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Insurance coverage and agency problems in doctor prescriptions: Evidence from a field experiment in China☆

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ABSTRACT

This study examines doctors' prescribing decisions using controlled hospital visits with randomized patient insurance and doctor incentive status. The results suggest that, when they expect to obtain a proportion of patients' drug expenditures, doctors write 43% more expensive prescriptions to insured patients than to uninsured patients. These differences are largely explained by an *agency hypothesis* that doctors act out of self-interest by prescribing unnecessary or excessively expensive drugs to insured patients, rather than by a *considerate doctor hypothesis* that doctors take account of the tradeoff between drug efficacy and patients' ability to pay.

1. Introduction

China's health expenditures totaled over 220 billion US dollars in 2009, and both health insurance coverage and health expenditures are rising rapidly.[1] Understanding the relationship between insurance coverage and expenditures is thus a key policy question for China and other developing countries. Previous studies have found that health care spending is highly correlated with insurance provision, and some of them speculate that doctors' incentives for generating more drug sales may be one mechanism underlying the strong correlation (Wagstaff and Lindelow, 2008; Wagstaff et al., 2009).

Arrow (1963) identifies the principle-agent problem between patients and doctors as one of the fundamental market failures in the health care market. In China, doctors can pocket profits from selling drugs. As patients have limited knowledge about proper treatments, doctors may recommend treatments to increase their own income rather than their patients' well-being. When patients have health insurance, doctors can leverage the greater ability to pay and prescribe further away from what is optimal for patients. This is an *agency explanation* for the increasing health expenditures under insurance coverage. Alternatively, doctors may hope to improve patients' well-being by taking into account both drug efficacy and their patients' ability to pay. This considerate doctor hypothesis can also drive up health expenditures under insurance coverage. The two hypotheses have opposite welfare implications: under the considerate doctor hypothesis, larger drug expenditures on insured patients represent improvements in treatment, although not necessarily in an efficient way; under the agency hypothesis, increased expenditures are associated with unnecessary or undesirable treatments. This paper provides the first in-field, experimental test of the relative importance of these two hypotheses.

To test these two hypotheses, it is crucial that we use a controlled field experiment rather than observational data. Observational studies are plagued by two endogeneity problems, involving which patients receive insurance coverage and which doctors have incentives to promote drug sales, and, more importantly, an identification problem due to the tendency that patients also respond to insurance. This study avoids these challenges by using controlled hospital visits with randomized insurance and incentives. In the experiment, the same patients were randomly presented as having insurance or not having insurance during hospital visits in Beijing, China. Doctors were randomly told either that the patient will buy drugs at the doctor's hospital (providing doctors with a financial incentive to prescribe more drugs)

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[1] Author's calculations from WHO World Health Statistics (2011).

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or that the drugs will be purchased elsewhere (eliminating the doctor's financial incentive, as drug sales elsewhere do not affect doctors' income). Testers describe health problems and communicate with doctors according to a standard script, thus eliminating different drug requests from patients due to insurance coverage.

The results demonstrate that doctors actively react to patients' insurance coverage when they have an incentive to do so, and provide strong support for the agency hypothesis, but little evidence for the considerate doctor hypothesis. When doctors are provided with an incentive to promote drug sales, prescriptions for insured patients cost 43% more on average than those for uninsured patients. Doctors prescribe more drugs and more expensive drugs to insured patients. Furthermore, doctors are more likely to prescribe unneeded drugs to the insured (64%) than to the uninsured (40%). In contrast, doctors without a personal financial incentive do not respond to patients' insurance status, which rules out the considerate doctor explanation. Doctors' personal incentives affect prescriptions to the insured patients, as usually predicted. Overall, this study shows that the interaction between insurance coverage and agency problems has significant impacts on medical expenditures, and that misaligned incentives contribute to rising health expenditures as insurance coverage expands.

Besides providing evidence on the separate effects of financial incentives and insurance coverage, this study explores the interacting effects of incentives and insurance, and tests whether it is doctors' self-interest or their concern for patients that leads to rising health expenditures under insurance coverage. The contributions are as follows.

First, it adds evidence to health agency literature (see McGuire (2000) for a review). Dalen et al. (2010) show that the treatment cost is lower if it is covered by the hospital whose doctors treat patients, rather than by the Norwegian national insurance. Currie et al. (2011) explore how patients' knowledge affects doctors' prescription of antibiotics and infer agency problems among Chinese doctors. They took a similar audit study approach as adopted in the current study — sending testers to see doctors. Rather than relying on indirect inference, the current study explicitly randomizes doctors' personal financial incentives, and provides evidence that is directly applicable to policy interventions to remove doctor incentives. In a subsequent audit study, Currie et al. (2012) further show that removing doctors' financial incentives has a stronger effect than does increasing patients' knowledge. Unlike the two studies by Currie et al., this analysis inspects the impact of health insurance, and especially how insurance coverage interacts with doctors' agency problems.

Second, this study provides insights into the effect of health insurance coverage on doctors' prescribing decisions. Due to the nature of observational data, most empirical evidence exploring the impacts of health insurance estimates the combined effects due to responses from both patients and doctors (Anderson et al., 2012; Card et al., 2008; Carrera, 2011; Lundin, 2000; Wagstaff and Lindelow, 2008; Wagstaff et al., 2009; Zweifel and Manning, 2000). However, understanding whether it is the doctor or the patient who is reacting to insurance coverage is essential for controlling rising health expenditures. Mort et al. (1996) and McKinlay et al. (1996) are exceptions that focus on doctors, but they explore doctors' reports of likely decisions rather than actual behaviors. This study explores actual hospital visits conducted in a standardized manner, and provides clean evidence on how doctors respond to a patient's insurance status.

Third, this study demonstrates a strong interacting effect between doctors' financial incentives and insurance coverage. It helps to explain the correlation between drug expenditures and insurance coverage. Agency problems are considered in many studies as a possible explanation for the rising drug expenditures associated with insurance coverage (Feldstein, 1970; Kessel, 1958; Wagstaff and Lindelow, 2008; Wagstaff et al., 2009). Two papers by Iizuka (2007, 2012) are closely related to the current study; they take into account both doctors' incentives and patients' out-of-pocket costs, with one paper analyzing hypertension drug expenditures and the other exploring the choice of generic versus brand-name drugs. The controlled random experiment in the current study has two advantages over previous studies in exploring the interacting effects of insurance coverage and doctors' agency problems. One, this study eliminates differential patient requests, which makes it clear that the findings explain decision making by doctors rather than by patients. Two, the study randomizes doctors' incentives, which rules out other factors in explaining the correlation between doctors' incentives and their prescribing behaviors.

In addition, this study adds to the growing literature using audit studies. The audit study approach has been used in a wide range of contexts, including the job market, car sales market, car repair market, and sports card trading, as well as drug prescription (Ayres and Siegelman, 1995; Bertrand and Mullainathan, 2004; Currie et al., 2011; Kravitz et al., 2005; List, 2004; Schneider, 2012).

The paper proceeds as follows. Section 2 introduces the insurance scheme and doctor incentives in China. Section 3 presents the experimental design and the predictions tested. Section 4 describes the data, and Section 5 presents the main results. Section 6 discusses alternative interpretations. Section 7 summarizes the paper and draws conclusions.

2. Institutional background

In China, most outpatients are treated by doctors in hospital clinics, and drugs dispensed in hospital pharmacies accounted for 74% of drug sales in 2009 (Chinese Medicine Development Research Center, 2010). Drug sales account for 40–50% of all hospital revenues.[2] In Beijing, the government decides the type of drugs that hospital pharmacies can sell. The government also decides both the wholesale drug price and the retail drug price at hospital pharmacies. Because a type of drug can be produced by multiple firms in different packages, a price is specified for each drug-brand-package. Except at community-level clinics, hospital pharmacies are allowed to charge a retail price that is 15% higher than the wholesale price. This 15% mark-up is intended to compensate hospitals for operating costs, given that the government sets hospital visiting fees at a very low level (Liu et al., 2000; Yip and Hsiao, 2008). There are many other pharmacies outside of hospitals. Outside pharmacies face different wholesale prices and operating costs. The prices at outside pharmacies can be slightly below those in hospital pharmacies (usually not as much as 15% below), and sometimes the former can also sell drugs at higher prices.

Doctors tend to be salaried employees affiliated with hospitals, but their performance pay often depends on the revenues generated in their own hospitals (Tang et al., 2007). Kickbacks from pharmaceutical companies can provide further incentives for doctors to prescribe (Yip and Hsiao, 2008). It is important to note that doctors are usually unable to share profits from drug sales other than in their own hospital pharmacies. In most cases when they prescribe, doctors see the price for each drug-brand-package on their computer screen. The doctors specify the drug-brand-package combinations from the pharmacy inventory list, and pharmacists cannot change them.

There are several large public health insurance systems, which separately target rural residents, urban residents and employees, and government workers. Although they differ in terms of deductibles and copay rates, different insurance systems share several common features. First, the insurance authorities have limited ability to monitor the quality of health care (Wagstaff and Lindelow, 2008). Second, doctors are paid on a fee-for-service basis when treating insured patients, in the same manner as they are paid for treating uninsured patients. Third, the copay rates are usually the same for brand-name drugs and generic drugs.

[2] From http://finance.sina.com.cn/roll/20110805/151410269229.shtml (in Chinese).

The particular type of insurance chosen for this study is the government insurance covering civil servants and other government workers. The favorable feature of government insurance for this study is that hospitals do not verify insurance status if a patient states that she has government insurance. With government insurance, patients pay all the medical fees to hospitals as if they did not have any insurance, and then file for reimbursement with the necessary receipts at their affiliated organizations. This feature facilitates the manipulation of insurance status in the study. The copay rate of the government insurance varies by organizations, but usually it is lower than the copay rate of the insurance for urban employees, the latter of which is 30% in Beijing. For simplicity, a 15% copay rate (the average of 0% and 30%) is assumed when calculating the out-of-pocket price for a patient with government insurance.

The top-rated "3A" hospitals are high-quality and large-scale hospitals. Although the distinction between primary care doctors and specialists is not emphasized in China, doctors in the top-rated hospitals are more likely to be specialists. They serve patients from a wide geographic area, both from Beijing and outside.

3. Experiment design and predictions tested

The experiment took an audit study approach and used undercover hospital visits to detect variations in how doctors prescribe. The experiment employed a 2-by-2 intervention design:

(1) The patient was presented either as having government insurance ("insured") or no insurance ("uninsured");
(2) Before the prescription was written, the doctor was informed either of the patient's intention to buy medicine from the doctor's hospital, so that the doctor had an "incentive" to prescribe extensively, or of the patient's intention to buy elsewhere ("no incentive").

	Incentive	No incentive
Insured	A	C
Uninsured	B	D

Thus, there were four possible interventions, as the chart shows: A. insured-incentive; B. uninsured-incentive; C. insured-no-incentive; D. uninsured-no-incentive. Insurance and incentive status was randomly assigned to doctors.

For this audit study, it was essential to have otherwise comparable hospital visits except for the designed variations. There were two challenges — testers might be different ex ante, and the same testers might behave differently ex post after being assigned to different interventions. This study took several measures to minimize the possible biases due to testers. First, this study chose diabetes, hypertension, and abnormal triglycerides as the purported health problems, which can be described objectively and numerically. Second, the hospital visits took the form of consultations on behalf of absentee patients – a common practice in China – and the testers told doctors upfront that they were not the patient. Thus, testers' other characteristics would have little impact on doctors' decisions. Third, each tester conducted multiple hospital visits under each of the four interventions, allowing an inclusion of tester-fixed effects in the statistical models. Finally, testers practiced so that they could strictly follow the standard protocol. The following describes the experiment in detail.

3.1. Hypothetical patients

Two hypothetical patients were constructed for the experiment with the assistance of several out-of-sample doctors (see Appendix 1 for details about the patients). Patient 1 was a new patient without relevant medical history, who was sent to see doctors of endocrinology. Patient 2 had continuing problems, and he was already on medication. He was sent to the department of cardiology. The two patient cases were designed to complement each other, and to increase the sample size.[3]

Patient 1 was described as a 66-year-old male. He recently received medical test results showing elevated triglycerides, high blood sugar, and high blood pressure, and was not yet taking any medications.[4] The levels of blood sugar and blood pressure were high enough that all the doctors would prescribe some drugs. The problem with triglycerides was included to test over-prescribing. If a patient were to look at the lab results without the help of doctors, it would be reasonable for him to conclude that he had a triglyceride problem and might need medication for it. However, according to medical guidelines, the patient should not be prescribed drugs for this level of triglycerides, given the possible side effects of the drugs.[5] Therefore, the prescription of triglyceride drugs indicated over-treatment or inappropriate treatment.

Patient 2 was described as a 65-year-old male with hypertension, already taking the brand-name Nifedipine controlled-release tablet, but with his blood pressure still abnormal. Doctors were expected to adjust the current drug or to add more drugs or do both.

The testers posed as family members who visited doctors.[6] They were prepared with answers for the most likely questions that doctors might ask concerning other health problems, such as histories of family illness, smoking, drinking, height, weight, etc. The prepared answers excluded all other risk factors. The testers presented the patients' test results directly to the doctors, but they would only give other information if asked by doctors, because knowing the relevance of other information might suggest that the testers or the patients were much more knowledgeable than is typical.

In all interventions, patients were described as living in other regions. If a patient lived nearby, a doctor might suggest that the patient visits the hospital himself. More importantly, in the no-incentive interventions, doctors might get angry if the patient refused to buy drugs at their hospitals, but they would understand if the patient lived far away. Non-local patients are common for the sample doctors at the top-rated hospitals.

This study intends to evaluate the effects of health insurance for the average patient (rather than, say, for a poor patient). Two elements were designed to indicate that the patient was not poor. First, the drug that was currently being taken by Patient 2 for hypertension is a relatively expensive brand-name drug. The brand-name Nifedipine controlled-release tablet by Bayer (hereafter called Bayer Nifedipine) costs about 163 yuan (around 24 dollars) per month,[7] which accounts

[3] To determine the number of necessary visits, I used an indicator variable to compare two interventions — whether a doctor prescribes more expensive drugs in one intervention than in the compared intervention. Then the largest possible standard variation for an indicator variable was 0.5. Using 0.05 significance level and 0.8 power, the sample size for detecting a 20% difference should be around 49 ($49 = [(1.96 + 0.84) * 0.5/0.2]^2$). This means that, in order to see a significant difference in whether doctors were actually 20% more likely to write a more expensive prescription in one intervention than in another intervention, it is enough to have 49 data points for each intervention. There are 32 top-rated comprehensive hospitals in the urban districts of Beijing, which have separate departments for endocrinology and cardiology. So each hospital had to be visited at least twice under each intervention.

[4] It is common for patients to demand medical tests. The reports of medical tests go directly to patients rather than to doctors, who order the test to be done through an outpatient service. It is up to patients to consult doctors after seeing the test results. In the report for blood tests, patients can see which indicators are below or above the normal range.

[5] For the guidelines in the U.S., see http://www.nhlbi.nih.gov/guidelines/cholesterol/atglance.htm.

[6] Doctors did not see actual patients. Instead, "family members" (testers) consulted doctors about a distant patient. Several phenomena show that such visits are routine in China. For example, doctors across different hospitals frequently write the same phrase "patient not present, family members consulted on patient's behalf." In an essay entitled "Things to tell doctors before and after drug prescribing," the first suggestion is to make it clear to the doctor who the patient is. The essay explains that one reason is that people sometimes see doctors on behalf of relatives from other regions. Although there are no quantitative data showing how frequently doctors see family members in the absence of patients, observational evidence suggests that this is part of doctors' regular practice. The advantage of using such a practice in this study is to facilitate no-incentive interventions, and to allow for better controls during hospital visits.

[7] The exchange rate was \$1 U.S. ≈ 6.8 CNY during the experimental period, the summer of 2010.

for 11% of the average income of an urban resident.[8] Bayer Nifedipine has a well-known generic substitute called Xinran. Xinran has been widely tested and shown to have the same effect as Bayer Nifedipine, but costs only about 2/3 as much as Bayer Nifedipine. Given the availability of a much cheaper generic equivalent, a patient who pays for Bayer Nifedipine out of his own pocket is likely to have a comfortable economic status. Second, if doctors asked about the economic status of an uninsured patient, the doctor was told that the patient had "middle income," which indicates that the patient is neither very poor nor very rich.

3.2. Testers and hospital visit procedure

Hospital visits were conducted by two "family members" (testers): the author, a 32-year-old Chinese female, and a 56-year-old Chinese female assistant. Each tester conducted hospital visits for both patients. Testers were randomly assigned to interventions.

Before the experiment, a standard protocol was generated for training testers and unifying hospital visits (see Appendix 2 for the experiment script). The assistant was informed of the importance of adhering to the protocol during hospital visits. Both testers read and memorized the experimental transcript. As family members commonly bring patient information when seeing doctors, testers also brought a reference sheet — a piece of paper with medical test results indicating health problems. Testers first practiced in front of each other. Then they practiced in front of an expert who assisted in the experiment design. Last, testers conducted mock hospital visits with several out-of-sample doctors who were unaware of the design.

Insurance and incentive status were presented to the doctors in two separate stages. When arriving at the hospital, a tester reported the insurance status – whether the patient had government insurance or not – to the staff at the registration window while she paid the visit fees, and provided information on the patient's name, gender, age, and other demographics. The registration staff either used a computer system to send the demographic and insurance information to doctors, or printed that information on a registration ticket for the patient to present to the doctor.

In the second stage, the tester presented a pre-determined incentive status to the doctor. When the tester saw a doctor, she introduced herself by saying, "I am coming to see you on behalf of my {the relative} who lives in my hometown. He wants a doctor in a top-rated hospital to look at his case." Then the tester described the health problems according to the standard script with the assistance of the reference sheet. Then testers said either "{the relative} asked me to buy the medicines here for him" for the incentive interventions, or "{the relative} wants to get a prescription and buy drugs at his local store" for the no-incentive interventions. In the end, the tester exited the doctor's office with printed or hand-written prescriptions.

3.3. Assign interventions to hospitals and doctors

Although it is ideal to visit the same doctor for all the four interventions in order to control for heterogeneity across doctors, four visits with the same numerical test results would make doctors suspicious. Instead, this study sent four visits to each hospital department with one visit under each intervention, and randomly assigned interventions to doctors within a hospital department. There are two types of doctors — attending doctors and chief doctors. All doctors can serve as attending doctors, and those doctors with higher qualifications can serve as chief doctors during specific work shifts and charge higher visit fees. It was important to visit attending doctors in order to make the sample visits representative of all hospital visits. However, it is difficult to pre-determine which attending doctors to visit due to practical difficulties. So we used a convenience rule to decide which doctors to visit. That is, in each hospital, testers first visited whichever attending doctors were on duty, and then visited chief doctors if a visit to attending doctors would lead multiple visits to the same doctor by the same tester. The characteristics of the four doctors in one hospital would follow some patterns. For example, the doctors visited earlier would be younger and have lower qualifications. However, the convenience rule largely reduced the possibility of choosing doctors after testers know the intervention type. To randomly assign interventions to doctors, I generated one random sequence of the four interventions for each hospital-patient combination, and then let interventions be carried out according to their order in the sequence. As doctors were pre-determined according to the convenience rule, the random order of interventions would generate a random matching between interventions and doctors.

It was difficult to prevent two testers from visiting the same attending doctor, because they usually did not see the name of an attending doctor until getting a prescription, and thus could not tell whether a particular doctor had been visited by another tester. To limit the possible memory effect on doctors, testers left a one-week gap between two visits to attending doctors.

3.4. Predictions tested

Following the literature that incorporates a disutility of acting against the best interests of the patient (Gruber and Owings, 1996; McGuire and Pauly, 1991), this analysis specifies a doctor's utility as a combination of her own income, her consideration for a patient's expenditure, and her professional concerns, capturing the disutility of deviating from the optimal prescription. Doctors maximize their utility by choosing quantity and price. Although the drug prices are largely set by the government, doctors can choose among different brand-name drugs or choose between brand-name and generic drugs. In both incentive and no-incentive interventions, the doctor may consider the tradeoff between drug efficacy and the patient's other consumption, and prescribe more drugs or more expensive drugs (possibly with higher quality) to insured patients, who pay lower out-of-pocket prices. In the incentive interventions, because the doctor's own income is in proportion to the expenditure on prescribed drugs, the doctor wants to increase the drug expenditure, but runs the risk of losing all the potential income if the drug expenditure is so high that a patient decides not to purchase drugs at the hospital. Insurance coverage reduces such a risk. Let A, B, C, D be the drug expenditures under the corresponding interventions. The 2-by-2 experiment design allows for testing five effects, four of which have clear predictions.

(1) Insurance effect under incentive: $A > B$. A doctor with incentives writes more expensive prescriptions to insured patients than to uninsured patients for two possible reasons — her consideration of the tradeoff between the patient's health and other consumption, or her intention to increase the expenditure up to a patient's budget limit.
(2) Insurance effect under no incentive: $C > D$. A doctor without incentives prescribes more expensive drugs to insured patients due only to her consideration of the tradeoff between the patient's health and other consumption. This is a test for the considerate doctor hypothesis.
(3) Agency problems for insured patients: $A > C$. If a patient has insurance, a doctor with incentives prescribes more expensive drugs than does a doctor without incentives due to the motivation for profit.
(4) Agency problems for uninsured patients: $B \geq D$ or $B < D$. There is no clear prediction on this effect. Because the doctor expects that an uninsured patient has limited ability to pay, doctors with financial incentives intend to make the prescriptions affordable;

[8] The average annual income per capita among urban residents in China was 17175 yuan in 2009, so the current drug expenditure on Bayer Nifedipine tablet is 11% of average income ($163 * 12 / 17175 \approx 11\%$).

otherwise, the patient might not buy the drugs. Whether the incentive increases drug expenditures depends on the relative magnitudes of the expected budget of a patient and the expenditures on prescriptions that doctors without incentives will write.

(5) Interacting effect: A–B > C–D. Insurance coverage relaxes patients' budgets and exacerbates the magnitude of the agency effect. This is a test of the agency explanation for the rising drug expenditures under insurance.

4. Data

Testers visited all top-rated hospitals with separate departments for endocrinology and cardiology in the urban districts of Beijing between June and August of 2010. Five hospitals were excluded from the sample because they either do not separate government insurance from the no-insurance status or do not provide prescriptions unless patients pay for drugs there. Most doctors were willing to give prescriptions for absentee patients. But testers encountered refusals. I first excluded two hospitals whose doctors in the endocrinology department refused to prescribe without seeing the patient.[9] For Patient 2, one more hospital was dropped due to refusals from doctors in cardiology. Therefore, the final sample includes 25 hospitals for Patient 1 and 24 hospitals for Patient 2. Among the visits to the hospital departments included in the sample, testers came across five additional refusals for Patient 1 and four refusals for Patient 2. The success rate of visits, if estimated conservatively, was 88% for Patient 1 and higher for Patient 2.[10] The success rate is comparable to the 91% consent rate in McKinlay et al. (1996) and is much better than the 64% consent rate in Mort et al. (1996) and 53–61% in Kravitz et al. (2005). There was no correlation between refusals and intervention types. When a refusal occurred, a second visit to a different doctor was attempted; in no case was a third try needed.

Visit characteristics include variables on who conducted the visit, whether the doctor was an attending doctor or a chief doctor, and the doctor's gender and age. The doctor's age was estimated based on the testers' best guess.[11] Descriptive statistics are presented in Table 1. As there is a random matching between intervention types and doctor visits, Table 2 shows that the visit characteristics across intervention groups are largely balanced for the two patients, and none of the F tests is statistically significant. The visit characteristics are also balanced for each patient separately (results are not reported).

Drug expenditures are computed based on the drug prices in the doctor's hospital pharmacy in all cases, no matter whether a patient indicates an intention to purchase drugs from the hospital pharmacy or from outside. Therefore, a difference in drug expenditure reflects different prescribing practices only.[12] The raw drug expenditure is the overall amount of payment associated with a prescription. Depending on the number of drugs per package and the doctor's preference, drugs are usually prescribed for 28 days, 30 days or 35 days. In the no-incentive interventions, the prescription only gives patients information on what drugs to use and how to use them, and it is difficult to know whether doctors intend to prescribe for 28 days or 35 days.[13] Therefore, the raw total expenditure is not calculated for the no-incentive interventions.

Table 1
Summary statistics.

Variables	Obs	Mean	Std.	Min	Max
For Patient 1					
Visited by author (0/1)	100	0.48	0.50	0	1
Expert visit (0/1)	100	0.33	0.47	0	1
Male doctor (0/1)	100	0.34	0.48	0	1
Doctor age (years)	100	43.00	8.29	30	65
Raw drug expenditure (yuan)	50	534.06	252.76	115.12	1394.86
Prescription for triglycerides (0/1)	100	0.43	0.50	0	1
Monthly expenditure D&H (yuan)	100	374.57	151.04	109.38	762.52
Number of drugs D&H	100	2.39	0.65	1	4
Unit of drugs D&H	100	2.37	0.78	1	5
Share of branded drugs D&H (0–1)	100	0.72	0.32	0	1
For Patient 2					
Visited by author (0/1)	96	0.49	0.50	0	1
Expert visit (0/1)	96	0.28	0.45	0	1
Male doctor (0/1)	96	0.42	0.50	0	1
Doctor age (years)	96	44.95	7.56	30	60
Raw drug expenditure (yuan)	48	349.43	143.38	122.63	794.28
Monthly expenditure D&H (yuan)	96	301.45	116.00	102.92	761.84
Number of drugs D&H	96	2.13	0.42	2	5
Unit of drugs D&H	96	2.08	0.47	1.5	4
Share of branded drugs D&H (0–1)	96	0.83	0.26	0	1

Notes: "D&H" represents "for diabetes and hypertension only."

Drugs prescribed for Patient 1 can be separated into three categories: drugs for triglycerides, drugs for diabetes and hypertension, and supplementary drugs. Drugs for Patient 2 include drugs for hypertension and supplementary drugs. Supplementary drugs are aspirin in most cases, except vitamin B1 during one visit. The brand-name aspirin costs about 15 yuan (3% of average raw drug expenditure) and has a small effect on drug expenditure. There is no clear medical justification for whether to prescribe aspirin for the two hypothetical cases.[14]

Patient 1 has an abnormal triglyceride level, but the level is well below the level requiring drug therapy according to medical guidelines. Therefore, whether doctors prescribe drugs for triglycerides can serve as an indicator for over-prescription. On average, 43% of doctors in this study prescribed drugs for triglycerides, and this seems to be evidence for over-treatment.

Both diabetes and hypertension require long-term drug therapy, and prescribing drugs for a longer period does not indicate a waste. Thus, I calculate monthly drug expenditure for diabetes and hypertension on a 30-day basis. The number of drugs and the unit of drugs capture the intensity of drug treatments, although admittedly neither is a perfect measure.[15] The number of drugs is a simple count of how many drug names are prescribed.[16] To construct the unit of drugs, a table of "unit

[9] As Patient 1 was expected to convey more interesting results, a hospital was excluded from the sample if the doctors in the endocrinology department refused to give prescriptions during the first two visits.

[10] Only two visits were conducted for hospitals which were dropped from the analysis. To calculate the success rate, I assume four refusals in each dropped hospital, which gives a success rate of 88% for Patient 1 ($4 * 2$ hospitals + 5 additional refusals divided by $4 * 27$ hospitals). For Patient 2, the first visit was successful in the hospitals which were dropped due to refusals to prescribe for Patient 1, so the success rate for Patient 2 should be higher than that for Patient 1.

[11] If a doctor seemed to be closer to 40 years old than 35 or 45 years old, her age was recorded as 40.

[12] Doctors see prices at their own pharmacy on the computer screen when prescribing, so they are likely to have these prices in mind even in the no-incentive cases. In addition, as the relative magnitude of drug prices in the wider market is similar to that at the hospital pharmacy, using prices at the hospital pharmacy to calculate drug expenditure is not likely to distort the interpretation of the doctors' intention.

[13] Some doctors did not include Nifedipine for Patient 2 in the prescription, although these doctors explicitly indicated that Nifedipine should be included. Sometimes they prescribed drugs for half a month without discussing how many days are covered by the prescription. In these cases, I include Nifedipine and increase the packages of drugs so that the prescriptions are complete for roughly a month.

[14] Aspirin is recommended for male hypertension patients above 50 years old if they do not have relevant contraindications for using aspirin, a condition which both Patients 1 and 2 satisfy, and if they are able to reduce their blood pressure below 150. Doctors who prescribe may expect the blood pressure to fall below 150, while those who do not prescribe may wait to prescribe until the blood pressure actually falls below 150. One doctor explicitly said "this time I don't prescribe aspirin, and he needs it when his blood pressure gets back to the normal level."

[15] The variables on drug intensity require a certain aggregation of effects of various drugs, but the precise measure of effects of drugs on blood sugar and blood pressure is complicated and not available.

[16] For Patient 2, two doctors suggested doubling the amount of the brand Nifedipine tablet; it is counted as two drugs in this case.

Table 2
Visit characteristics by intervention type.

Variables	Insured incentive	Uninsured incentive	Insured no incentive	Uninsured no incentive	F test	p value
For both patients						
Visited by author (0/1)	0.49	0.51	0.51	0.43	0.64	0.59
s.e.	(0.07)	(0.07)	(0.07)	(0.07)		
Expert visit (0/1)	0.29	0.27	0.31	0.37	0.80	0.51
s.e.	(0.07)	(0.06)	(0.07)	(0.07)		
Male doctor (0/1)	0.37	0.33	0.41	0.41	0.53	0.66
s.e.	(0.07)	(0.07)	(0.07)	(0.07)		
Doctor's age (years)	43.57	43.67	44.08	44.49	0.14	0.95
s.e.	(1.17)	(1.19)	(1.15)	(1.08)		
Observations	49	49	49	49		

Note: Standard errors are in parentheses.

dosage" for each drug is compiled, based on the most commonly prescribed quantity or the representative dosage of the brand-name drug. The differences between the number and the unit of drugs can be illustrated by an example. If a typical usage of Metformin is a 500 mg dose taken 3 times a day (500 mg $*$ 3), and a doctor prescribes 250 mg $*$ 3, then Metformin is counted as 1 in terms of the number of drugs, but 0.5 in terms of the unit of drugs.

The share of brand-name drugs is the number of brand-name drugs divided by the number of all drugs. A drug is classified as a brand-name drug if (i) it is clearly labeled as a brand-name drug in the prescription;

Table 3
Outcomes by intervention type.

Dependent variables	Insurance incentive	No insurance incentive	Insurance no incentive	No insurance no incentive
For both patients				
Raw drug expenditure (yuan)	522.11	365.14	–	
s.e.	(35.80)	(23.63)	–	
Prescription for triglycerides (0/1)	0.64	0.40	0.28	0.40
s.e.	(0.10)	(0.10)	(0.09)	(0.10)
Monthly drug expenditure D&H (yuan)	424.78	298.71	324.50	307.03
s.e.	(23.54)	(15.84)	(18.95)	(15.44)
Number of drugs D&H	2.47	2.20	2.18	2.18
s.e.	(0.10)	(0.08)	(0.07)	(0.06)
Unit of drugs D&H	2.53	2.09	2.16	2.12
s.e.	(0.11)	(0.08)	(0.09)	(0.07)
Share of branded drugs D&H (0–1)	0.83	0.68	0.81	0.80
s.e.	(0.04)	(0.05)	(0.03)	(0.04)
Obs. for triglycerides	25	25	–	–
Obs. for other variables	49	49	49	49

Notes: "D&H" represents "for diabetes and hypertension only." Standard errors are in parentheses.

Table 4
Effects of insurance and incentive.

Dependent variables	(1)	(2)	(3)	(4)	(5)
Raw drug expenditure (yuan)	155.49***				
	(37.67)				
Prescription for triglycerides	0.26*	−0.07	0.35***	−0.01	0.34**
(0/1)	(0.14)	(0.09)	(0.10)	(0.13)	(0.14)
Monthly drug expenditure	125.53***	16.67	101.22***	−5.09	103.71**
D&H (yuan)	(25.46)	(23.38)	(30.93)	(19.38)	(38.37)
Number of drugs D&H	0.27**	−0.01	0.29**	0.02	0.26**
	(0.12)	(0.09)	(0.11)	(0.09)	(0.13)
Unit of drugs D&H	0.45***	0.02	0.38***	−0.04	0.39**
	(0.11)	(0.10)	(0.13)	(0.10)	(0.16)
Share of branded drugs	0.14**	0.01	0.02	−0.11*	0.13*
D&H (0–1)	(0.05)	(0.04)	(0.04)	(0.06)	(0.07)
Control for:					
Hospital fixed effects	Y	Y	Y	Y	Y
Visit characteristics	Y	Y	Y	Y	Y
Obs for triglycerides	50	50	50	50	100
Obs for other variables	98	98	98	98	196

Notes: "D&H" represents "for diabetes and hypertension only." The dependent variables are listed on the left, and each coefficient is from one separate regression. All regressions are linear regressions. Both Patients 1 and 2 are included in the sample. Column (1) tests the effect of insurance on various outcome variables when doctors are expected to pocket part of their patients' drug expenditure, while column (2) tests the effect of insurance when doctors are not incentivized. Columns (3) and (4) show the impact of doctors' incentives among insured patients and uninsured patients separately. Column (5) presents the effect of the interaction of insurance and incentive. Standard errors, clustered at the hospital level, are in parentheses. * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level.

or (ii) its price is much closer to the price of the corresponding brand-name drug than to the generic equivalent; or (iii) it is a Chinese patent medicine.[17] Not all brand-name drugs have a generic equivalent, and some brand-name drugs may be cheaper than the generic drugs of other types, but generic drugs are always much cheaper than their brand-name equivalent.

5. Results

This section tests the five effects listed in Section 3. Table 3 presents the averages of various outcome variables under each intervention. Table 4 shows results from the linear regression model for the purpose of simple interpretations, but all the results survive the tests of alternative model specifications, which include taking logarithms for expenditure-related variables, using a logit model for the binary variable on whether drugs are prescribed for triglycerides, applying a Poisson model for the number of drugs, and taking a Tobit model for the share of brand drugs whose values range between 0 and 1.[18] As the experiment took a repeated sampling approach, to test the sharp null hypotheses that insurance or incentive does not have treatment effects, permutation tests are conducted as suggested in Anderson (2008). All the results from the linear models remain at the same significance level in the permutation tests. In addition, the issue of multiple hypothesis testing may arise, as this study tests the effects of multiple interventions on various outcomes, so I conduct hypothesis testing by controlling False Discovery Rate (FDR), following Benjamini and Hochberg (1995). Among the thirteen hypothesis tests that are significant at 0.05, eleven of them remain significant after the adjustment. Results related to alternative model specifications, permutation tests, and adjustments controlling FDR are reported in Appendix Tables 1, 2 and 3. Results for each patient are presented in Appendix Tables 4 and 5 to show that the findings are not driven by specific characteristics of Patient 1 or Patient 2. Although the analysis of insurance and incentive can be combined in one regression, separate regressions help to present results more transparently.

5.1. Effects of insurance under incentives

The specification in Eq. (1) is used to test Prediction 1.

$$Y_{hi} = \alpha_0 + \alpha_1 Insurance_{hi} + X_{hi} + hospital_{hi} + e_{hi}. \quad (1)$$

The variable Y_{hi} indicates an outcome variable for hospital h and visit i. The key predictor $Insurance_{hi}$ equals 1 if a patient has insurance and 0 otherwise. The control variables X_{hi} include the four variables for visit characteristics. The analysis is restricted to observations under the two incentive interventions. The outcome variables are listed on the left, and each coefficient comes from one separate regression. The first column of Table 4 presents the estimated coefficients for the key predictor — $Insurance_{hi}$. All the standard errors are clustered at the hospital level. The sample size is 50 for prescriptions for triglycerides and 98 for all other outcome variables.

Referring to Table 3, patients pay 522 yuan in total if they have insurance and 365 yuan otherwise. The raw difference is 157 yuan; after adjusting for visit characteristics, the difference is 155.49 yuan (line 1 column 1 in Table 4), which represents 43% of the amount an uninsured patient pays. Alternatively, if drug expenditures are compared within each hospital, Patient 1 pays a higher expenditure in 19 out of 25 hospitals if he is insured; the corresponding number for Patient 2 is 20 out of 24.

Drugs for triglycerides should not be recommended for Patient 1. Doctors who did not prescribe tended to say “the level is not very high” or “when the level of blood sugar is reduced, the blood lipid will go down automatically.” Overall, 64 versus 40% of doctors prescribe drugs for triglyceride under each insurance status respectively, and the 24 percentage point difference is weakly significant ($t = 1.95$, $p = 0.064$).

For the health problems which require drug therapy – hypertension and diabetes for Patient 1, and hypertension for Patient 2 – the insured pay 126 yuan more in terms of the monthly drug expenditure, about 42% more than the uninsured pay, which is similar to the percent in the raw drug expenditure. Higher monthly drug expenditures could be driven by two factors: (1) doctors use more intensive drug therapy, and (2) doctors prescribe more expensive drugs. Evidence is shown for both channels. On average, doctors prescribed 0.26 more kinds of drugs or 0.44 more units of drugs to the insured. The share of brand-name drugs to the insured is 15 percentages higher.

Although the drug expenditure is 43% higher for an insured patient than that for an uninsured patient, assuming a 15% copayment rate for the government insurance, the out-of-pocket expenditure of an insured patient is less than 22% of what an uninsured patient pays ($1.43 * 15\% = 21.5\%$).[19] Therefore, doctors may prescribe differently because they want to optimize a patient's drug consumption at different out-of-pocket prices. The following subsection explores this possibility.

5.2. Effects of insurance under no incentives

When doctors know that patients will not buy drugs from their hospitals, they have no financial incentive to prescribe more than they think is optimal for the patient's health. Prediction 2 suggests that doctors might prescribe less expensive drugs to the uninsured if they care about the patient's out-of-pocket expenditure. I use a similar empirical strategy as in Eq. (1) but restrict the analysis to the sample under the no-incentive interventions.

During the visits, several doctors said the patient did not have health insurance, so they planned to prescribe inexpensive but effective drugs for the patient, which suggests that those doctors were empathetic toward uninsured patients. However, the comparison between means does not provide strong support for the consideration hypothesis. The second column in Table 4 presents the results for the comparison between the insured-no-incentive intervention and the uninsured-no-incentive intervention. When doctors do not expect profits from prescriptions, none of the outcomes is statistically different across insurance statuses. Doctors were not more likely to prescribe drugs for triglycerides to an insured patient; the negative difference in prescriptions for triglycerides was not expected, but it is far from being significant. The 17 yuan difference represents 5.5% of the drug expenditure of the uninsured, and it is not statistically significant.

Even without a financial incentive, 34% of doctors (an average of 0.28 and 0.40) prescribe the unnecessary drugs for triglycerides. This may reflect the general over-medication problem, as shown in Das and Hammer (2007) and Currie et al. (2011). Because testers described triglycerides as a concern, doctors might have suggested drugs for triglycerides to avoid frustrating the testers. In addition, an individual doctor's habit or competence also may explain the results. However, the overall tendency for over-treatment does not threaten the validity of the analysis, as the conclusions focus on the comparison across interventions, so that the common over-treatment tendency cancels out.

The 5.5% difference in drug expenditure is in some ways comparable to the 7.5% difference in recommendations for medical tests found in Mort et al. (1996). Nevertheless, such a difference is too small to account

[17] The monthly expenditures for Chinese patent drugs are comparable to or higher than those of brand-name western drugs, except for one Chinese patent drug.

[18] If the model is featured by the maximum likelihood estimation, the hospital fixed effects are dropped out of the specification. For the number of drugs, I also try the negative binomial model, but the concavity assumption is not satisfied for several specifications.

[19] Except for one drug, all other drugs that were prescribed in the study can be reimbursed at a similar rate.

for the 43% increase in drug expenditures prescribed by incentivized doctors. The considerate doctor hypothesis cannot explain the insurance effect under incentives.

5.3. Agency problems for insured patients

Eq. (2) is used to test the effects of the incentive where $Incentive_{hi}$ equals 1 in the incentive interventions and 0 otherwise. This subsection focuses on insured patients.

$$Y_{hi} = \alpha_0 + \alpha_1 Incentive_{hi} + X_{hi} + hospital_{hi} + e_{hi}. \tag{2}$$

The third column in Table 4 tests Prediction 3. Doctors with incentives are much more likely to prescribe drugs for triglycerides than are doctors without incentives if the patient is insured. Incentivized doctors write 100 yuan (31%) more expensive prescriptions for diabetes and hypertension. Evidence also shows that doctors with incentives use drugs more intensively for both patients. However, the share of brand-name drugs is 83% with an incentive and 81% with no incentive, and incentivized doctors are about equally likely to prescribe brand-name drugs as are doctors without incentives.

5.4. Agency problems for uninsured patients

The fourth column in Table 4 presents results for the effects of incentives when a patient does not have insurance coverage. The net effect of an incentive on an uninsured patient is not clear; it depends on the expected budget constraint of a patient. Diabetes and hypertension are among the most common illnesses for the elderly. As chronic diseases, they require long-term drug treatments and impose substantial financial burdens on patients.

When Patient 1 has no insurance, doctors with and without incentives have the same likelihood of prescribing triglyceride drugs. The drug expenditures and intensities of drugs are more or less similar. Doctors with incentives appear to be less likely to prescribe brand-name drugs. The possible explanations for the difference in the share of brand-name drugs will be discussed in the next subsection.

5.5. Interacting effect of insurance and incentive

The interacting effect of insurance and incentive can be calculated roughly by subtracting the second column from the first column or the fourth column from the third column in Table 4. Alternatively, the interacting effect can be expressed as β_1 in Eq. (3).

$$Y_{hi} = \beta_0 + \beta_1 Insurance_{hi} * Incentive_{hi} + \beta_2 Insurance_{hi} + \beta_3 Incentive_{hi} + X_{hi} + Hospital_{hi} + e_{hi}. \tag{3}$$

Prediction 5 states that the interaction between insurance and incentive could have strong effects on drug expenditure if incentivized doctors take advantage of the enlarged ability to pay under insurance coverage. The results on all outcome variables support Prediction 5. Doctors are much more likely to prescribe drugs for triglycerides when insurance and incentive are both present. The interaction effect accounts for a 105 yuan difference in the monthly drug expenditure for diabetes and hypertension, and is about 80% of the expenditure difference across insurance status when doctors have incentives. The fifth column of Table 4 only presents the estimated coefficients for the interaction between insurance and incentive, and Table 5 shows the coefficients of all the variables. After controlling for the interaction, insurance and incentive have null effects individually.

Referring to average outcomes by intervention types in Table 3, the interaction effects on drugs for triglycerides, drug expenditure and drug intensity for diabetes and hypertension are driven by the fact that prescriptions in the insurance–incentive intervention deviate from those in the other three interventions. However, the interaction

Table 5
Effects of all variables on prescriptions.

Independent variables	Dependent variables:				
	Prescription for triglycerides	Monthly expenditure	Number of drugs	Unit of drugs	Share of brand drugs
Insurance * Incentive	0.34**	103.71**	0.26**	0.39**	0.13*
	(0.14)	(38.37)	(0.13)	(0.16)	(0.07)
Insurance	−0.10	21.07	0.01	0.05	0.02
	(0.10)	(24.33)	(0.09)	(0.11)	(0.04)
Incentive	0.02	−3.49	0.03	−0.02	−0.11*
	(0.13)	(21.86)	(0.09)	(0.10)	(0.06)
Visited by author	−0.11	−16.17	0.05	−0.00	−0.02
	(0.08)	(20.32)	(0.09)	(0.10)	(0.05)
Expert visit	0.09	44.82**	0.12	0.10	0.13*
	(0.13)	(21.40)	(0.11)	(0.13)	(0.06)
Male doctor	0.07	−1.67	−0.04	−0.03	0.07
	(0.17)	(25.74)	(0.12)	(0.15)	(0.05)
Doctor's age	0.00	−1.14	0.00	0.01	−0.01**
	(0.01)	(1.66)	(0.01)	(0.01)	(0.00)
Hospital fixed effects	Y	Y	Y	Y	Y
Observations	100	196	196	196	196

Notes: Standard errors, clustered at the hospital level, are in parentheses. * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level.

effect on drug brand is caused by doctors who prescribe a lower percentage of brand drugs in the uninsured-incentive intervention. The shares of brand-name drugs are similar — 0.83, 0.81, and 0.80 in the other three settings, which are higher than the share of 0.68 in the uninsured-incentive intervention. There are multiple possible explanations for this result. Doctors may think that brand-name drugs are of higher quality, and prescribe generic drugs only if necessary. Alternatively, the brand names, as compared to the scientific names of drugs or generic names, might be more convenient for doctors to remember or to communicate with patients; this may suggest that doctors may not bother to mention generic names in the no-incentive interventions. If the latter were the case, simply removing doctor incentives would have limited impacts on reducing drug expenditures for insured patients.

The experiment used a repeated sampling approach to assign interventions to doctors, and many doctors were visited only once. However, 38 doctors were visited multiple times by chance. Among the doctors with multiple visits, a within-doctor comparison can be conducted by comparing whether the same doctor prescribed more aggressively in the insured-incentive setting than in any of the other three settings. The results support the main findings: (1) in terms of monthly drug expenditure, 15 out of 22 comparisons support the main finding, while 4 comparisons go against it, and drug expenditures are exactly the same in 3 comparisons[20]; (2) in terms of drugs for triglycerides, 3 out of 11 comparisons support the main result and none of the comparisons go against it.

5.6. Other effects

Table 5 also shows that the visit characteristics have little impact on the prescriptions, except for two patterns — chief doctors tend to write more expensive prescriptions, and older doctors are less likely to prescribe brand-name drugs. I further interact the visit characteristics with the insurance–incentive interaction and add them to Eq. (3) one at a time. None of the visit characteristics affect the estimated coefficients on the insurance–incentive interaction at the conventional 0.05 significance level (results are therefore not presented). Whether a visit was conducted by the author or the assistant has no independent or joint effects on prescriptions, which suggests that the two testers conducted doctor visits in a similar way, even though the author apparently knows more about the research hypotheses.

[20] The analysis excludes doctors who were never visited in the insured-incentive setting.

6. Discussion

In the literature, audit studies are used in numerous setting for detecting discrimination (Pager, 2007). The advantage of this method is that it can change a variable under study while keeping all other variables constant through matching. One major concern is effective matching — whether the designed variation changes that particular variable only (Heckman and Siegelman, 1993). Several measures were put in place to ensure otherwise identical hospital visits except for the designed variations. However, if those designed variations not only change the insurance status or the incentive status, but also lead to differences in other characteristics of patients, the interpretation of results should be different. I discuss several concerns below.

First, do doctors view patients as being more price sensitive or caring less about drug quality when the doctor is told that the patient will not purchase drugs locally? If this is the case, it may not be the incentive but consideration for patients that changes doctors' behaviors. Before the experiment, several out-of-sample doctors were interviewed. These doctors believe that, in general, poorer or uninsured patients are less likely to purchase drugs, but that this is difficult to judge when it comes to non-local patients. Overall, they suggested that there are many reasons why patients might prefer to fill prescriptions non-locally, few of which related to income or willingness to pay. For example, not all insured patients can get reimbursement for drugs purchased in other regions, so it is not ideal for them to buy drugs in Beijing. However, this does not necessarily mean that these types of patients face a higher copay rate. If patients are not present and family members consult instead, it may not be convenient to deliver drugs to patients, which explains why they would not purchase locally. Not purchasing drugs in Beijing hospital pharmacies does not imply low drug quality for a non-local patient, as his hometown hospital pharmacy is always an option for quality drugs. The interviewed doctors also suggested that the use of family members rather than patients made it clear that the patient was non-local, so that it was reasonable that testers might not wish to purchase drugs locally. Thus, while we cannot rule out the possibility that doctors inferred additional information beyond what was in the script, we believe that it is unlikely that such inferences are the main factors generating our results.

Second, do doctors prescribe a more limited range of drugs for non-local patients because of limited availability of drugs in other regions? Drug expenditure would be lower if doctors skip prescribing drugs that might be unavailable. In terms of drugs for diabetes and hypertension, except for two Chinese patent drugs, all other drugs prescribed in the experiment are listed in the National Catalog of Essential Drugs, published by Ministry of Health in 2009. As provinces tend to add more drugs to the provincial catalogs and rarely remove drugs, there is no reason to expect that those drugs appearing in the catalog are not available in other regions. The two Chinese patent drugs were prescribed to only two hospital-patients, and dropping the relevant hospital-patients in the analysis does not change the main findings (results are not reported). In terms of drugs for triglycerides, as any region should be reasonably expected to have some drugs for triglycerides, the concern about availability may affect the kinds of prescribed drugs, but should not affect whether or not doctors prescribed drugs.

Third, are doctors in the no-incentive cases concerned about their prescription being reviewed by other doctors? It is possible that doctors prescribe less aggressively when they know that their prescriptions will be viewed by another doctor or pharmacist. However, in China, drug prescriptions are valid for no more than one month, so a patient has to visit doctors at least once a month if he purchases drugs at the hospital pharmacy. Therefore, even in the incentive treatment – where the doctor expects that the prescription will be filled at doctor's hospital – prescriptions for chronic illnesses are frequently viewed by another healthcare professional. In addition, if doctors are concerned about being reviewed, it is difficult to explain why the hometown purchase has an effect only under the insurance condition.

7. Conclusions

This study examines doctors' prescribing behaviors by conducting a field experiment using controlled hospital visits. The field experiment not only solves the usual endogeneity problems associated with insurance and incentive status, but also avoids the confounding effect in observational studies where insured patients may demand more drugs. The results show that Chinese doctors write 43% more expensive prescriptions to insured patients than to uninsured patients when they expect to get a proportion of their patients' drug expenditures. Further analysis suggests that 80% of the increased drug expenditure under insurance coverage is motivated by doctors' financial interest and thus represents a welfare loss for patients, as implied by the agency hypothesis, rather than an improvement in patient welfare as suggested by the considerate doctor hypothesis.

It is interesting to compare the results of this study to the results in other studies on the impacts of health insurance coverage and agency problems. Iizuka (2012) shows that Japanese doctors respond to drug prices when choosing between brand-name drugs and generic drugs only if they expect to pocket some share of drug expenditure. His results are similar to our findings. If patients who previously were uninsured become covered by insurance with a zero out-of-pocket price, incentivized Japanese doctors become 41% less likely to prescribe generic drugs.[21] This result is similar to the 51% change in the generic prescription rate for Chinese doctors in the current study.[22]

In terms of the agency problems, for an insured patient, this study shows that eliminating doctors' financial incentives can reduce monthly drug expenditures for hypertension and diabetes by 24%.[23] In the Japanese prescription drug market where the copay rate ranges from 0% to 30% (close to the insurance case in my study), Iizuka (2007) finds a 15% reduction in hypertension drug expenditures if the doctor's incentive is eliminated. For an uninsured patient, this study finds that the drug expenditure is independent of doctors' financial incentives. Currie et al. (2012) also explore the prescribing behaviors of Beijing doctors using an audit study and find that drug expenditures for treating mild flu-like complaints can be reduced by 63% if a tester states that he or she will purchase drugs at outside pharmacies.[24] However,

[21] This is the author's calculation. The responsiveness of Japanese doctors is equal to the average treatment effect of out-of-pocket drug price per yen on generic prescription rate (0.0475), multiplying the change in the out-of-pocket price from uninsured status to fully insured status, then dividing by the rate of the generic prescription for an uninsured patient. Iizuka (2012) mentions that patients are employees from large firms, which means that most of them should be younger than 70 years old. According to Iizuka (2007), the copay rate is between 10% and 30% for patients younger than 70, so he uses a 20% copay rate for simulations. Therefore, when patient status changes from being uninsured to being insured, the change in out-of-pocket price is approximated by dividing the average out-of-pocket price of insured patients by the average copay rate, which gives 2.39 yen (2.39 yen = 0.478 yen/20%). The reported generic prescription rate in Iizuka (2012), that is, 0.277, is the average rate of all doctors with and without personal financial incentives and for insured patients who enjoy an 80% reimbursement rate. To get the generic prescription rate of the uninsured, ideally, I should adjust the number upward, as unincentivized doctors have a lower generic prescription rate, and downward, as the generic prescription rate is higher for patients with a higher copay rate. Due to the lack of data, I simply use 0.277 as the baseline generic prescription rate of the uninsured, and the percent change in the generic prescription rate is 41% ($0.41 = 0.0475 * 2.39/0.277$). Many assumptions are made for the calculation. For example, it is assumed that drug firms do not respond in pricing or marketing when all patients change from being uninsured to being fully insured. A linear extrapolation is assumed in order to calculate an effect of a large change based on the effect of a small change in out-of-pocket price.

[22] The calculation of 51% is the change in generic prescription rates between the insured and the uninsured, divided by the change in the copay rate (equal to the reimbursement rate of the insured), and then divided by the generic prescription rate of the uninsured ($0.51 = 0.14/0.85/0.32$).

[23] The 24% reduction is calculated by dividing the regression adjusted expenditure difference between the insured-incentive case and the insured-no-incentive case by the monthly drug expenditure in the insured-incentive case (0.24 = 101.22 yuan/424.78 yuan).

[24] The 63% reduction is calculated by dividing the regression adjusted expenditure difference between the incentive case and the no-incentive case by the drug expenditure in the incentive case (0.63 = 65.53 yuan/104.652 yuan). All patients are uninsured in Currie et al. (2012).

there are at least two differences in experimental design between Currie et al. and this study that are worth mentioning. A drug prescription is largely contraindicated in their study, while unwarranted drugs account for a small proportion of drug expenditure in the current study. The other difference is that their testers exhibited strong price sensitivity when stating why they planned to purchase drugs elsewhere.

External validity is a key issue in this study, as I focus on top-rated hospitals in Beijing, two specific patient cases, and a particular type of insurance. However, top-rated hospitals treat patients from a large geographic area, and their treatments serve as references for lower-level hospitals. Diabetes and hypertension are among the most common illnesses, and they impose substantial financial burdens on patients, which is the central issue that health insurance is designed to address. Although government insurance is probably more generous than other health insurance, the different types of insurance are similar in that they reduce patients' out-of-pocket payments and pay doctors largely on a fee-for-service basis. The monitoring of doctors is limited across all types of insurance. The 15% markup for drug prescription is nearly universal in Chinese hospitals, except at the community clinics.

These caveats notwithstanding, the analysis suggests that, although insured patients receive more drugs or more expensive drugs, they may not be receiving better health treatment. The results suggest caution in interpreting the welfare consequences of increased health expenditures under insurance coverage in China. In developing countries like China, multiple market failures may interact — the lack of health insurance limits the extent of agency problems, while expanding insurance coverage can exacerbate agency problems. This study emphasizes the importance of coordinating an expansion of health insurance with a reform of doctors' incentive structures.

Appendix 1. Basic information of hypothetical patients

Patient 1: male, 66 years old.
Basic description of health problems is:
- He was recently tested with problems.
- Fasting blood sugar is 7.5 mmol/L and 2-hour postprandial blood sugar is 11.5 mmol/L.
- Fasting c-peptide is 2.1 ng/ml and 2-hour postprandial c-peptide is 10.2 ng/ml.[25]
- Hemoglobin A1C level is 7.8%.
- Blood pressure is 160/90.
- Triglyceride is 2.3 mmol/L (equivalent to 199 mg/dL).
- Cholesterin is normal.
- Hearst rate is 80.
- He does not feel sick.

For doctors who ask for other information, prepared answers include:
- Liver function and kidney function are normal.
- Height is 175 cm and weight is 70 kg.
- He does not smoke and he drinks little.
- He does not eat too much food.
- He does not have family history.

Patient 2: male, 65 years old.
Basic description of health problems is:
- He has hypertension.
- He is taking Bai Xin Tong (the brand-name NIFEDIPINE control-released table) one tablet per day.
- Blood pressure is 155/80.
- Heart rate is 75.
- He does not feel faint.

For doctors who ask for other information, prepared answers include:
- Liver function and kidney function are normal.
- Height is 175 cm and weight is 70 kg.
- Highest blood pressure can reach 170.
- He has had hypertension for three years.
- He has taken Bai Xin Tong for several months.
- He does not smoke and he drinks little.

Appendix 2. Experimental transcript

In the registration process
I want to see an attending doctor/a chief doctor/{doctor's name} in the department of endocrinology/cardiology. This is the card/form.[26] *How much does it cost?*

Introduce self to doctors
Hello, doctor! I am coming to see you on behalf of my {the relative} who lives in my hometown. He wants a doctor in a top-rated hospital to look at his case.

Describe basic health problems
For each patient, describe health problems according to the basic descriptions in Appendix 1, but skip the contents in parentheses.

Manipulate the incentive status
For the incentive interventions: *{the relative} asked me to buy the medicines here for him.*
For the no-incentive interventions: *{the relative} wants to get a prescription and buy drugs at his local store.*

If doctors ask about other information, which is prepared, answer according to prepared answers in Appendix 1.

If doctors ask about other health problems for which the tester has not prepared
He shouldn't have that problem. He never mentioned that problem.

If doctors ask about the patient's economic situation
About in the middle.

If doctors suggest more medical tests or some behavioral changes (like doing more physical exercise)
Okay. I will tell him. Can you write them down for me?

In the no-incentive case, if doctors write the prescription by hand
Can you print out a prescription?

If doctors ask for how long drugs should be prescribed,
One month.

[25] The test of C-peptide is not standardized, and different labs have different normal range for fasting C-peptide. From the various internet sources, we see three more standards: (1) 1.49–3.41 ng/ml; (2) 1.1–4.4 ng/ml; and (3) 3.77–4.23 ng/ml. Overall, the constructed C-peptide indicates that the patient has Type II diabetes, which is obvious even without the C-peptide test, given that the patient is already 66 years old. Some doctors ask about the reference range; if so, the answer is "from zero point something to three point something." Some doctors may think that the C-peptide level is below normal.

[26] All hospitals ask new patient to fill out a brief form including name, gender, birth date, and insurance information. In some hospitals, patients go to a separate window to get a card, and then go to the registration window to pay the visit fees; in other hospitals, these two windows are combined.

Appendix Table 1
Effects of insurance and incentive (using alternative specifications).

Dependent variables	(1)	(2)	(3)	(4)	(5)
Raw drug expenditure (yuan)	0.35***				
Log expenditure	(0.07)				
Prescription for triglycerides (0/1)	1.14*	−0.41	1.69***	0.01	1.57**
Logit regression	(0.60)	(0.57)	(0.57)	(0.57)	(0.68)
Monthly drug expenditure D&H (yuan)	0.34***	0.04	0.28***	−0.02	0.29**
Log expenditure	(0.06)	(0.08)	(0.08)	(0.07)	(0.12)
Number of drugs D&H	0.11**	−0.00	0.13***	0.01	0.11**
Poisson regression	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)
Unit of drugs D&H	0.45***	0.02	0.38***	−0.04	0.39**
	(0.11)	(0.10)	(0.13)	(0.10)	(0.16)
Share of branded drugs D&H (0–1)	0.42**	0.02	0.08	−0.28*	0.35*
Tobit regression	(0.18)	(0.11)	(0.13)	(0.17)	(0.19)
Control for:					
Hospital fixed effects	Y	Y	Y	Y	Y
Visit characteristics	Y	Y	Y	Y	Y
Obs for triglycerides	50	50	50	50	100
Obs for other variables	98	98	98	98	196

Notes: "D&H" represents "for diabetes and hypertension only." The dependent variables are listed on the left, and each coefficient is from one separate regression. Both Patients 1 and 2 are included in the sample. Column (1) tests the effect of insurance on various outcome variables when doctors are expected to pocket part of their patients' drug expenditure, while column (2) tests the effect of insurance when doctors are not incentivized. Columns (3) and (4) show the impact of doctors' incentives among insured patients and uninsured patients separately. Column (5) presents the effect of the interaction of insurance and incentive. Standard errors, clustered at the hospital level, are in parentheses. * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level.

Appendix Table 2
Effects of insurance and incentive (reporting permutation-based p value).

Dependent variables	(1)	(2)	(3)	(4)	(5)
Raw drug expenditure (yuan)	155.49***				
	(37.67)				
p value	0.004				
Prescription for triglycerides	0.26*	−0.07	0.35***	−0.01	0.34**
(0/1)	(0.14)	(0.09)	(0.10)	(0.13)	(0.14)
p value	0.086	0.500	0.006	0.994	0.028
Monthly drug expenditure D&H	125.53***	16.67	101.22***	−5.09	103.71**
(yuan)	(25.46)	(23.38)	(30.93)	(19.38)	(38.37)
p value	0.000	0.518	0.000	0.776	0.024
Number of drugs D&H	0.27**	−0.01	0.29**	0.02	0.26**
	(0.12)	(0.09)	(0.11)	(0.09)	(0.13)
p value	0.018	0.884	0.014	0.812	0.050
Unit of drugs D&H	0.45***	0.02	0.38***	−0.04	0.39**
	(0.11)	(0.10)	(0.13)	(0.10)	(0.16)
p value	0.000	0.086	0.002	0.664	0.012
Share of branded drugs D&H	0.14**	0.01	0.02	−	0.13*
(0–1)				0.11*	
	(0.05)	(0.04)	(0.04)	(0.06)	(0.07)
p value	0.016	0.772	0.552	0.056	0.066
Control for:					
Hospital fixed effects	Y	Y	Y	Y	Y
Visit characteristics	Y	Y	Y	Y	Y
Obs for triglycerides	50	50	50	50	100
Obs for other variables	98	98	98	98	196

Notes: "D&H" represents "for diabetes and hypertension only." The dependent variables are listed on the left, and each coefficient is from one separate regression. All regressions are linear regressions. Both Patients 1 and 2 are included in the sample. Column (1) tests the effect of insurance when doctors are expected to pocket part of their patients' drug expenditure on various outcome variables, while column (2) tests the effect of insurance when doctors are not incentivized. Columns (3) and (4) show the impact of doctors' incentives among insured patients and uninsured patients separately. Column (5) presents the effect of the interaction of insurance and incentive. Standard errors, clustered at the hospital level, are in parentheses. * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level. The p values are permutation-based p values, and the number of permutations is 1,000.

Appendix Table 3
Effects of insurance and incentive (reporting hypothesis testing by controlling for FDR).

Dependent variables	(1)	(2)	(3)	(4)	(5)
Raw drug expenditure	155.49***				
(yuan)	(37.67)				
	Reject				
Prescription for triglycerides	0.26*	−0.07	0.35***	−0.01	0.34**
(0/1)	(0.14)	(0.09)	(0.10)	(0.13)	(0.14)
	Not	Not	Reject	Not	Reject
Monthly drug expenditure	125.53***	16.67	101.22***	−5.09	103.71**
D&H (yuan)	(25.46)	(23.38)	(30.93)	(19.38)	(38.37)
	Reject	Not	Reject	Not	Reject
Number of drugs D&H	0.27**	−0.01	0.29**	0.02	0.26**
	(0.12)	(0.09)	(0.11)	(0.09)	(0.13)
	Not	Not	Not	Not	Not
Unit of drugs D&H	0.45***	0.02	0.38***	−0.04	0.39**
	(0.11)	(0.10)	(0.13)	(0.10)	(0.16)
	Reject	Not	Reject	Not	Reject
Share of branded drugs	0.14**	0.01	0.02	−0.11*	0.13*
D&H (0–1)	(0.05)	(0.04)	(0.04)	(0.06)	(0.07)
	Reject	Not	Not	Not	Not
Control for:					
Hospital fixed effects	Y	Y	Y	Y	Y
Visit characteristics	Y	Y	Y	Y	Y
Obs for triglycerides	50	50	50	50	100
Obs for other variables	98	98	98	98	196

Notes: "D&H" represents "for diabetes and hypertension only." The dependent variables are listed on the left, and each coefficient is from one separate regression. All regressions are linear regressions. Both Patients 1 and 2 are included in the sample. Column (1) tests the effect of insurance when doctors are expected to pocket part of their patients' drug expenditure on various outcome variables, while column (2) tests the effect of insurance when doctors are not incentivized. Columns (3) and (4) show the impact of doctors' incentives among insured patients and uninsured patients separately. Column (5) presents the effect of the interaction of insurance and incentive. Standard errors, clustered at the hospital level, are in parentheses. * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level. The hypothesis testing controlling for FDR uses a p level at 0.05.

Appendix Table 4
Effects of insurance and incentive (Patient 1 only).

Dependent variables	(1)	(2)	(3)	(4)	(5)
Raw drug expenditure	202.13***				
(yuan)	(64.56)				
Prescription for triglycerides	0.26*	−0.07	0.35***	−0.01	0.34**
(0/1)	(0.14)	(0.09)	(0.10)	(0.13)	(0.14)
Monthly drug expenditure	140.80***	13.79	105.16**	−14.96	128.49**
D&H (yuan)	(31.30)	(35.82)	(49.43)	(33.26)	(56.73)
Number of drugs D&H	0.29**	−0.04	0.27*	−0.02	0.36**
	(0.10)	(0.14)	(0.15)	(0.16)	(0.17)
Unit of drugs D&H	0.58***	−0.08	0.47**	−0.13	0.64**
	(0.14)	(0.20)	(0.22)	(0.20)	(0.28)
Share of branded drugs D&H	0.10	0.03	−0.07	−0.14*	0.07
(0–1)	(0.09)	(0.07)	(0.08)	(0.08)	(0.12)
Control for:					
Hospital fixed effects	Y	Y	Y	Y	Y
Visit characteristics	Y	Y	Y	Y	Y
Observations	50	50	50	50	100

Notes: "D&H" represents "for diabetes and hypertension only." The dependent variables are listed on the left, and each coefficient is from one separate regression. All regressions are linear regressions. Only Patient 1 is included in the sample. Column (1) tests the effect of insurance on various outcome variables when doctors are expected to pocket part of their patients' drug expenditure, while column (2) tests the effect of insurance when doctors are not incentivized. Columns (3) and (4) show the impact of doctors' incentives among insured patients and uninsured patients separately. Column (5) presents the effect of the interaction of insurance and incentive. Standard errors, clustered at the hospital level, are in parentheses. * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level.

Appendix Table 5
Effects of insurance and incentive (Patient 2 only).

Dependent variables	(1)	(2)	(3)	(4)	(5)
Raw drug expenditure (yuan)	99.07***				
	(27.38)				
Prescription for triglycerides (0/1)					
Monthly drug expenditure D&H (yuan)	92.93***	20.21	110.52***	16.38	72.68*
	(24.58)	(20.06)	(29.33)	(23.83)	(37.00)
Number of drugs D&H	0.18	0.03	0.29**	0.13*	0.14
	(0.12)	(0.03)	(0.12)	(0.06)	(0.15)
Unit of drugs D&H	0.25**	0.15	0.30**	0.12	0.11
	(0.10)	(0.09)	(0.14)	(0.12)	(0.16)
Share of branded drugs D&H (0–1)	0.17***	−0.03	0.14**	−0.05	0.18*
	(0.05)	(0.06)	(0.06)	(0.07)	(0.09)
Control for:					
Hospital fixed effects	Y	Y	Y	Y	Y
Visit characteristics	Y	Y	Y	Y	Y
Observations	48	48	48	48	96

Notes: "D&H" represents "for diabetes and hypertension only." The dependent variables are listed on the left, and each coefficient is from one separate regression. All regressions are linear regressions. Only Patient 2 is included in the sample. Column (1) tests the effect of insurance on various outcome variables when doctors are expected to pocket part of their patients' drug expenditure, while column (2) tests the effect of insurance when doctors are not incentivized. Columns (3) and (4) show the impact of doctors' incentives among insured patients and uninsured patients separately. Column (5) presents the effect of the interaction of insurance and incentive. Standard errors, clustered at the hospital level, are in parentheses. * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level.

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