_2 m_2^L$ are the per-patient net revenues from H and L patients, respectively. Let λ_j be the Lagrange multiplier on the budget constraint for service j, and focus on the subset of services that are profitable to offer in equilibrium, so that $m_j^H > 0$ and $m_j^L > 0$ for all j. The Kuhn-Tucker first order conditions yield

$$\frac{dv_1^H}{dm_1^H} = \lambda_1 + S_1\beta + C_0^H P_1, \tag{4}$$

$$\frac{dv_1^L}{dm_1^L} = \lambda_1 + S_1\beta + C_0^L P_1, \tag{5}$$

$$\frac{dv_2^H}{dm_2^H} = \lambda_2 + S_2\beta + C_0^H P_2, \tag{6}$$

$$\frac{dv_2^L}{dm_2^L} = \lambda_2 + S_2\beta + C_0^L P_2. \tag{7}$$

$$\lambda_j \left[n^H m_j^H + n^L m_j^L - B_j \right] = 0, \quad j = (1, 2) \,. \tag{8}$$

Note in (4) through (7) that apart from the last term representing co-payment burden on the patient (which differs according to insurance status), the marginal benefit of spending on each service is set equal across heterogeneous patients. For example, if all patients were fully insured so that $C_0^i = 0$, then $\frac{dv_j^H}{dm_j^H} = \frac{dv_j^L}{dm_j^L} = \lambda_j + S_j\beta$. This constant marginal utility of spending represents a "shadow price" for spending. The fully insured patient does not pay a "price" at point of service for treatment; yet clinical decisions allocating available resources across patients result in a "shadow price" that defines spending, just as the "actual price" of co-payments would define spending for a patient weighing treatment benefit against the price of care. This supply-side "shadow price" arises from resource constraints and supply-side financial incentives. Thus we define the shadow price for service j as

$$q_j \equiv \lambda_j + S_j\beta. \tag{9}$$

The first term in the shadow price literally represents the shadow price of resources: λ_j is the Lagrange multiplier on the budget limit for spending on service j. Increasing the budget B_j relaxes the budget constraint and reduces its shadow price λ_j. In the limit, if available resources are more than sufficient to meet demand (or patient 'need' as the physician clinically defines it), then $\lambda_j = 0$. By contrast, tighter and tighter budgets raise the shadow price so that the patient must be in more dire 'need' – i.e., have high $\frac{dv}{dm}$ – to qualify for treatment. An extremely high shadow price is equivalent to denying access to that service for virtually everyone.

The second term in the shadow price, $S_j\beta$, represents the influence of financial incentives on physician treatment decisions. When a budget constraint does not bind (i.e., $\lambda_j = 0$), physician payment incentives alone define the shadow price. This part of the shadow price is zero in two cases: (1) when the physician puts zero weight on own net revenue, $\beta = 0$; or (2) physician compensation incentives are completely "neutral" with respect to spending, $S = 0$ (cost reimbursement), so that the physician neither gains nor loses from allocating spending in a way different from what is in the best interest of the patient. (Of course, both (1) and (2) could hold simultaneously.) The more the physician values net income (i.e., as β increases), the more supply-side cost sharing S shapes clinical decisions. High S encourages low spending: the quality concern with high supply-side cost sharing is underprovision, stinting or skimping (and risk selection; see Newhouse 1996 and 2002). By contrast, low S – particularly $S < 0$, representing fee-for-service or bonuses that increase in utilization – encourages generous or even excessive spending.

Indeed, the physician may encourage spending beyond the point of zero marginal benefit (i.e., the amount desired by a fully insured, fully informed patient). The controversial phenomenon of *supplier-induced demand* (SID) exists when the supplier "influences a patient's demand for care against the physician's own interpretation of the best interest of the patient" (McGuire 2000, p. 504). Supplier-induced demand can arise in the model when $q < 0$, meaning that the physician recommends so much treatment that the true marginal benefit of the last RMB yuan spent is negative: $\frac{dv_j^L}{dm_j^L} = q_j < 0$. Since the true shadow price of resources (λ_j) and the physician's marginal rate of substitution between income and patient benefit (β) are both nonnegative, SID with a negative shadow price arises when $S < 0$ (and $\beta > 0$). In other words, a hospital can encourage physicians to induce over-use for profitable services by paying them FFS bonuses according to utilization. Over-use is well-documented in many contexts involving FFS payment (see for example Institute of Medicine 2001 and Newhouse 2002) and widely believed to plague China as well (e.g., World Bank 1997). Our model thus allows for physicians to induce demand, but their ability to do so is not without limit, even when patients are poorly informed.[5]

With providers allocating spending according to service-specific shadow prices q_j , spending on each service becomes

$$m_j^i = \frac{a_j - (C_0^i P_j + q_j)}{b}. \qquad (10)$$

Comparative statics on the physician optimization problem (3), or more directly (10), reveal that spending increases when (1) the marginal

[5]We build into the simulation a constraint on the extent of supplier-induced demand (e.g., $q_1 > -0.3$) that can be varied in sensitivity analyses.

benefit of treatment a_j increases ($\frac{dm}{da} > 0$); (2) the co-payment price of care $C_0^i P_j$ decreases, either because of a decrease in the coinsurance rate C_0^i or a decrease in the administrative price per unit P_j ($\frac{dm}{dCo} < 0$, $\frac{dm}{dP} < 0$); and/or (3) the shadow price q_j falls ($\frac{dm}{dq} < 0$).

We show in the appendix an extension to under-the-table payments (a.k.a. gratuities or *hongbao*). Patients are more likely to offer such *hongbao* payments to physicians when (1) access to care is restricted, and/or the physician has financial incentive to stint ($q_j > 0$); (2) perceived marginal benefit (a_j) is high; and/or (3) formal co-payments (C_0^i) are low. This simple extension can help to explain the proliferation of under-the-table payments in China currently, and the possible policy remedies. For further discussion, see Yip, Eggleston and Meng (2003).

We next turn to the second decision-maker in the model, the hospital administrator.

3.2 Hospital Behavior and Hospital-Doctor Contracting

Although physicians have the primary role in deciding which patients receive how much of which services, hospital administrators also shape clinical decisions in many ways. We capture this influence with two decisions: how much to invest in equipment and staffing for specific services (i.e., the generosity of the spending budget B_j for each service j) and the compensation scheme for physicians (i.e., S, with R then set to fulfill the physician participation constraint). In the model, these two dimensions can be captured with a single variable: the shadow price, $q = q(B, S)$. As shown above, the physician's optimization problem leads naturally to allocation of spending across patients according to service-specific shadow prices given by (9). To influence physician behavior and thereby hospital net revenue, a hospital administrator can therefore choose a preferred shadow price for each service.

The hospital administrator chooses shadow prices in light of the incentives embodied in the hospital payment system. A simple linear formulation, paralleling that described above for physicians, well captures the gamut of hospital payment methods currently used and/or proposed in China. Payment includes two components. First, for each patient, the provider may receive a fixed pre-payment (prospective payment), r^i. If these payments are risk adjusted, r^i will differ according to the risk adjusters (such as age, sex, and diagnoses of patient i) included in the risk adjustment formula. (For an overview of risk adjustment internationally, see Ellis and Van de Ven 2000.) Few developing countries use such payment systems, however, and no Chinese social insurance bureaus that we know of risk adjust hospital payments. We therefore assume that the fixed payment, if any, does not differ across patients, except to the extent that social insurance uses prospective payment ($r^H > 0$) while self-pay patients do not ($r^L = 0$).

In addition to r, the hospital receives reimbursement $(1 - s_j)\, m_j^i$ for each service j , with $s_j \leq 1$. The hospital therefore is at risk at point of service for the proportion of spending $s_j m_j^i$, and $s_j > 0$ denotes supply-side cost sharing. (A lower-case s denotes the hospital supply-side cost sharing, and an upper-case S denotes physician supply-side cost sharing. The two are intimately connected, as we demonstrate below.)

We focus first on the behavior of a hospital administrator who seeks to maximize net revenue. Much literature on nonprofit hospitals finds little difference between their behavior and that of net revenue maximizers (e.g., Sloan 2000). Later we will discuss the additional constraints and assumptions affecting government-owned hospitals.

3.2.1 Net-Revenue Maximizers

The choice variable is the vector of service-specific shadow prices, q. Both spending per patient, $m(q)$, and the number of patients treated, $n(q)$, vary with the shadow prices, the former according to (10) and the latter as will be discussed further below. In general, more generous spending, achieved with low (or even negative) shadow prices, attracts patients, except to the extent that patients cannot afford to pay and/or dislike supplier-induced demand.

Aware of the demand response to spending generosity across services, a profit-maximizing hospital administrator can try to attract profitable patients with generous spending on services those patients value most. The hospital sets a shadow price for access to service j such that "the patient must 'need' or benefit from services above a certain threshold in order to qualify for receipt of services" (FGM, p.836):

$$\frac{dv_j^i}{dm_j^i} = q_j. \tag{11}$$

This shadow price is precisely that which flows from the physician optimization problem; compare (4) through (7) and (9). The hospital administrator will want to design doctors' compensation to implement profit-maximizing shadow prices.

Given the linear payment system, the hospital's revenue per patient treated is $r^{\mathsf{i}} + \sum_j (1 - s_j)\, m_j^i (q)$. Cost is total spending on patient care, $\sum_j m_j^i (q)$ per patient i, and total physician compensation W, which we assume is fixed by physicians' reservation utility. Demand from patients of type i is $n^i (q)$. Thus the hospital administrator's expected net revenues $\pi(q)$ are

$$\pi(q) = \sum_i n^i(q)\left[r^{\mathrm{i}} + \sum_j (1-s_j)\, m^i_j(q) - \sum_j m^i_j(q)\right] - W \quad (12)$$
$$= \sum_i n^i(q)\left[r^{\mathrm{i}} - \sum_j s_j m^i_j(q)\right] - W.$$

Assume $\pi(q)$ is strictly concave. Define $\pi^i(q)$ as the hospital's gain or loss for patient i, $\pi^i(q) = r^{\mathrm{i}} - \sum_j s_j m^i_j(q)$. Unprofitable patients are those for which $\pi^i(q) < 0$.

A profit-maximizing hospital administrator chooses the shadow price for each service j to maximize $\pi(q)$:

$$\frac{d\pi}{dq_j} = \sum_i \left(\frac{dn^i(q)}{dq_j}\pi^i + n^i(q)\left[\frac{d\pi^i}{dq_j}\right]\right) = 0, \text{ or}$$
$$\sum_i \left(-n^i s_j \frac{dm^i_j}{dq_j}\right) = \sum_i \left(-\frac{dn^i}{dq_j}\pi^i\right) \quad (13)$$

This first order condition describes the trade-offs involved in setting shadow prices. The marginal benefit from raising the shadow price is less spending per enrollee, $-n^i s_j \frac{dm^{\mathrm{i}}_{\mathrm{j}}}{dq_{\mathrm{j}}} > 0$. The marginal cost of raising q_j is discouraging profitable patients from choosing the provider ($-\frac{dn^{\mathrm{i}}}{dq_{\mathrm{j}}}\pi^i > 0$ if $\pi^i > 0$).[6]

Under cost reimbursement ($s = 0$) or fee-for-service payment ($s < 0$)) – i.e., whenever the payment system does not include any supply-side cost sharing – the left-hand side of (13) is zero or negative. Without any marginal benefit to restricting spending, hospitals will not want to restrict access to services. Indeed, the hospital administrator may wish to encourage supplier-induced demand to bring in additional fee-for-service revenues from profitable services.

Clearly, the profit-maximizing shadow price can exceed or fall short of the socially optimal value for a fully insured consumer, $q^{**} = 1$, which equates marginal benefit with social marginal cost:

$$q^{**}\left(C^i_0 = 0\right) = \arg\max\left[v(m(q)) - m(q)\right] = 1 \quad (14)$$

When patients differ in their insurance status or generosity, socially efficient spending levels require differentiating shadow prices by patient insurance as well as by service.

[6] As FGM note, "the idea behind competition among managed care providers is that ... the provider by rationing too tightly will lose profitable customers – to balance the provider's incentive to reduce services to the existing enrollees" (p.838).

The simulation models the case of two services, $j = 1, 2$, and two consumer types. Consistent with China's current state of 50% insured residents in urban areas, we assume 50% of the population of each type, with the two types distributed identically, so that demand for a health provider consists of $n^H\left(m^H, C_0^H\right)$ and $n^L\left(m^L, C_0^L\right)$. Hospital profit (12) then becomes $n^H(q)\,\pi^H(q) + n^L(q)\,\pi^L(q)$.

In this two-service, two-type case, the first-order conditions for choice of profit-maximizing shadow prices q_1^* and q_2^* are

$$\frac{\partial n^L}{\partial q_1}\pi^L + \frac{\partial n^H}{\partial q_1}\pi^H - s_1\left(n^H\frac{dm_1^H}{dq_1} + n^L\frac{dm_1^L}{dq_1}\right) = 0 \tag{15}$$

$$\frac{\partial n^L}{\partial q_2}\pi^L + \frac{\partial n^H}{\partial q_2}\pi^H - s_2\left(n^H\frac{dm_2^H}{dq_2} + n^L\frac{dm_2^L}{dq_2}\right) = 0 \tag{16}$$

3.2.2 A Simple Case

Since this framework of physician-hospital-patient interaction with the hospital as a multi-product firm is rather complicated, we illustrate the primary analytical results first with the simplest possible case: a single service and a single patient type. In this case, hospital net revenue (12) becomes $\pi = n(q)\left[r - sm(q)\right] - W$ and the first order condition (13) defining the optimal shadow price becomes

$$-ns\frac{dm}{dq} = -\frac{dn}{dq}\left[r - sm\right]. \tag{17}$$

Once again, the left-hand side represents the marginal benefit of increasing q: reduced treatment costs and thus higher hospital revenues if the hospital is at risk for any of the cost ($s > 0$). The right-hand side represents the marginal cost of increasing q: fewer patients ($\frac{dn}{dq} < 0$), each of whom is profitable ($r - sm > 0$).

The central payment incentive result is that *increasing supply-side cost sharing (toward fully prospective payment) induces better cost control and more stringent rationing of care, because the profit-maximizing shadow price q increases with cost sharing s.* This follows from totally differentiating (17) with respect to q and s and solving for $\frac{dq}{ds}$, noting that the denominator is negative by concavity of $\pi(q)$, and the numerator is negative because $\frac{dn}{dq} < 0$ and $\frac{dm}{dq} < 0$:

$$\frac{dq}{ds} = \frac{\frac{dn}{dq}m + n\frac{dm}{dq}}{\frac{d^2\pi(q)}{dq^2}} > 0 \tag{18}$$

Administrative prices implicitly define the degree of supply-side cost sharing for each service, since the hospital 'shares the cost' of any services for which the administrative price does not cover the cost of care. Thus

$$s = 1 - P. \tag{19}$$

The result above predicts that hospitals will under-provide services for which administrative prices do not cover marginal cost ($s > 0$) and over-provide services for which prices exceed marginal cost ($s < 0$). We use the simulation model to illustrate the interaction across patient groups and services, but the underlying logic is the same as for this simplest case.

3.2.3 Government hospitals

Government-owned hospitals may behave differently from net-revenue maximizers. Hart, Shleifer and Vishny (1997) posit that a government hospital manager has less residual control of investment decisions, and therefore invests less in both cost control and quality improvement innovations, than a private counterpart.

We assume that government hospitals set shadow prices at a given level and then private hospitals compete by optimizing, given the government hospitals' decisions. Government hospital shadow prices are fixed at the optimal Nash equilibrium shadow prices chosen by two government hospital administrators that (1) care directly about patient welfare as well as net revenue; (2) do not face stiff competition for patients; and (3) are constrained to spend no more than a binding threshold amount per patient. Specifically, the objective function places weight on patient benefit v, similar to that posited for physicians in (2). This is a fairly standard method of modeling the behavior of providers with objectives beyond pure profit maximization (see discussion in McGuire 2000). With the weight on patient benefit of 0.5, prices set at the benchmark levels of the simulation model ($P_1 = 1.2$ and $P_2 = 0.85$, so that $s_1 = -0.2$ and $s_2 = 0.15$), the spending constraint set at the socially efficient spending per patient, and the travel cost parameter $c = 2,000$ (see (21) below) to represent low competition for market share, the government shadow prices are $q_1^G = 0.1$ and $q_2^G = 0.5$. We use these values throughout, unless noted otherwise.

Note that these benchmark shadow prices imply that even government providers encourage more use of the profitable than the unprofitable service ($q_1 < q_2$), that well-insured patients will over-use both services (because $q < 1$), and that uninsured patients will often under-use services (because the co-payment price plus the shadow price exceeds 1). These are all consistent with evidence about patterns of Chinese patient utilization in the 1990s, when government providers dominated because the private sector share of the inpatient care market was quite small.

We assume that government hospitals are 'first movers' against which the private competitors optimize, and investigate only the initial market equilibrium (i.e., before government hospitals have been able to re-optimize). Government hospitals are likely to experience adverse selection as competitors cream skim more profitable patients. Certainly this sequence of events has been documented elsewhere (see for example Duggan 2000). We calculate what volume of subsidies would be necessary to cover any resulting negative net revenue. In other words, a government hospital enjoys a soft budget constraint (Kornai 1986) allowing it to break even while serving a disproportionate share of unprofitable poor and uninsured patients at the fixed shadow prices $q_1^G$and q_2^G.

3.2.4 Hospital-physician contracting

A hospital administrator can implement a given vector of service-specific shadow prices through choices of service-specific budgets B_j and/or service-specific cost sharing, S_j, with their staff physicians. If a hospital administrator knows physicians' reactions functions (in particular, weight on net revenues β), the administrator can implement a desired shadow price vector through appropriate choice of service-specific budgets B_j and cost-sharing S_j as follows:

$$S_j^* = \frac{q_j^*(s)}{\beta}, \tag{20}$$

where q_j^* satisfies (13) and is thus a function of administrative hospital prices P that define payer-hospital cost sharing, s, as in (19). The 'correct' degree of hospital-doctor cost sharing S_j^* induces the doctor to internalize the hospital administrator's desired constraint on spending. For β low enough (or q_j^* high enough) that $\frac{q_1^*}{\beta} > 1$, the hospital administrator will need to impose a binding budget constraint to implement q_j^* (since hospital-doctor cost sharing cannot exceed 100%). For further discussion of hospital-physician contracting, see Eggleston (2002).

3.3 Consumer Choice of Hospital

The final decision-maker in the model is the health care consumer, or patient. Hospitals respond to patient demand when setting shadow prices, as outlined above. Here we detail how consumer choice defines patient demand $n(q)$. Consider two competing health providers, A and B, at "distances" from consumer i of ρ_i^A and ρ_i^B, respectively. In addition to geographic location, "distance" measures any aspect of convenience or taste not captured by health service spending. Define

$c > 0$ as "travel cost" per unit distance. Patient i will choose provider A over provider B if and only if $v^{iA}\left(m^{iA}\right) - c\rho_i^A > v^{iB}\left(m^{iB}\right) - c\rho_i^B$, or $v^{iA}\left(m^{iA}\right) + c\left(\rho_i^B - \rho_i^A\right) > v^{iB}\left(m^{iB}\right)$. Defining $\overline{u}^i \equiv v^{iB}\left(m^{iB}\right)$ and $\mu^i \equiv \rho_i^B - \rho_i^A$, a patient chooses provider A when $v^{iA}\left(m^{iA}\right) + c\mu^i > \overline{u}^i$ (as in FGM).

The hospital does not know each patient's μ_i but does know the cumulative distribution from which it is drawn, $\Phi_i\left(\mu_i\right)$. The hospital manager considers the probability that patient i will choose it to be

$$\begin{aligned} n^i\left(m^i, C_0^i\right) &= prob\left(\mu_i > \frac{\overline{u}^i - v^i\left(m^i, C_0^i\right)}{c}\right) \\ &= 1 - \Phi_i\left(\frac{\overline{u}^i - v^i\left(m^i, C_0^i\right)}{c}\right). \end{aligned} \tag{21}$$

For well-insured patients, demand increases in the spending generosity of the provider: $\frac{dn^{\mathrm{i}}}{dm^{\mathrm{i}}} = \frac{\Phi_{\mathrm{i}}'}{c}\frac{dv^{\mathrm{i}}}{dm^{\mathrm{i}}} > 0$. A decrease in c corresponds to an increase in competition and a stronger demand response to changes in spending $\left(\frac{d}{dc}\frac{dn^{\mathrm{i}}}{dm^{\mathrm{i}}} = \frac{-\Phi_{\mathrm{i}}'}{c^2}\frac{dv^{\mathrm{i}}}{dm^{\mathrm{i}}} < 0\right)$. In other words, a monopoly can ration stringently without loosing insured patients, but a hospital in a competitive market (low travel cost c) cannot reduce spending generosity–that is, availability of services or "quality"–much below that of its rivals without loosing a significant volume of insured patients.

In contrast, uninsured patients must balance the marginal benefit of treatment against the marginal cost of paying the full price of care. Moreover, they may face ability-to-pay or liquidity constraints in paying hospital bills because of imperfections in credit markets and/or labor markets in China, as in other developing and transitional economies. As Banerjee (1997) notes, "this assumption of capital market imperfection is relatively uncontroversial in the context of education or health" (p.1291). Given the evidence that a significant fraction of Chinese patients refuse hospitalization due to financial constraints, even when hospitalization is recommended by a health professional, we assume that liquidity constraints are binding for a fraction of uninsured patients that increases as the total bill the patient has to pay increases (see Table 2).

Thus, in this model the consumer can choose between hospitals based on reputation or perceived spending, but once at the hospital must either accept or reject a "take-it-or-leave-it-offer" of treatment. (We do not model choice of physician at a given hospital.) It may seem unrealistic that patients often must choose between an excessive amount of care and no treatment at all, but we think that this model captures important features of the reality facing many Chinese patients (and patients in some other countries). Patients rarely can judge how much care is "necessary" or medically indicated. The hospital and/or physician may have financial incentive to recommend expensive treatments, and often has authority to demand a deposit for the projected cost of care prior to rendering treatment. (For discussion of evidence regarding patient access problems, inability to pay and liquidity constraints for urban Chinese, see Yip, Eggleston and Meng 2003).

4 Simulating China's Reforms

Although the analytic results above give important clues about the potential outcomes of China's reforms, it is also useful to illustrate various specific reform scenarios by calibrating a simulation model. In this section we describe model calibration and the simulation results.

We use linear demand for medical care (as in other health sector simulations, such as Keeler, Carter, and Newhouse 1998), based on the average spending of insured and uninsured Chinese patients in the 1998 National Health Survey (Ministry of Health 2001, 2002). The national data does not disaggregate spending by service category, but we need to do so to simulate the impact of differential incentives across profitable and unprofitable services. Evidence from other countries and anecdotal evidence from China suggest that demand for the services paid above marginal cost in China – primarily high technology diagnostic procedures and pharmaceuticals – is more elastic than demand for the services priced below marginal cost (e.g., the charge for an inpatient bedday). Based on the assumptions of more elastic demand for (profitable) service 1 than (unprofitable) service 2 and of combined spending levels on the all services for insured and uninsured patients from the 1998 National Health Survey, we specify demand for each service as follows:

$$D_1 = \frac{dv_1}{dm} = 1.8 - 0.0006m_{1,} \tag{22}$$

$$D_2 = \frac{dv_2}{dm} = 2.5 - 0.001m_{2.}$$

The demand elasticities of the two services implied by this specification are consistent with the evidence on demand elasticities found in the RAND China Health Insurance Study, i.e., about –0.6 for outpatient services and -0.4 for inpatient services (Cretin, Duan, Williams, Gu, and Shi 1988; Phelps 1992, pp.124-125).

We assume that all patients are homogenous in the severity of their health conditions and the value that they place on health (i.e., willingness to pay), and that 50% are insured. As discussed above, we build in "cash constraints" for uninsured patients so that for an endogenously defined fraction of the population, willingness to pay exceeds ability to pay.

Table 2 about here

On the supply side, the literature provides less clear guidance on simulating behavior. Therefore we simulate a range, e.g., of ability to induce demand for profitable service 1 (see Table 2). We assume that the private sector optimizes given government investments as embodied in government-hospital shadow prices (as discussed in the "government hospitals" sub-section above). In each simulation, two representative providers compete for patients. In the benchmark, two government hospitals serve relatively isolated markets. In the equilibria with private competition, a lower travel-cost parameter ($c = 100$) simulates direct provider competition for patients. We use the term "provider" to include both hospital administrators and physicians, since they jointly shape patient treatment.

Table 3 about here

Table 3 reports the results comparing the benchmark under government ownership to that of private competition (i.e., one government hospital competing with a private sector entrant). The private entrant lures patients who can afford to pay by offering more generous spending, thus lowering both shadow prices, and maximizes net revenue by inducing demand for the profitable service 1 (as indicated by a negative shadow price q_1), relative to the benchmark. The private hospital serves a disproportionate share of the insured patients (62%), who can afford profitable service 1, while the government hospital ends up with a disproportionate share of the uninsured (59%). The percentage of patients who opt for self-treatment because they cannot afford hospitalization increases significantly, because spending conditional on use increases (20%). Although the loss of access translates into a lower increase in total health spending than would otherwise pertain, total spending per person (not conditional on use) nevertheless increases (10%). The simulation thus underscores the primary analytic results discussed earlier: pricing distortions will generate service distortions, with wasteful over-spending on profitable services, and these distortions will be greater with hospitals who are net revenue maximizers competing for patients, if only because they have greater flexibility to invest in the profitable services. Patients most severely affected are those who cannot afford to pay the charges for more intensive hospital care.

Figure 1 about here

Figure 1 shows shadow prices for service 1 and service 2 under four different payment scenarios. To focus on changes in price-cost margins and their effects on provider behavior, Figure 1 assumes no benchmark service distortions (i.e., the government shadow prices are uniform at $q_1 = q_2 = 0.1$). The four payment scenarios illustrate increasing price-cost divergence between the two services. The first column shows that providers would choose uniform and positive shadow prices when paid uniform prices (with some supply-side cost sharing for the two services, $P_1 = P_2 = 0.95$, and pre-payment to cover costs, $r = 200$). As price-cost margins diverge, however, so do shadow prices and service-specific spending. As the price for service 1 increases, the shadow price falls. The negative shadow price for profitable service 1 indicates induced demand; in the last column with $P_1 = 1.3$ the constraint on the extent to which providers can induce demand ($q_1 \geq -0.3$) is binding. Note that for a small distortion in prices, the profitability of service 1 actually helps to make the provider willing to offer more of the less profitable service, consistent with the policy intent of implicit insurance and service cross-subsidization. However, as price-cost margins diverge further, revenue-maximizing providers will increasingly induce demand for the profitable service and restrict spending on the unprofitable service. Proposed price reforms in China would move from right to left in Figure 1, from large service distortions toward uniform incentives for spending across services.

Figure 2 about here

Figure 2 illustrates how total health spending increases as price-cost margins diverge, fueling cost escalation.[7] Conversely, price reform toward more uniform margins across services will help to control costs.

Figure 3 about here

The flaw of using low administered prices to provide implicit insurance for poor patients becomes clear when one focuses on the contrasting patient and provider responses, as illustrated in Figure 3. As the administered price for service 2 (the "basic" service) falls lower and lower, low-income patients want to buy more of the service. Call this the intended effect: lowering prices for basic care increases access because patients can afford to buy the service. This prediction, however, ignores a critical factor: supply-side incentives. As the price falls increasingly

[7] Of course the cost escalation could be even higher if all services were quite profitable; provider effort to restrain use of unprofitable services actually helps to keep total spending down and healthcare affordable.

below cost, providers try to restrict access to the service, and in the limit may not provide the service at all. This unintended effect undermines the policy's *raison d'être*. Thus when providers heavily shape treatment decisions–as they almost invariably do–lowering administered prices can actually reduce patient access.

Figure 4 about here

Nevertheless, under soft budget constraints for government hospitals (which subsidize inefficiency as well as access), lowering the price of service 2 may improve access–in that fewer uninsured patients are rationed out of the market by binding liquidity constraints (see Figure 4)–but not because providers willingly provide the loss-making service to all comers. Instead, revenue-maximizing hospitals limit market exposure, and eventually exit the market entirely, when they are unable to cover losses from service 2 with profits from service 1 (due to the constraint on induced demand for service 1). Access only is maintained because government hospitals "must" provide the service and enjoy a soft budget constraint to prevent bankrupcy (see Figure 5). To the extent that the government cannot or will not subsidize government hospitals or compel them to provide such services, access will suffer.

Figure 5 about here

In sensitivity analyses, outcomes changed in expected ways. For example, increasing the coinsurance rate for the insured patients helps to constrain spending, but simultaneously exacerbates service distortions and leaves the insured with a larger financial burden. The converse scenario is to expand insurance by covering the uninsured (modeled by lowering the coinsurance rate for the "uninsured" from 1 toward parity with that of the originally insured). This decreases the service-specific shadow price distortions, decreases the number of nonusers, and increases total spending. These are all intuitive outcomes of expanded insurance. With concurrent price reform, the latter outcome of increased spending could be greatly reduced, since providers would no longer have incentive to over-invest in high technology equipment. Sensitivity analysis on the constraint on supplier-induced demand reveals that as the constraint is relaxed, price-cost margin differences between services lead to even larger service distortions.

If private hospitals achieve lower marginal costs than government hospitals, they can achieve better profit margins even with administered prices unchanged. Simulations (described in more detail in the appendix) show that under plausible assumptions, decreasing private sector marginal cost reduces inducement and increases access to basic services, while increasing private sector market share.

Changes in market competitiveness–modeled by changing the travel cost parameter c– also have expected effects: more market power tends to exacerbate service distortions, although competition for patients does not uniformly increase "quality" or spending levels across services or patients. Only reform of pricing and payment can address the core issue of service distortions. And since price distortions remain in place predominantly to provide implicit insurance, removing the costly service distortions will require expansion of insurance to the currently uninsured and/or subsidies to providers linked to serving the uninsured (such as the program of Disproportionate Share Hospital Payments to hospitals in the US that serve a disproportionate share of poor and uninsured patients; see Duggan 2000).

5 Conclusion

This paper develops a model of public-private hospital competition under regulated prices, recognizing that hospitals are multi-service firms and that equilibria depend on the interactions of three key participants: patients, hospital administrators, and physicians.

Using data from China to calibrate a simulation model, we analyze the probable impact of China's recent urban health sector payment and organizational reforms on cost, quality and access.Given the inherent uncertainty surrounding various factors that will impact the results of China's health sector reforms (e.g., the extent to which some patients will find cost escalation a barrier to access and become nonusers), we emphasize our qualitative rather than our quantitative findings.

Both the analytic and simulation results show clearly how providing implicit insurance through distorted FFS prices leads to over/under use of services by profitability. Competition for patients under distorted FFS prices contributes to cost escalation. Unless policies otherwise subsidize access–through expanded insurance and/or provider subsidies linked to serving the poor and uninsured–these cost increases will reduce access for those who cannot afford to self-pay for care. Thus, ironically but not unpredictably, using price regulation to try to guarantee access may actually undermine equitable access to care. Hospital privatization and competition for patients will improve social welfare only if policymakers pay careful attention to payment incentives and regulation.

A Appendix: The Simulation Model

The simulation model assumes that patient demand takes the form of (21) with the cumulative distribution Φ_i defined as the cdf for a logistic random variable:

$$n^i\left(m^i\right) = 1 - \left(\frac{1}{1 + \exp\left[-\left(\frac{\overline{u}^{\mathrm{i}} - v^{\mathrm{i}}(m^{\mathrm{i}})}{c}\right)\right]}\right)$$

The regulated private hospital administrator maximizes (12) taking prices and the competing government hospital's shadow prices (which enter demand through $\overline{u}^i$) as given.

Hart, Shleifer and Vishny (1997) and other theories of ownership and competition posit that private providers often achieve lower unit costs than government-run providers. To simulate the impact of such differential price control on market outcomes, we consider a range of cost differences (5-25%) between public and private hospitals, starting from the benchmark of identical marginal costs, $m = 1$. Recall that each administered price P is set relative to m, so that supply-side cost sharing $s = (m - P)/m = 1 - P$. For example, $p = 0.8$ is equivalent to $s = 0.2$; $P = 1.1$ is equivalent to $s = -0.1$. For $P > 0$ ($s < 1$), private providers lower supply-side cost sharing $Y\%$ by lowering marginal cost $x\%$, where $Y = (P/(1-x)) - P$. For example, consider the case of $P = 0.5$ ($s = 0.5$). If a provider decreases marginal cost by $x = 1/6$ (about 17%), that provider decreases its supply-side cost sharing to $s = 0.4$.

Finally, we detail a simple model of patient under-the-table payments, or *hongbao*. Let H be a 'conversion factor' from RMB yuan to more healthcare spending or "quality." A patient pays Hh to obtain treatment spending $m(h) = (1+h)m$. Individual utility thus becomes

$$V^i = \sum_{j=1}^{2}\left[a_j m - \frac{b_j}{2\theta_j^i}(m)^2 - C_0^i P_j m - H h_j^i\right] + c\mu^i$$

where $m = \left(1 + h_j^i\right) m_j$. The first order condition for optimal under-the-table payment h_j^i by patient i for service j gives

$$h_j^i = \frac{a - \left(\frac{H}{m_{\mathrm{j}}^{\mathrm{i}}(q_{\mathrm{j}})} + C_0^i P_j\right)}{b m_j^i\left(q_j\right)} - 1.$$

We see that the patient wants to purchase extra care with under-the-table payments $h_j^i > 0$ when access is restricted, and/or the provider stints on "quality" ($q_j > 0$); and/or when perceived marginal benefit (a) is high. Formal co-payment requirements reduce *hongbao* ($\frac{dh^i}{C_0^i} < 0$).

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Table 1. Differential policies towards for-profit and non-profit hospitals

Hospital Type	**Policies**		
	Pricing	Government subsidies	Tax
Government owned	Regulated price for most services	Yes	Exempt
Private non-profit	Regulated price, but allow flexibility within range	No	Exempt
For-profit	Unregulated price	No	Taxed

Table 2. Simulation Parameters, Sources, and Ranges

Variable	Symbol	Benchmark	Source	Simulated Range	
				Minimum	Maximum
Demand elasticity			RAND China study, late 1980s: inpatient –0.4, outpatient -0.6	--	--
Linear demand for each service, MB=a-bm	a1 a2	1.8 2.5	(Authors' calibration, consistent with demand elasticities and average spending levels, below; service2 less elastic)	--	--
	b1 b2	0.0006 0.001		--	--
Average spending	mH* mL* m*	4500 2650 2833	mH* and mL* are <u>desired</u> spending of insured and uninsured at benchmark prices and co-insurance rates (1998 National Health Survey: urban average spending for a hospitalization = 4037 RMB; for uninsured = 2729 RMB; for SOE insured (LIS), 4424 RMB; for GIS insured, 5095). m* represents socially efficient average spending for these linear demands.		
Percent nonusers (liquidity constrained L)		20% of L, 10% overall	1998 National Health Survey (recommended hospitalization but refused for financial reasons ~18%)	Endogenous	
Distribution of nonusers		100% of uninsured self-treat when bill greater than half of household average annual income (14,076 RMB in 1998 National Health Survey)			
Percent insured	nH	50%	1998 National Health Survey (urban)	50%	100%
Co-insurance rate for insured	Co	35%		10%	60%
Profit margin for high tech services; Price for service1	(1-s1) P1	20% 1.2		1% 1.01	50% 1.5
Profit margin for basic services; Price for service2	(1-s2) P2	-15% 0.85		-50% 0.5	10% 1.1
Constraint on supplier-induced demand		q1> -0.3		-0.1	-0.5
Competition	Travel 'cost'	100		50	200
Private hospital marginal cost (% below public)		0		0%	25%

Table 3. Comparing the Benchmark to Private Competition under Distorted Regulated Prices (P1=1.2, P2=0.85)

	Benchmark	Private Competition	Difference (%)
q1: Shadow price for service1	0.10	-0.27	-366%
q2: Shadow price for service2	0.50	0.23	-54%
nH: Private market share, insured patients	n/a	0.62	n/a
nL: Private market share, uninsured patients	n/a	0.41	n/a
Percent of patients who cannot afford a hospitalization	0.04	0.12	205%
Average spending for insured patients	3845.72	4379.10	14%
Average spending for uninsured patients, conditional on use	1993.19	2455.36	23%
Average spending, conditional on use	2961.28	3551.00	20%
Total spending per person (unconditional)	2833.33	3117.45	10%

Figure 1. As Price-Cost Margins Diverge, So Do Shadow Prices and Spending

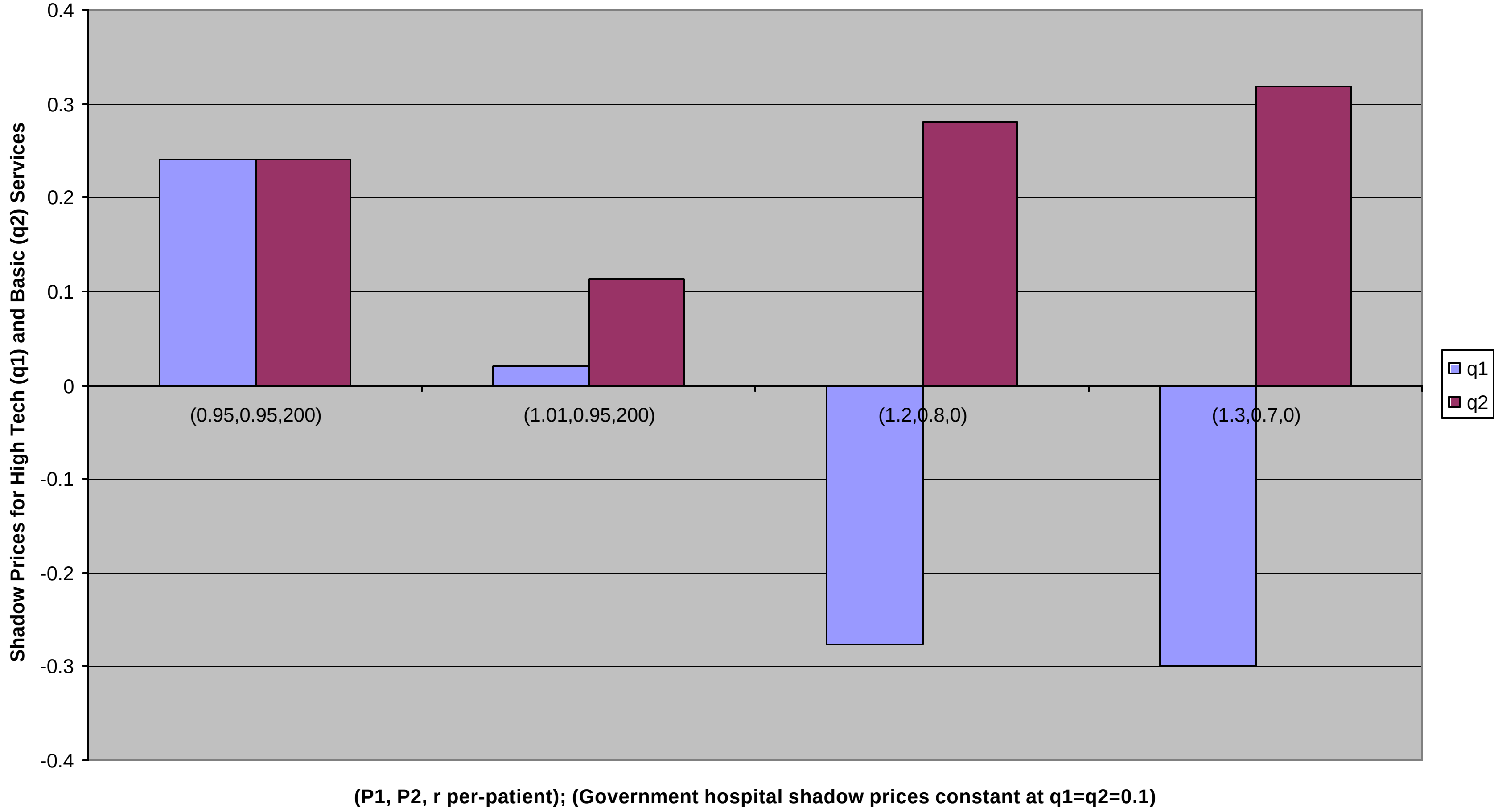


Figure 2. Total Spending Is Higher When Price-Cost Margins Diverge

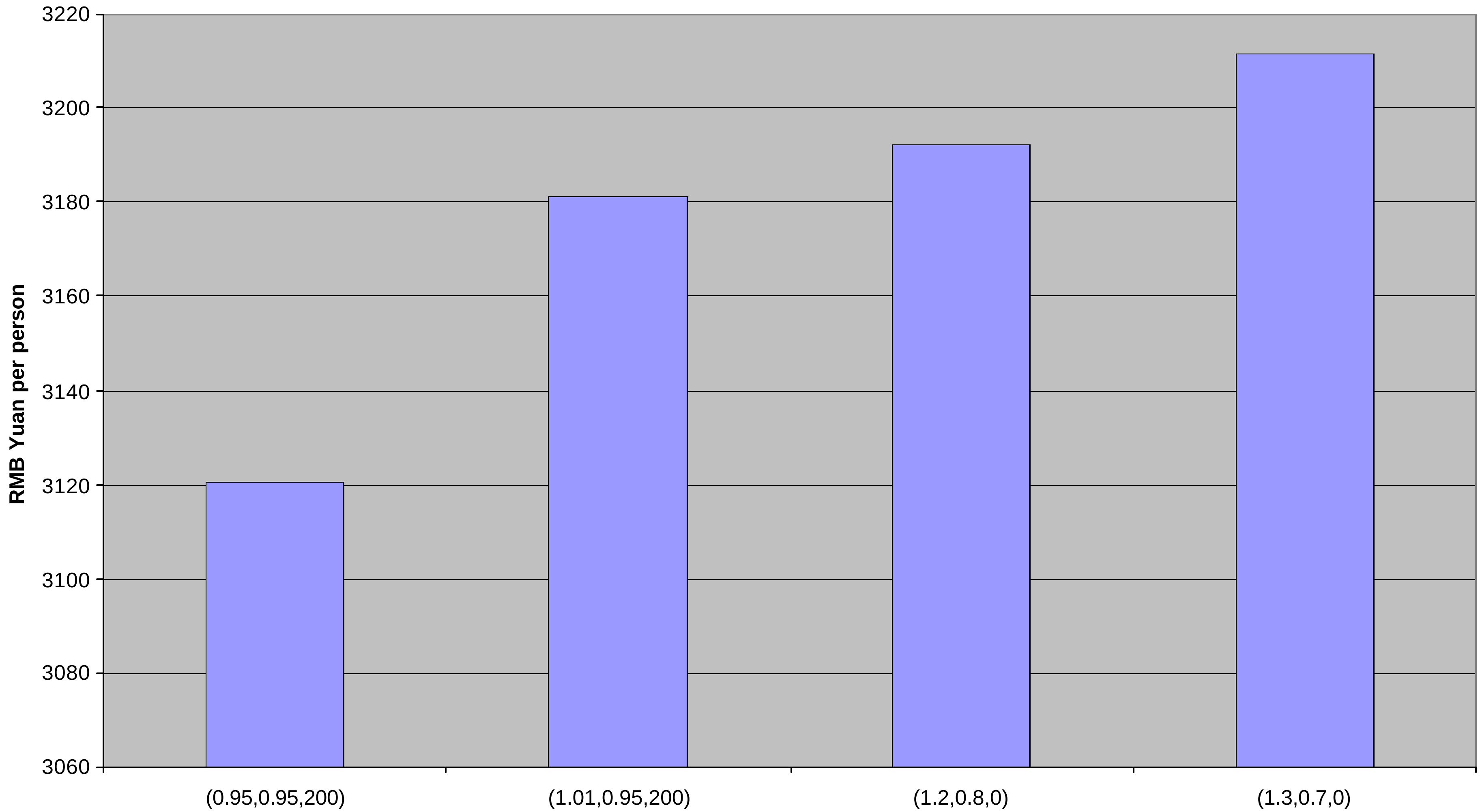


Figure 3. Implicit Insurance and Unintended Provider Response

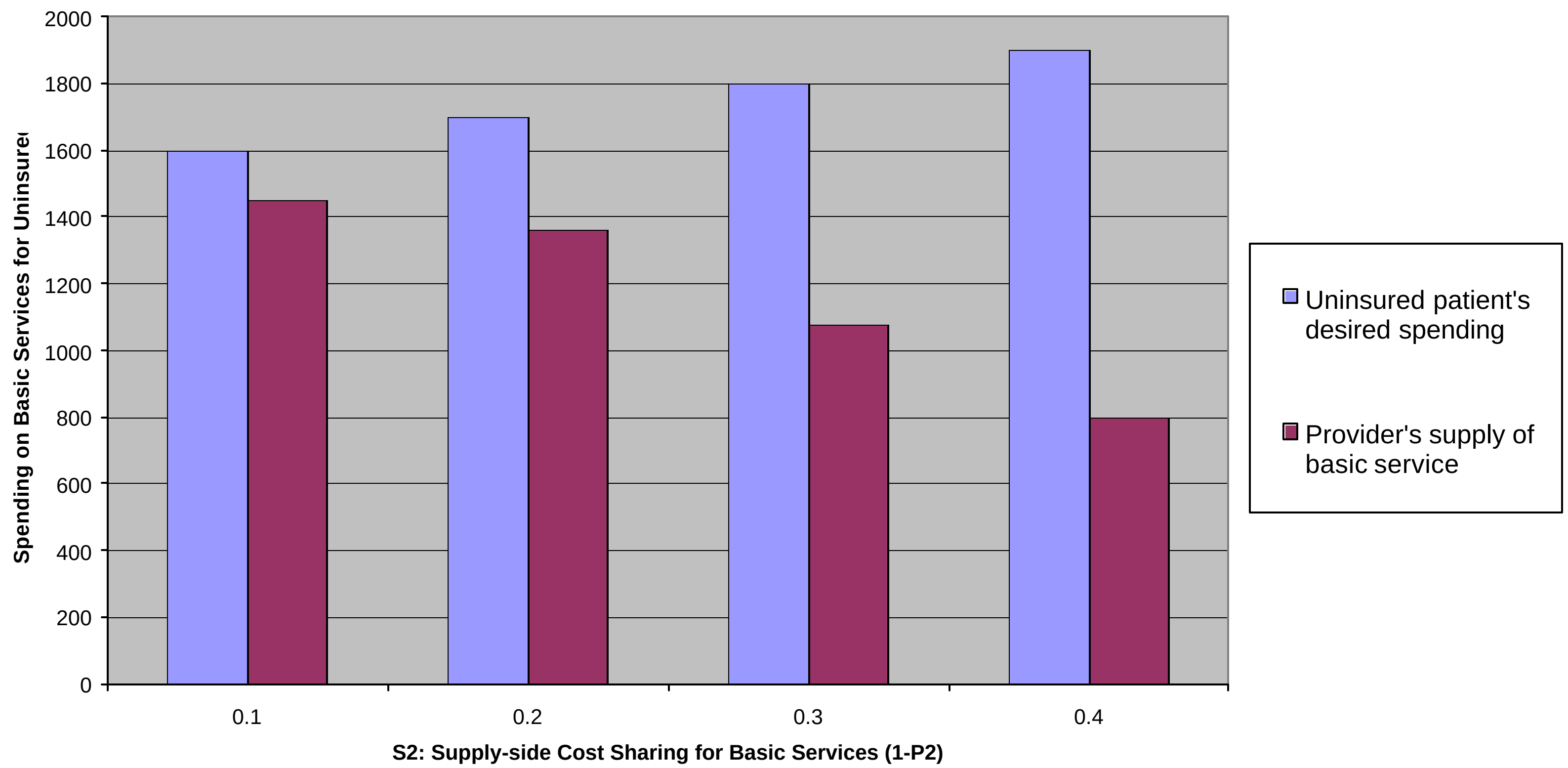
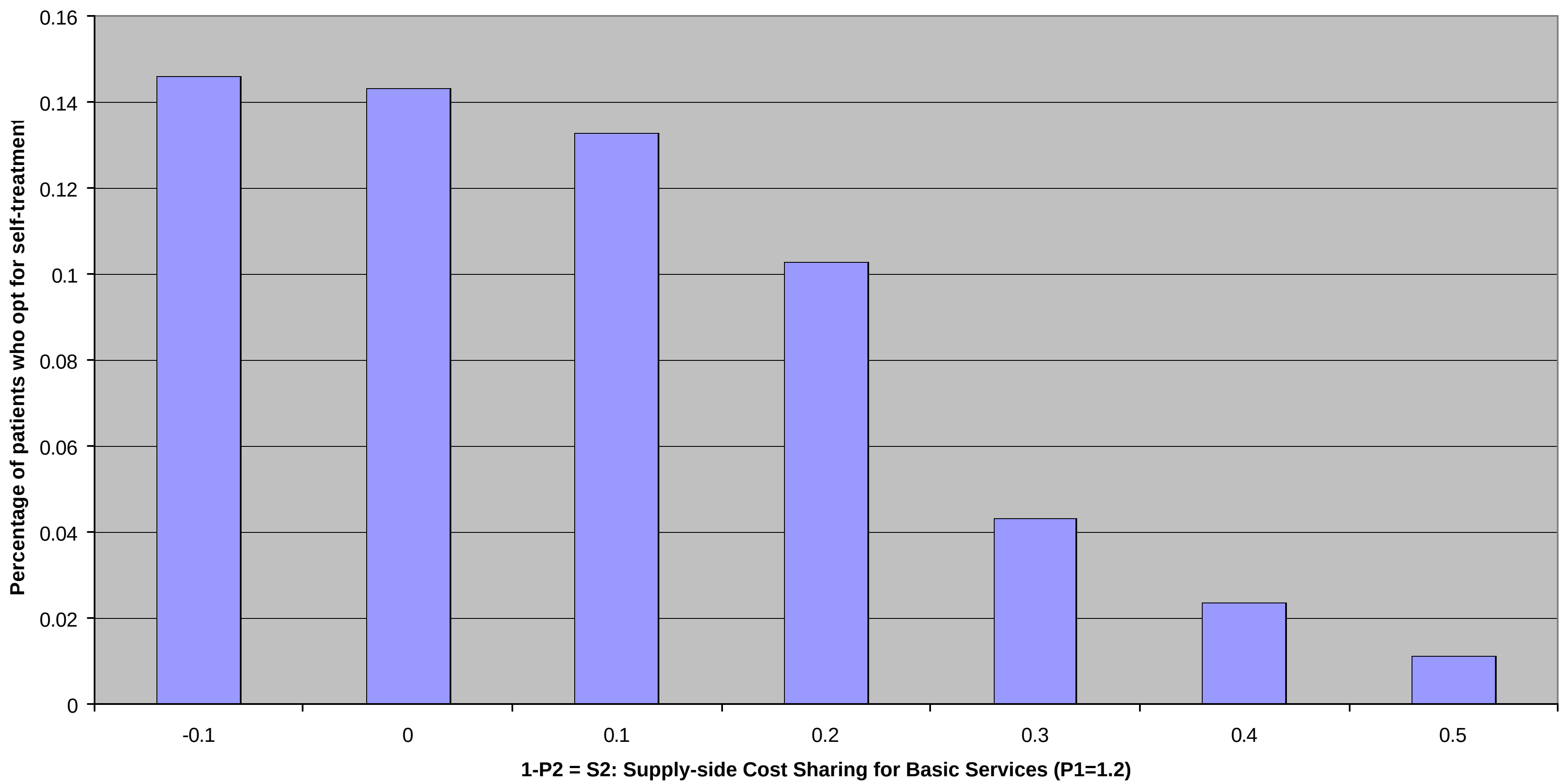


Figure 4. Access Improves (Fewer Uninsured Rationed Out by Liquidity Constraint) As Price For Basic Care Decreases



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