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ABSTRACT Since economic liberalization in the late 1970s, China's health care providers have grown heavily reliant on revenue from drugs, which they both prescribe and sell. To curb abuse and to promote the availability, safety, and appropriate use of essential drugs, China introduced its national essential drug list in 2009 and implemented a zero markup policy designed to decouple provider compensation from drug prescription and sales. We collected and analyzed representative data from China's township health centers and their catchment-area populations both before and after the reform. We found large reductions in drug revenue, as intended by policy makers. However, we also found a doubling of inpatient care that appeared to be driven by supply, instead of demand. Thus, the reform had an important unintended consequence: China's health care providers have sought new, potentially inappropriate, forms of revenue.

During the late 1970s and early 1980s, a variety of factors led to large reductions in revenue for China's rural health providers^{1,2}—and, as a result, encouraged their increasing reliance on drug revenue.³ Because clinicians both prescribe and sell drugs, they have financial incentives to recommend drug therapies to their patients, even when not clinically appropriate.⁴⁻⁶ Moreover, because patients are generally unable to judge the clinical necessity of drugs recommended to them, providers are able to prescribe—and profit from—unnecessary medications.

As a result, the appropriate provision of essential medicines has given way to unwarranted prescription and overuse of drugs sold by providers at high markups.⁷⁻⁹ By the mid-1990s, drug sales in China accounted for about 70 percent of outpatient revenue and 55 percent of inpatient revenue, with average provider wholesale-to-retail markups estimated to be nearly 50 percent (some markups were as high as 150 percent).¹⁰⁻¹²

The average number of prescriptions per encounter at township health centers has been reported to be 43–150 percent more than the standard recommended by the World Health Organization for outpatients in developing countries and could contribute to antibiotic resistance.^{13,14} Moreover, insurance rates have risen over the past decade,¹⁵ and people with insurance are more likely than others to receive inappropriate prescriptions.¹⁶

To address these problems, in April 2009 China introduced its national essential drug list, with the goal of promoting the availability, safety, and appropriate use of essential drugs while reducing excessive household spending on clinically unnecessary medicines.^{17,18} A central component of the essential drug list is its zero markup policy, which focuses on decoupling provider compensation from the prescription and sale of drugs. The policy mandates that state-owned medical facilities stock all drugs on national and provincial essential drug lists; that drugs not on essential drug lists not be sold; and, importantly, that all essential drugs be sold with no

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markup from wholesale to retail price.

Because rural health facilities relied so heavily on drug revenue before the implementation of the zero markup policy, there was also concern that the policy might have unintended consequences as providers sought to make up for lost drug revenue from other sources. To address this concern, the Chinese government began providing subsidies to health facilities (which are calculated as a function of service provision indicators) to help offset losses.¹⁹ Despite these subsidies, however, health facilities still confronted substantial reductions in revenue under the zero markup policy.^{20,21}

There is little empirical evidence on the distortionary or unintended consequences of the policy. Previous studies of China's national and provincial essential drug lists and the zero markup policy have instead focused largely on the policy's intended effects.²⁰⁻³⁰ These studies have reported varying and sometimes conflicting results, perhaps in part because of their reliance on cross-sectional and before-after study designs. Some report reductions in clinicians' income under the policy.^{20,21} These findings underscore the importance of research on possible unintended consequences if providers seek new sources of revenue.

This article presents new empirical analyses of both direct effects and unintended distortionary effects of the zero markup policy. Given the objectives of the policy, we investigated whether township health centers with more revenue at risk under the policy had greater reductions in revenue share from drug sales (intended consequences) and greater (potentially distortionary) increases in the supply of services other than drug sales (unintended consequences), compared to centers with less revenue at risk. We used new primary data collected nationwide from rural health facilities and households in their catchment areas, both before (2007) and after (2011) the introduction of the zero markup policy.

The study focused on township health centers, which are the backbone and the middle tier of China's three-tier rural health system, between village clinics and county hospitals.³¹ Exploiting the fact that the impact of the zero markup policy should vary with each facility's reliance on drug revenue before the policy's implementation, we conducted a difference-in-differences analysis of how outcomes that reflect both intended and unintended consequences of the new policy changed differentially across townships with varying policy intensity (that is, varying amounts of revenue at risk) during the policy's implementation.

Study Data And Methods

SAMPLING AND DATA COLLECTION We used data that we collected through the China Public Goods and Public Service Survey, the product of a collaboration between the Chinese Academy of Sciences and Stanford University. Given our focus on the zero markup policy, we used data from the second and third waves of the survey, which we conducted in April 2008 and April 2012 (collecting data from 2007 and 2011). This allowed us to study township health center providers and the local populations that they serve both before and after implementation of the policy. We also used the first wave of data, collected in 2004, to assess our "parallel trends" assumption, which we describe below.

The China Public Goods and Public Service Survey uses a multistage stratified cluster sampling procedure (stratifying by China's agricultural and ecological zones; then sequentially selecting provinces, counties, townships, and villages using random sampling; and finally selecting facilities and households within villages, also by random sampling). More details about the sampling procedure are available in online Appendix 1 and Appendix Exhibit A1.³² In addition, Appendix Exhibit A2 shows the geography of our sample areas, and Appendix Exhibit A3 shows the representativeness of our sample.³²

Our full sample consisted of forty-three township health centers³³ in forty-three randomly selected townships and 1,761 households in eighty-six villages (two randomly selected villages within each township) across twenty-five counties. Appendix Exhibit A4 provides summary statistics for our sample by module and wave, and Appendix 1 provides details on data collection.³²

MEASUREMENT OF ZERO MARKUP POLICY INTENSITY To measure intensity of the zero markup policy in each township, we exploited the fact that the policy's impact should vary with each township health center's reliance on drug revenue before implementation. Specifically, we constructed a measure of revenue at stake under the policy, representing each center's revenue from drug sales as a share of gross revenue in 2007. An important advantage of this approach is that using 2007 data (collected before implementation of the policy) allowed us to measure the relative importance of drug sales for each center before the essential drug list reforms—and therefore to capture how much revenue each center stood to lose under the zero markup policy.

We used two versions of this measure: a dichotomous indicator variable for whether a center's 2007 drug revenue as a share of gross revenue fell above or below the median in our sample, and a continuous measure of drug revenue as a

share of gross revenue in 2007. To probe the sensitivity of our results, we used both versions (our results using both measures generally agree). We present results using the dichotomous indicator in the article; for results using the continuous measure, see the Appendix.³²

STATISTICAL ANALYSIS To estimate the relationship between the zero markup policy and the behavior of Chinese health providers (intended and unintended), we analyzed primary outcomes at both the level of the township health center and the level of the individual. Our primary outcome variables measuring intended consequences at the center level were the number of drugs stocked at the end of the year, value of drugs stocked at the end of the year, revenue from drug sales, share of revenue from drug sales, and share of revenue from government subsidies. Our primary outcome variables measuring potentially unintended consequences at the center level were the number of annual outpatient visits, number of annual inpatient visits, and gross revenue.

At the individual level, our primary outcome variables (among individuals not referred elsewhere for care) were the use of township health center outpatient services (for the most recent episode of illness), individual spending for this outpatient care, use of center inpatient services (for the most recent episode of illness), and individual spending for this inpatient care. Additionally, we studied whether or not an individual was referred to other health facilities by the health facility from which he or she first sought care for the most recent episode of illness.

To isolate differential changes in these primary outcomes associated with intensity of the zero markup policy, we used a difference-in-differences study design implemented at both the township health center level and the individual level. We used ordinary least squares regression for continuous dependent variables and probit models fit by maximum likelihood estimation for dichotomous dependent variables.

Specifically, we regressed each primary outcome on our measure of zero markup policy intensity, accounting both for unobserved differences across counties that did not vary over time and for common changes across sample counties over time by including province and year fixed effects, respectively. Our regressions at the township health center level also included time-varying characteristics of the New Cooperative Medical Scheme, China's rural health insurance program; of the center; and of the township.

Our individual-level regressions also included time-varying individual characteristics, attributes of the centers, and attributes of local

New Cooperative Medical Scheme programs. In all of our analyses (at both the center and individual levels), we clustered our standard errors at the township level, relaxing the assumption that observations within townships were independent and identically distributed.

Appendix Exhibit A5³² provides evidence consistent with the "parallel trends" assumption made by our difference-in-differences approach. Using data from the first two survey waves, we found no differential trends before implementation of the zero markup policy (between 2004 and 2007) in our primary outcomes that were correlated with future (2007) policy intensity at the township health center level.

LIMITATIONS Our study had both important strengths and limitations. Its strengths include its use of unique data from both health facilities and the individuals they serve; its approach to measuring the impact of the zero markup policy by using revenue at risk under the reform; and its use of panel data methods (instead of cross-sectional or before-after study designs) to overcome some of the limitations of previous studies. Nonetheless, given its observational design and use of survey data, the possibility of confounding influences and measurement error due to recall inaccuracies cannot be ruled out.

Study Results

We present results at the township health center and individual levels. We focus on results using our dichotomous measure of intensity of the zero markup policy (described above). For results using our continuous intensity measure, see Appendix Exhibit A6.³² Our results were generally insensitive to the choice of intensity measures.

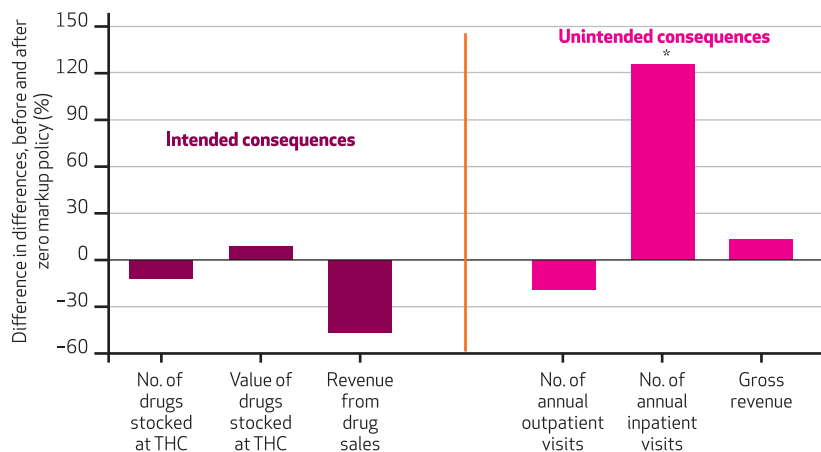
We summarize results from our analysis at the center and individual levels using figures based on our multiple regression models. Specifically, we show point estimates and *p* values for the association between intensity of the zero markup policy and key outcomes. For corresponding tables of our regression results, see Appendix Exhibit A7.³²

Estimates from specifications with natural log transformed dependent variables can roughly be interpreted as percentage changes (or relative changes). Estimates from linear probability models with dichotomous outcomes can be interpreted as percentage-point changes (or absolute changes).

RESULTS AT THE TOWNSHIP HEALTH CENTER LEVEL Changes in the number and value of drugs stocked at township health centers were not significantly associated with intensity of the zero markup policy (Exhibit 1). This lack of a significant effect may reflect a move away from drugs

EXHIBIT 1

Difference-In-Differences Estimates For Outcomes At Township Health Centers (THCs) In China (Township Health Center Sample)



SOURCE Authors' statistical analysis of study data. **NOTES** The point estimates for natural log transformed dependent variables can roughly be interpreted as percentage changes between the second and third waves of the China Public Goods and Public Service Survey (before and after implementation of the zero markup policy, respectively), as shown in the exhibit. The results are also shown in Appendix Exhibit A7 (see Note 32 in text). The means of the outcome variables shown at baseline (from the second wave of the survey) are as follows: number of drugs stocked at the THC at the end of the year, 666; value of drugs stocked at the THC at the end of the year, 180,000 yuan (1 yuan equals about \$0.16); revenue from drug sales, 700,000 yuan; number of annual outpatient visits, 17,950; number of annual inpatient visits, 758; gross revenue, 1,470,000 yuan. All results were obtained as described in the "Study Data And Methods" section and were adjusted for characteristics of the New Cooperative Medical Scheme (degree of the scheme's coverage at the township level, reimbursement rate for inpatient expenditures at the THC, and reimbursement rate for inpatient expenditures at the county hospital), the township (population, per capita net income, square of per capita net income, and number of village clinics [for more details about village clinics, see Babiarz KS et al. New evidence on the impact of China's New Rural Cooperative Medical Scheme and its implications for rural primary healthcare (Note 15 in text)]), the THC (fixed assets, share of fixed assets represented by medical equipment, number of medical staff, share of medical staff who were senior medical staff), and province dummies. *p* values for differences exceeded 0.10 except where indicated. * *p* < 0.10

commonly prescribed prior to 2009 and to lower-price drugs on the essential drug list.^{20,23,34}

However, the results from our examination of changes in center revenue suggest that centers that had been more reliant on drug revenue experienced larger declines in both their revenue from drug sales and their share of gross revenue from drug sales. Specifically, annual revenue from drug sales in centers with above-median reliance on drug revenue before implementation of the zero markup policy declined by 47 percent more than revenue in centers with below-median reliance (Exhibit 1). This estimate falls just shy of significance at conventional levels ($p = 0.14$). However, Appendix Exhibit A5 shows that the estimate for change in annual revenue from drug sales was significant (a reduction of 176 percent; $p = 0.05$; baseline mean: 700,000 yuan [1 yuan equals about \$0.16]) when we used a continuous measure of drug revenue reliance.³²

Centers more reliant on drug revenue before the reform also experienced a 76 percent in-

crease in revenue from direct government subsidies (an increase of 14 percentage points; baseline mean: 19 percent) (Exhibit 2).³⁵ However, this increase was insufficient to offset losses in drug revenue.

We also assessed the possibility that the zero markup policy had indirect distortionary effects—if township health centers responded to the policy by seeking new sources of revenue, for example. We found no significant change in the number of annual outpatient visits (Exhibit 1). However, centers previously more reliant on drug revenue experienced a significant increase in the number of annual inpatient visits (an increase of 127 percent; baseline mean: 758). There was no significant decline in gross center revenue, which suggests that centers with greater reliance on drug revenue before the reform were able to offset reductions in drug revenue through increases from other sources.

RESULTS AT THE INDIVIDUAL LEVEL In contrast to our findings using center-level data, when we used individual-level data, we found no significant associations between township health centers' pre-reform reliance on drug revenue and individuals' use of either outpatient or inpatient services (Exhibit 3).³⁶ We also did not find a significant association between centers' pre-reform reliance on drug revenue and individuals' reported medical expenditures for either outpatient or inpatient care (Exhibit 4). We discuss possible explanations for this incongruence between center- and individual-level results below.

Discussion

INCONGRUENCE BETWEEN CENTER- AND INDIVIDUAL-LEVEL RESULTS Our results suggest that while township health centers with greater reliance on drug revenue before implementation of the zero markup policy reported a significant increase in inpatient admissions, individual villagers did not report commensurate changes in inpatient care. We note several possible explanations for this discrepancy. First, because our household survey asks only about inpatient service use for the most recent episode of illness (instead of for the entire year), the individual-level analyses might simply have less ability to detect a true effect.

Second, individual-level responses might be measured with greater error (because of recall error or inability to correctly distinguish between inpatient and outpatient services, for example) than our center-level data. In contrast, we collected township health center data directly from the center registries, focusing on indicators that are required for government financial reporting and that are based on administrative

records maintained by center personnel.

A third possible explanation is that centers might have falsified inpatient service records—for reimbursement reasons, for example, recording services not actually provided. Centers more reliant on drug revenue before the reform would have stronger incentives to do so. We note that there have been independent reports of fake patients.³⁷ In addition, results from follow-up household phone interviews that we conducted to investigate this possibility were consistent with having at least some portion of our findings explained by this phenomenon (for details on the phone interviews, see Appendix 2).³²

Ultimately, we cannot determine which of these three explanations is the most likely. However, we emphasize that all three would imply unintended consequences (regardless of whether the increase in inpatient care is real or the result of intentional misreporting) of the zero markup policy.

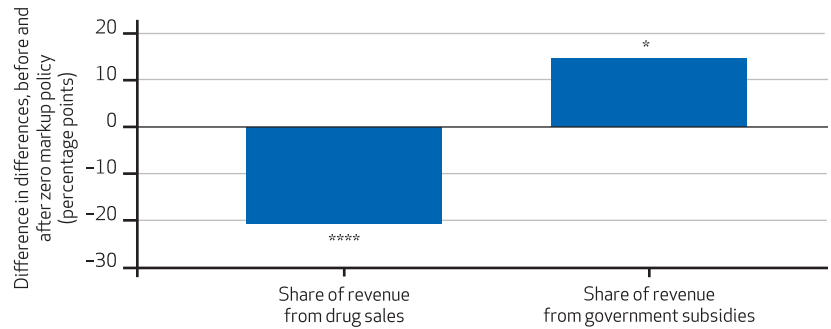
We also note that changes in individuals' use of health services at facilities other than township health centers are unlikely to explain the discrepancy. We found little evidence that individuals in the catchment areas of centers with more drug revenue at risk sought less inpatient care from county hospitals or that referral patterns changed under the zero markup policy³⁸ (see Appendix Exhibits A8 and A9).³²

DEMAND- AND SUPPLY-SIDE EXPLANATIONS If inpatient service use at township health centers really did increase under the zero markup policy, there are at least three major possible explanations. First, on the demand side, reliance on drug revenue before implementation of the policy could be correlated with the degree of New Cooperative Medical Scheme coverage.^{15,39} In other words, our estimates might reflect increases in service use as a result of reductions in effective out-of-pocket prices through insurance. Second, the zero markup policy might also have made center inpatient services relatively more attractive to individuals in other ways (for example, reduced drug charges could have resulted in lower total inpatient care charges at centers). Third, on the supply side, centers confronting reductions in revenue under the policy might have increased their provision of other lucrative services, such as inpatient care.

To the extent possible, we used our data to investigate these explanations. First, using data from the second survey wave, we examined the relationship between intensity of the zero markup policy and degree of New Cooperative Medical Scheme coverage at the township level. The pairwise correlation coefficient between policy intensity and degree of coverage was -0.08 and was insignificant ($p = 0.44$), suggesting little re-

EXHIBIT 2

Difference-In-Differences Estimates For Revenue Sources At Township Health Centers (THCs) In China (Township Health Center Sample)



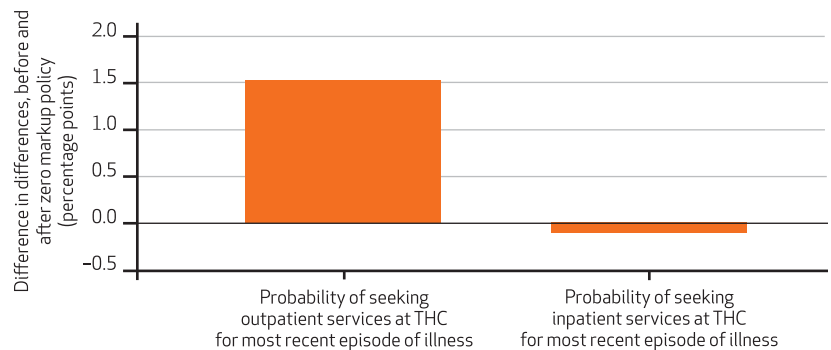
SOURCE: Authors' statistical analysis of study data. **NOTES** The point estimates for continuous dependent variables can be interpreted as percentage-point changes between the second and third waves of the China Public Goods and Public Service Survey (before and after implementation of the zero markup policy, respectively), as shown in the exhibit. The results also shown in Appendix Exhibit A7 (see Note 32 in text). The means of the outcome variables shown at baseline (from the second wave of the survey) are as follows: share of revenue from drug sales, 47; and share of revenue from government subsidies, 19. All results were obtained as described in the "Study Data And Methods" section and were adjusted for characteristics of the New Cooperative Medical Scheme, the township, the THC, and province dummies (see notes to Exhibit 1 for details). * $p < 0.10$ **** $p < 0.001$

lationship between the two. (We also controlled for this coverage in our main statistical analysis.)

Second, if the zero markup policy made township health center inpatient services more attrac-

EXHIBIT 3

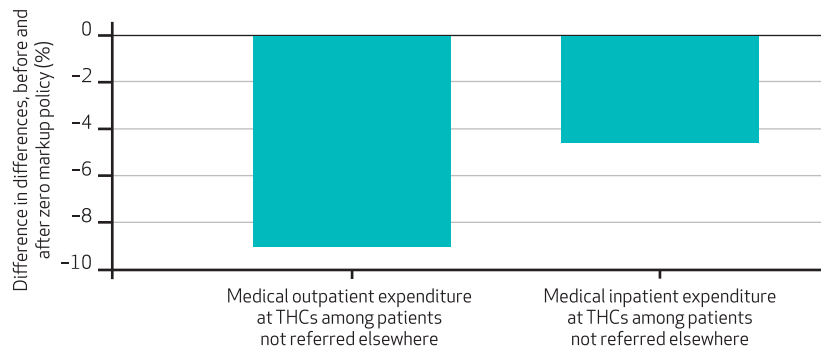
Difference-In-Differences Estimates For Patients' Use Of Outpatient And Inpatient Medical Services At Township Health Centers (THCs) In China (Individual Sample)



SOURCE: Authors' statistical analysis of study data. **NOTES** The point estimates reported for dichotomous dependent variables can be interpreted as percentage-point changes between the second and third waves of the China Public Goods and Public Service Survey (before and after implementation of the zero markup policy, respectively), as shown in the exhibit. The results are also shown in Appendix Exhibit A7 (see Note 32 in text). The means of the outcome variables shown at baseline are as follows: probability of seeking outpatient services at the THC for most recent episode of illness, 14 percent; and probability of seeking inpatient services at the THC for most recent episode of illness, 2 percent. All results were obtained as described in the "Study Data And Methods" section and were adjusted for characteristics of the New Cooperative Medical Scheme (reimbursement rate for inpatient expenditures at the THC and reimbursement rate for inpatient expenditures at the county hospital), the THC (fixed assets, share of fixed assets represented by medical equipment, number of medical staff, and share of medical staff who were senior medical staff), and individuals (age, square of age, male, whether received any education, enrollment in the New Cooperative Medical Scheme, value of family house, dummies for type of diseases, and self-reported severity of illness), and province dummies. p values for differences exceeded 0.10.

EXHIBIT 4

Difference-In-Differences Estimates For Patients' Medical Outpatient And Inpatient Expenditures At Township Health Centers (THCs) In China (Individual Sample)



SOURCE: Authors' statistical analysis of study data. **NOTES** The point estimates reported for natural log transformed dependent variables can roughly be interpreted as percentage changes between the second and third waves of the China Public Goods and Public Service Survey (before and after implementation of the zero markup policy, respectively), as shown in the exhibit. The results also shown in Appendix Exhibit A7 (see Note 32 in text). The means of the outcome variables shown at baseline are as follows: medical outpatient expenditure at the THC for those not referred elsewhere, 227 yuan (1 yuan equals about \$0.16); and medical inpatient expenditure at the THC for those not referred elsewhere, 1,726 yuan. All results were obtained as described in "Study Data And Methods" section and were adjusted for characteristics of the New Cooperative Medical Scheme, the THC, individuals, and province dummies (see notes to Exhibit 3 for details). *p* values for differences exceeded 0.10.

tive to individuals in surrounding catchment areas, this should be evident as a change in inpatient composition (because new inpatients attracted by changes under the zero markup policy would likely be different from the average inpatient before implementation of the policy). Appendix Exhibit A10 shows estimates using as dependent variables both inpatient demographic characteristics and the types of diseases for which inpatient care was sought.³² Although we do not consider this to be a definitive test, the estimates suggest no significant changes in inpatient composition correlated with policy intensity.

Taken together, these results offer little evidence that the observed increase in township health center inpatient service use was driven by demand. Alternatively, we highlight the fact that supply-side explanations for the increase in inpatient care at township health centers are consistent with evidence from case studies. For example, one case study found that under the zero markup policy, centers developed adaptive strategies to address reductions in revenue by providing financial incentives for doctors to admit outpatients as inpatients.²⁰

Conclusion

This article presents new evidence on the intended—and unintended—consequences of China's zero markup policy for drugs under its essential drug list reform. The policy was in-

tended to decouple provider compensation from the prescription and sale of drugs. We found that the share of gross revenue from drug sales declined by 43 percent at township health centers with greater pre-reform reliance on drug revenue. Noting the strong incentives created for centers to offset these reductions in drug revenue, we also found evidence of unintended responses to the zero markup policy.

Facility-level analyses showed that the number of inpatients treated at township health centers previously more reliant on drug sales rose by 127 percent, a change that we believe appears to be driven by supply instead of demand. Our individual-level analyses revealed no commensurate increase in self-reported inpatient service use or spending (and no change in inpatient service use at county hospitals, which are substitute sources of inpatient care). This discrepancy could be explained by recall difficulty among individual respondents, differences in reporting periods (individual respondents report on the last episode of illness during the previous calendar year, while township health centers report on all services during the same period), or by centers' reporting data about fake patients (a phenomenon documented by other studies).⁴⁰

Although we were ultimately unable to determine which of these explanations was the most likely, any of them implies unintended behavioral responses among providers seeking to offset lost drug revenue under the zero markup policy (the first two imply true increases in inpatient care, and the last implies inappropriate billing). Further research is needed to confirm our results and to further investigate the underlying behavioral responses that led to them.

We conclude by noting potential policy approaches to address any distortionary responses among health providers to the zero markup policy. Given the well-known difficulties of simple provider monitoring strategies, one approach would be to fully decouple health provider salaries from township health center profits. Although this decoupling has already occurred for the administrative directors of primary health facilities in China, provider bonuses are still a function of facility profits (other than those linked to drug sales or diagnostics).⁴¹ Of course, this decoupling might have unintended consequences of its own, such as reducing overall provider effort.

When viewed from a broader perspective, policy approaches to addressing unintended consequences of the zero markup policy might be considered a subset of more comprehensive quality improvement efforts. These efforts could emphasize improving provider accountability to patients and administrators through either mar-

ket-based or social accountability approaches. Such approaches might include provider payment reform using high-powered incentives (such as capitation and performance pay, which could include specific components for appropriate drug prescription) as well as the provision of health facility quality “report cards” and social accountability interventions.^{4,42,43} The role of these quality improvement mechanisms in rural China remains underexplored. ■

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NOTES

- 1 Although they are not the focus of our article, similar forces were also at work in urban China.
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- 31** Additional reasons to focus on township health centers are that they were an early target of the zero markup policy in rural areas, and they are one of the primary sources of health care in rural areas, especially among the poor.
- 32** To access the Appendix, click on the Appendix link in the box to the right of the article online.
- 33** Seven townships originally sampled (and households in their catchment areas) were excluded from our analysis because they met either of two exclusion criteria: They lacked a township health center in the survey year, or their center merged with one or more other centers between the second and third survey waves.
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- 35** Government subsidies did not fully offset losses in drug revenue, and we have no information about whether or not township health center personnel expected the subsidies to be permanent. Both the insufficiency and the uncertainty of government subsidies may provide reasons for center personnel to look for alternative sources of revenue under the zero markup policy.
- 36** Because the probability of seeking outpatient care or inpatient services at the township health centers might be considered a rare event, we also used an alternative logit model developed for rare events to test the robustness of our results (see Note 13). In general, our main findings remained unchanged when we used this alternative maximum likelihood estimation procedure.
- 37** In 2010, for example, the National Audit Office reported evidence of outpatient services documented and reimbursed by the New Cooperative Medical Scheme as inpatient services in 48 percent of audited township health centers.
- 38** In rural China, village clinics do not provide inpatient care, so the only real substitute for inpatient care at township health centers is inpatient care at county hospitals. Village clinics differ in many aspects (including location, function, and staffing) from township health centers. See Note 15.
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