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Pharmaceutical price regulation: macro-level evidence from China between 1997 and 2008

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Abstract This paper uses macro-level data between 1997 and 2008 to evaluate the effects of China's pharmaceutical price regulations. We find that these regulations had short-run effects on medicine price indexes, reducing them by less than 0.5 percentage points. The effects could have been slightly reinforced when these regulations were imposed on more medicines. However, these regulations failed to reduce household health expenditures and the average profitability of the pharmaceutical industry, and firms on the break-even edge were worse off. Finally, although these regulations have no significant effects on the price of substitutes or complements for medicines, they increased expensive medicine imports.

Keywords Pharmaceutical price regulation; Medicine price indexes; Health expenditure; Pharmaceutical industry.

JEL Classification I18; I11; L51

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1 Introduction

Substantial rises in pharmaceutical prices and household health expenditures have presented a challenge to households and governments in many countries, including China. The seventh Chinese National Survey on household evaluations of security (conducted by the Chinese National Bureau of Statistics in 2007) indicated that unaffordable health care has become a top concern among households. A report by the World Bank showed that 52 percent of China's total health expenditure in 2003 was devoted to medicines, much higher than the ratios (between 15 percent and 40 percent) in many other countries (World Bank 2004). Further, China's Ministry of Health found that inpatient and outpatient medicines accounted for 42.3 percent and 50.8 percent of total health expenditures, respectively.

The price of medicine has become the focus of new health care reform in China. The Chinese government has frequently imposed pharmaceutical regulations to deal with excessively high prices; more than 30 regulations were enacted after 1997, most of which imposed price ceilings on certain kinds of medicines. Research on whether these policies have been effective is scarce, and this paper attempts to fill the gap.

Medicine price regulations have been common in many countries (Sood et al. 2009). Although evidence exists that price controls are successful in reducing prices and health expenditures (Rane 1998; Lopez-Casasnovas and Puig-Junoy 2000; Brekke et al. 2009), other studies argue the opposite (Vernon et al. 2004; Skinner 2005; Santerre and Vernon 2006). These studies stress that when a reference price (or price ceiling) is imposed, prices of related medicines converge to the reference price, price diversity declines, and average price changes become uncertain (Borell 1999; Danzon and Chao 2000). Additionally, reductions in the price of regulated medicine do not necessarily lead to reductions in health expenditures (Mrazek 2002); particularly, the price of unregulated medicines or of health care services can rise and counteract the regulation effects (Drummond et al. 1997). Finally, even if price regulation succeeds in reducing household health expenditures, it may be undesirable if pharmaceutical innovations are discouraged, making households worse off in the long run (Scherer 2000).

China's frequent interventions in the pharmaceutical market have raised much debate over necessary government action. Although there have been many qualitative discussions (Yu et al. 2007; Huang and Cao 2008), there have been few quantitative studies except for those by Meng et al. (2005) and Dong et al. (2008). Meng et al. (2005) used data from two hospitals in Shandong Province to evaluate the effect of one single price regulation at the end of 2000,

and found that this regulation policy had no significant effect on patient expenditures on medicines because physicians changed the types or amounts of medicines prescribed. Dong et al. (2008) employed data from five hospitals in Beijing to evaluate the effects of a series of price regulations between 1998 and 2005 and found similar results.

This paper exploits aggregate monthly or quarterly data to evaluate the average effect of China's pharmaceutical price regulations between 1997 and 2008. In particular, it aims to answer the following questions: (1) Did the regulations reduce average medicine prices, and did the effects differ between urban and rural areas? (2) How did the regulations alleviate household health care burdens and adversely affect pharmaceutical firms? (3) Did the regulations induce any new behavior distortions?

This paper examines both the short-term and long-term effects of the regulations, and how the effects vary under regulation coverage and intensity. We treat regulations as exogenous policy changes, confirmed by Granger causality tests. To address the potential problem of nonstationarity or structural changes occurring in trends in the time series regression, we try different methods such as controlling for nonlinear trends and many other macro variables to ensure that the residuals are stationary. We also use Newey-West standard errors to correct autocorrelations.

Consistent with Meng et al. (2005) and Dong et al. (2008), we find that the overall effect of the price regulations is unsatisfactory. Medicine prices decline only by a very small amount (less than 0.5 percentage points), and the effects do not last long (less than five months). Although we find no significant changes to consumer health care expenditures or to average pharmaceutical firm profitability, new distortions such as an increase in medicine imports are presented, especially concerning high-priced medicines. The rest of this paper is organized as follows: Sect. 2 provides the institutional background; Sect. 3 introduces the empirical models; Sect. 4 presents estimations of the regulation effects; Sect. 5 focuses on the evidence from a micro survey on consumer perception of the pharmaceutical market; and Sect. 6 presents conclusions and discusses policy implications.

2 Background on China's pharmaceutical price regulations

Since 1996, the Chinese government has adopted three methods of pricing medicines: direct pricing by the government, reference pricing by the government, and pricing by the market. In addition, the government has enacted frequent pharmaceutical price regulations. About 30 price reduction policies have been introduced, and several adjustments have been made to

the list of regulated medicines, involving more than 300 traditional Chinese medicines and 2,000 Western medicines. Prices have been reduced by 15 percent to 20 percent on average, and up to 60 percent for some medicines. Before 2000, regulations were imposed mainly on imported medicines and approximately 200 frequently used medicines; after 2000, the scope for regulated medicines was extended. In 2008, the National Development and Reform Commission (NDRC) announced a switch from large-scale price reductions to fine adjustments once every two years. Since then, most of the price regulations have been upward price adjustments. It was only in December 2010 that the government attempted to cut prices again.

In this paper we constrain our analysis to the period between 1997 and 2007 to evaluate the effects of pharmaceutical price reductions, due mainly to the change in direction of price regulations in 2008. In addition, we want to avoid complications that may have resulted from the 2008 global financial crisis and the new round of health care reform beginning in 2009. Table 1 lists all the price regulations during that period, with detailed information regarding the time of announcement, time of implementation, and regulation details. Industrial report estimates of regulation coverage and intensity are also provided. Here, the coverage of a regulation is measured by sales reduction, or the product of the previous-year sales amounts and the amounts deducted from regulated-medicine prices. The intensity of a regulation is measured by the ratio of a price cut, defined as the ratio of sales reduction to total previous-year regulated medicine sales.

[Insert Table 1 here]

Figure 1 presents a straightforward illustration of the regulations. Here, "reduction in sales" represents the aforementioned sales reductions (in hundred millions of RMB) due to the intervention, and "regulation" denotes the month in which the regulation was implemented. It shows that the regulations were mostly evenly distributed, although there were more frequent regulations in 2003 and 2007.

[Insert Figure 1 here]

Whether these regulations are effective has been a source of much debate in China. The government argues that along with the regulations, the prices of frequently used medicines kept falling between 2001 and 2007. Moreover, households in rural areas were able to afford medicines that were originally expensive but became cheaper after regulation. However, many researchers argue that pharmaceutical firms responded by changing their production plans. Following the regulation, these firms either reduced or stopped their production of regulated medicines due to lower profit margins, and instead produced more so-called

"innovative" medicines that were unregulated and had high profit margins. These "innovative" medicines differed from the regulated medicines only in that the dosages or packages were changed. Meanwhile, hospitals and retailers tended to carry more expensive medicines; with a regulation ensuring no more than a 15 percent mark-up on retail prices, more expensive medicines generated more profit. This further reduced the incentives for pharmaceutical firms to produce cheap medicines. Finally, health care providers could also change the type and/or amount of prescribed medicines to evade the regulations and maintain revenues.

These mechanisms resulted in a phenomenon called "regulation failure": either medicine prices did not decline, or prices declined while consumer health expenditures did not, adversely affecting pharmaceutical firms. China's aggregate time series data may be used to identify the causal effect of regulation on medicine prices, consumer affordability of health care, pharmaceutical industry profitability, and other behavioral changes.

3 Empirical approach

This section examines the effects of regulation on pharmaceutical prices, household health expenditures, pharmaceutical firm profit margins, and other induced behavioral distortions. A few items must be noted. Pharmaceutical prices are considered to be the retail price index (RPI) and the consumer price index (CPI) of medicines. The difference between these two indexes incorporates intermediary mark-up behavior to some extent.[1] For example, hospitals in China distribute a substantial amount of medicines (80 percent) to patients, and the CPI incorporates the changes in hospital selling behavior. Such behavioral responses making prescription changes, replacing medicines with examinations, or lowering bid prices to pass losses on to the pharmaceutical firms. More detailed comparisons between these two price indexes are presented in Table 2. Here, the ultimate effects are the main focus.

[Insert Table 2 here]

As for behavioral distortions, we look at the prices of medical apparatuses and health care services, the two substitutes for medicines. We also consider differences in price between traditional Chinese medicines and Western medicines. Changes in medicine and medical apparatus imports are also studied. As there are far fewer price regulations on imported medicines, which are relatively more expensive in China, hospitals and physicians who

[1] The difference between retailer and consumer price indexes arises mainly from the following two factors: first, sampling coverage, of which the former covers consumer and firm consumption of goods only, while the latter covers consumption of both goods and services; and second, sampling weights, of which the former adopts weights based on retail sales structures while the latter adopts weights based on consumer consumption spending structures.

pursue higher profit margins tend to carry and prescribe imported medicines over domestic medicines. Finally, we explore the changes in the ratios of administrative and marketing expenses to sales revenues or to total pharmaceutical firm expenditures. If hospitals have more bargaining power, they can pass their losses on to pharmaceutical firms, possibly incurring higher costs for the latter. Meanwhile, to market so-called "innovative medicines," pharmaceutical firms may need to bribe hospitals, increasing marketing expenses. There is no direct measurement for this type of expense; however, a common procedure in China is to categorize marketing-related expenses as administrative or marketing expenses on the financial books. Hence, we use these two items of expenditure as proxy measures.

We use monthly time series data on the RPI of medicines and health care articles (hereafter RPI_medicine), the CPI of health care and personal articles (hereafter CPI_health) and its detailed categories between 1997 and 2008, monthly data on medicine imports and exports for the same period, quarterly data on household health expenditures during the same period, and the panel data for the monthly financial reports of pharmaceutical firms between 1999 and 2007.[2] Data were collected from *China Latest Economic Indicators* (issued semimonthly by the National Bureau of Statistics of China) and the China Economic Information Network (CEI).

For time series data, we consider the following linear regression model:

$$Y_t = \alpha_0 D_t + \alpha_1 D_{t-1} + \alpha_2 D_{t-2} + \alpha_3 D_{t-3} + \alpha_4 D_{t-4} + \beta X_t + \varepsilon_t \,, \quad (1)$$

where Y_t represents variables of interest at month t. D_t is the dummy variable indicating whether a price regulation is implemented at month t. D_t takes value 1 if any pharmaceutical price regulation policy is released between the 21st of month t-1 and the 20th of month t, and 0 otherwise.[3] Since price regulations may have lagged effects, we also consider regulations implemented k months earlier (D_{t-k}, k = 1, 2, 3, 4). This enables us to estimate the effective duration of the regulations. Furthermore, ignoring the lagged effects may lead to a downward bias.[4] We allow for five lags based on the test results from the Akaike Information Criterion (AIC), and find that the results do not vary much when more lags are

[2] For firm financial reports, only quarterly data were available after 2007.

[3] Among all regulations, 10 were implemented after the 20th of the month, and five after the 25th of the month. It is unlikely that these regulations would have strong effects in the current month. Different definitions were attempted, such as "implementing before the 31st" or "implementing before the 15th," and only negligible changes in results were found.

[4] The intervals between two adjacent regulations were often less than three months. The effects of these regulations can be underestimated if lagged effects are not taken into account. For example, consider the case where one price regulation was enacted in month A and no regulation was enacted in month B, but there was a price regulation in one month before B. Suppose the true effect of the regulation was reducing the medicine price by x percentage points in the first month, and reducing the price by y percentage points in the next month. In that case, a direct comparison of the medicine prices between month A and month B would give an estimate of x-y percentage points in the first month, which would underestimate the true effects.

added.[5] In addition to the dummy variable D_t, we also consider the effects of the coverage and intensity of each regulation as "reduction in sales" and "ratio of price cut."

X denotes a vector of other control variables: a continuous variable "year" to control for the linear time trend of the outcome *Y* and dummy variables controlling for monthly or quarterly seasonal adjustments. It also includes two dummy variables, "SARS" and "SARS2," that control for the long-run and peak effects of the unusual Severe Acute Respiratory Syndrome (SARS) event in 2003. "SARS" is 1 for the last three quarters in 2003 and 0 otherwise, while "SARS2" is 1 for April, May, and June 2003 and 0 for other months.[6] Moreover, because there were several changes in price index definition in 2003 and 2001 (see the details in Table 2), *X* includes a dummy variable called "time before 2003," when dependent variables were price indexes, and another called "time before 2001," when dependent variables were consumer price indexes. Similarly, a dummy variable called "time before 2002" is used to control for the effects of China's entry into the World Trade Organization (WTO), when the dependent variables are medicine and medical appliance imports and exports. *X* may also include other control variables, such as GDP, when necessary, which will be discussed in later sections.

The scatter plots show that many dependent variables have structural changes during the sampling years. Further, price regulation frequency varies with time; hence, simple linear regressions of these dependent variables on price regulations may lead to spurious correlations. For example, large-scale price regulation policies were frequently enacted after 2000 and before 2008. The scatter plot illustrates that the RPI of medicine declined substantially after 2001 and then surged after 2007. However, the negative correlation between the RPI of medicine and price regulation may have resulted from a third factor (i.e., aggregate economic fluctuations) that may have been related to regulation implementation and also may have affected medicine prices. We borrow from the existing literature and solve the problem by taking the following three steps: first, we filter the structural changes by controlling for the nonlinear trends; second, we add macroeconomic variables to control for the potential third factors that may result in the correlation between the regulations and pharmaceutical prices; and finally, we run the stationarity test for residuals. If the residuals

[5] There were two reasons for choosing five lag periods. First, tentative regressions show that the effect of regulations enacted five months ago had no significant effect on current prices. Second, the maximum lag for most dependent variables was less than 5, according to Akaike information criterion.

[6] "SARS" and "SARS2" were defined based on scatter plots of price indexes. There were unusual upward trends in price indexes in April, May, and June 2003, and indexes for the rest of the months in 2003 were also higher than the corresponding months in other years. When defining "SARS" as 1 for the months between April 2003 and April 2004, the estimates are similar.

are stationary, it means that the dependent and independent variables are stationary, or that dependent variables are cointegrated with independent variables. Hence, the point estimates of the coefficient will be unbiased and consistent.[7]

We consider two methods to control for the nonlinear trends. The first, our benchmark model, allows for different independent variable slopes and intercepts among different time intervals in the linear regression. For example, for the regression of the RPI of medicines, we add four variables: two dummy variables representing time before January 2001 ("year<2001") and time after January 2006 ("year>2006"), and their interactions with the year ["year*(year<2001)" and "(year*year>2006)"]. Since the intervals for a dependent variable are partitioned according to the scatter plot, the break points between intervals are subjective to some extent. Moreover, since this method filters only relatively large structural changes, we cannot control for the effects of other macroeconomic or industrial policies.

The second method that we consider is the use of the HP filter to filter both the dependent variables and macro control variables, and then the use of equation (1) to estimate the effects of price regulations on the HP fluctuations of dependent variables.[8] The second method filters not only the large structural changes, but also the change in trends caused by macro or industrial policies. We confirm that most of the variables become stationary after the HP filtering. Moreover, the change in the HP trend of dependent variables can be used to evaluate whether the break points used in the first method are appropriate. However, the second method is subject to the problem that price regulation effects may be underestimated, since the changes in trends that resulted from price regulations are also filtered. This problem is less severe for the first method, since large structural changes in the dependent variable trends are less likely to be caused by price regulations. Hence, we treat the first method as our baseline model.

Because filtering trends do not solve the problem of omitted variables, we add macro-level variables in the regression to control for factors that may affect both dependent variables and regulation implementation. The macro variables to be added vary with the dependent variables. For the medicine price indexes, the most important macro variable is the aggregate price indexes for all goods other than medicine or health care. However, since the

[7] Existing literature suggests that if structural changes exist for time series variables, structural change filtering is required before the stationary test (see, Zivot and Andrews 1992; Lumsdaine and Papell 1997; Gregory and Hansen 1996, for more details).

[8] Parameters for the HP filter are chosen as follows: λ=14,400 for monthly data, and 1,600 for quarterly data. For monthly data, since the literature does not provide a guideline, we considered three choices for λ: 4,800, 14,400, and 296,000. The results show that as λ increases, HP trends become smoother, and the deviation term *s* becomes more volatile. We find that the HP trend under λ=14,400 is quite similar to that under λ=4,800 and that the trend under λ=14,400 is located between that under λ=4,800 and that under λ=296,000. Hence, we present only results under λ=14400.

weights for each good and service are available in China, we use the simple average of the price indexes for goods other than medicine as a proxy.[9] In addition, we add the logarithm of GDP and the Consumer Confidence Index (CCI) in the regression to check the robustness of the results.[10] When the dependent variable is medicine imports or exports, we control for the imports and exports of other goods; when the dependent variable is household medical expenses, we control for household income and/or expenditures on other consumption; and when the dependent variable is pharmaceutical firm profitability, we control for the profitability of other related industries.

Another problem for the time series regression is that error terms may be autocorrelated. When all the covariates are exogenous, a good way to address the problem is to replace the standard deviations of the ordinary linear square (OLS) estimations with the Newey-West standard deviations. This also helps solve the heteroskedasticity problem. To check the exogeneity condition, we use Granger tests to check for a reverse causal relationship between price regulations and medicine prices (RPI_medicine and the CPI_health). The results indicate that the hypothesis that RPI_medicine (CPI_health) led to regulation policies was rejected at the 10 percent (5 percent) level of significance, but that the hypothesis for the reverse relationship could not be rejected. Therefore, it is reasonable to argue that price regulation is exogenous to prices, which justifies our focus of the Newey-West standard deviations in this paper.[11]

As to the impacts of regulation on pharmaceutical firms, we will mainly consider the fixed effect model for the panel data. Meanwhile, problems of structural change, stationarity, and autocorrelation will also be taken into account. More details are discussed in Sect. 4.3.

4 Regression results

4.1 Effects of regulation on pharmaceutical prices

[9] We considered controlling for the official "aggregate price index"; however, since it includes prices of medicines and medical services, it cannot be treated as exogenous in principle. Fortunately, for most dependent variables, estimations controlling for aggregate price indexes are quite similar to those controlling for the price index of other goods or services.

[10] Since the sample size is small and potential biases can be induced by adding unrelated macro-level variables, we focus on the case where only the price indexes for nonpharmaceuticals are controlled. We then add other macro-level variables to check robustness. Although the GDP logarithm is a good proxy for the economic cycle, only quarterly data were available. We considered replacing it with household income in urban and rural areas, but the coefficients of household incomes were not significant. The Consumer Confidence Index (CCI) is a leading indicator for predicating economic growth and consumption. While we find that this variable is significantly negatively correlated with the aggregate price index, data on the CCI were available only after 1999.

[11] We chose 6 as the number of the maximum lag for the Newey-West regressions. The literature suggests that the maximum lag for Newey-West regressions should be less than one quarter of the sample size. Woodridge (2003) points out that for monthly data, the maximum lag should be less than 12. We considered using 3, 6, and 12 as numbers of maximum lag and found that the results were similar. Results of using 6 fell between those of using 3 and using 12.

Results on the effects of regulation on pharmaceutical prices are reported in four aspects: average effects of dummy variables that indicate whether the regulations were nationally implemented; effects of regulation scales and intensities; effects of the regulations on various types of medicines and other goods and services related to medicines; and effects of the regulations on pharmaceutical prices in urban and rural areas. Table 2 gives the detailed contents of each price index.

4.1.1 Effects on pharmaceutical price indexes

Figure 2 displays the time trends and the HP trends for RPI_medicine and CPI_health (base period: same month in 1997). Aggregate retail price index (RPI_agg), the simple average of retail price indexes for goods other than pharmaceuticals (RPI_other), aggregate consumer price index (CPI_agg), and the simple average of consumer price indexes for goods and services other than health care are also presented. The figure shows that all the indexes rose sharply after 2007. The trend for RPI_medicine differs from that of CPI_health, and the difference increases after 2001. Moreover, the pharmaceutical price index trend behaves differently from that of the price index for other goods, with the latter appearing to mimic the aggregate price index trend.

[Insert Figure 2 here]

Table 3 reports the regression results for the effects of regulation on RPI_medicine and CPI_health when five lags are allowed.[12] The first two columns list the results for the benchmark model, in which we directly control for the nonlinear structural changes for prices and the corresponding average price index for nonpharmaceuticals. According to the scatter plots, the trends of RPI_medicine and CPI_health are allowed to change in January 2001 and January 2006. Stationarity tests show that residuals for these two regressions are stationary at the 2 percent level of significance.[13] The first column indicates that while the regulation policy significantly lowers RPI_medicine, the magnitude is moderate at only 0.46 percentage points. Moreover, the negative effect of regulations on RPI_medicine falls with time, with a reduction of 0.45, 0.28, and 0.27 percentage points for the first, second, and third months after the policy implementation, respectively, and becomes insignificant four months later. The second column shows that the regulations also have a significant negative

[12] Results for four lags are similar.

[13] We consider ADF and Phillips-Perron tests for the stationary test of residuals. These two tests rely on different principles to correct the autocorrelations of time series data. They are similar to a cointegration test in that no constant or time trend variables are added. The critical values for 10%, 5%, and 2.5% are -3.5, -3.78, and -4.32, respectively. The maximum lag for the ADF test is chosen according to Schwarz Information Criterion (SIC), and the maximum lag for the Phillips-Perron test is set by default.

effect on CPI_health, although the magnitude is smaller than that for RPI_medicine. The negative effect, however, appears to rise at first and then starts to decline over time: CPI_health drops by 0.20, 0.27, and 0.17 percentage points followed by an insignificant amount in the first, second, fourth, and fifth months, respectively. Therefore, compared with its effects on RPI_medicine, the effects of regulation on the CPI are lagged and are much weaker.

[Insert Table 3 here]

The third and fourth columns present the regression results controlling for the logarithm of GDP and the CCI. The residuals still pass the stationarity test. Apart from the month when the negative impact fades, there is not much change in the estimation results. The significant negative effect of regulation on RPI_medicine lasts for only three months, the largest magnitude being 0.43 percentage points in the month when the policy is implemented. In contrast, the negative effect of regulation on CPI_health lasts for five months. The strongest effect (0.31 percentage points) appears in the second month of implementation, 29 percent less than that of RPI_medicine.

The last four columns in Table 3 present estimates for the effects of regulation on the cyclical component of the price indexes after the HP filter. Again, the residuals pass the stationary test. As discussed previously, the effects of regulation may be underestimated, and the results show both that the estimates in the last four columns are weaker than those in the first four columns and that the effects seem to last for shorter periods. Despite this, the difference in the results is not large; the negative impact of regulation on RPI_medicine lasts for three months. The strongest effect appears in the first month at a level of 0.37 to 0.42 percentage points, and the negative effect on CPI_health lasts for three to four months, with the strongest effect appearing in the second month (0.18 to 0.25 percentage points).

We also conduct a number of sensitivity tests. Only regulations with available information on coverage and intensity are considered, and 2008 data are excluded to avoid possible disturbances caused by the post-mid-2007 inflation speed-up. The time window defined for the dummy variable that indicates whether regulation policy is implemented in a given month is changed (for example, "whether there is regulation before the 20th" is replaced with "before the 31st"), and the logarithms of price indexes are used as dependent variables. Other alternative macro-level control variables such as household incomes or China's Inter-Bank Offered Rate are used, and the definitions for some variables such as "SARS" or parameters such as the HP filter parameter or the lags for the Newey-West regression are changed.

The results remain similar. The effects of regulation on RPI_medicine last no longer than

five months. The largest magnitude in price reduction is between 0.33 and 0.49 percentage points. As for CPI_health, the effect lags behind slightly. The duration of the effect is no longer than six months, and the largest drop in price ranges between 0.27 and 0.35 percentage points. In brief, the results presented in Table 3 are considerably robust.[14]

4.1.2 Effects on subcategory items of CPI_health

The results shown in Table 3 indicate that the effect of regulation on CPI_health is slightly weaker than that on RPI_medicine. A potential reason is that the difference between these two indexes results from the change in intermediary or hospital behavior. However, since CPI_health includes some personal articles, such as beauty and cosmetics products that are not subject to pharmaceutical regulation, the effects of regulation on CPI_health might be much lower than that on RPI_medicine. Therefore, it is useful to rule out the noise from CPI_health to estimate the real effects of regulation on the medicine CPI.

Table 4 displays the estimated effects of regulation on the CPI_health subclass items. In particular, we have information on the price index excluding personal articles, referred to as the CPI of health care (CPI_medicine). Since data on the subclass items of CPI_health are available only after 2001, we consider the effects of regulations that were implemented afterward. Accordingly, the price indexes are adjusted by using the same month in 2000 as the base period.[15] The corresponding results on the HP fluctuations of these price indexes are similar to those in Table 4 and hence are not reported. Again, we report results with four lags, as the effects of regulations after 2001 are shown to persist for shorter periods. Results with five lags are almost identical.

[Insert Table 4 here]

Theoretically, pharmaceutical regulations should have no effect on personal articles. The first column of Table 4 confirms this and suggests that the significant effect in Table 3 is not a result of any third factors related to the regulation policies.

Columns 2 and 3 employ the benchmark model to compare the differences between the effect of regulation on CPI_health and CPI_medicine. We find that the effect of regulation on CPI_health is weaker than that on CPI_medicine. In particular, the peak effect of regulation on CPI_medicine rises to 0.43 percentage points, compared with 0.29 percentage points for CPI_health. All other results remain unchanged: the largest effect occurs in the

[14] Results are available upon request.

[15] Scatter plots show that the trends for CPI_health and CPI_medicine are similar. Both appear to have a distinct structural change around January 2006. The trend for personal articles, however, is quite different, with a structural change occurring around January 2004.

second month of regulation implementation and lasts for less than five months. To better compare the difference in regulation effect on retail and consumer price indexes, the fourth column examines how the post-2001 regulations affected RPI_medicine using 2000 as the base year. It shows that the effect of regulations on RPI is still stronger than that on CPI_medicine by a difference of 0.18 percentage points. Nevertheless, it is possible that this difference is attributable to a difference in content: CPI_medicine includes health care appliances and services, while RPI_medicine does not.[16]

The rest of the columns in Table 4 report the results for the CPI_medicine subclass items.[17] Price indexes for items such as traditional Chinese medicines and Western medicines are directly influenced by regulations, whereas other items such as medical instruments and health care appliances and services are indirectly affected. Column 5 shows that regulations reduce the price of traditional Chinese medicines the most, with the peak effect occurring at a level of 1.5 percentage points one month after implementation and no significant effect afterward. In contrast, the effect on Western medicines is much weaker, as the peak effect is only 0.21 percentage points despite the effect lasting one month longer.[18]

The theoretical predictions of the effects that medicine regulations have on the price of medical instruments and health care appliances and services are ambiguous. On the one hand, hospitals can increase the frequency of medical examinations, or raise the price of health care services to maintain profits. On the other hand, if the price of medicine declines relative to other kinds of health care, patients may rely more on medicine for treatment or even choose self-treatment (i.e., purchasing medicine in retail pharmacies) rather than visiting hospitals, which may drive hospitals to lower prices on medical exams or health care services to attract more patients. Similarly, competition between health care appliances and medicines could induce falling appliance prices. Columns 7 to 9 display the estimates for the effects of regulations on these price indexes. We see that regulations affect the health care price index only after three months of implementation, and this significant effect may disappear under other specifications. Although regulations affect medical instrument prices

[16] Since the information on the weights of each item in CPI_health and RPI_medicine is unavailable in China, it is impossible to construct a consumer price index that is entirely equivalent to RPI_medicine.

[17] Based on the scatter plots and HP trends for each price index, the prices of Western medicines and health care products are allowed to have different trends in January 2005, while the break point for other price indexes is January 2006. We conduct sensitivity tests for other break point choices.

[18] Nevertheless, the estimate for the effect on Western medicines is sensitive to the break points of structural change in the trends. Table 4 reports the results when the break point is January 2005. The estimate becomes insignificant when the break point switches to January 2006. We also estimated the effects of regulations targeted at traditional Chinese medicines and the effects of regulations targeted at Western medicines. The results show that for Chinese medicines, the effect of regulations not targeted at Chinese medicines is similar to the effects of regulations targeted at Chinese medicines. In contrast, the effect of regulations not targeted at Western medicines is much weaker than the effects of regulations targeted at Western medicines.

negatively, the effect is statistically insignificant. However, the estimate becomes significant when we change the breaking points of the structural change in trends. Finally, regulations have no significant effect on the CPI of health care appliances, and this finding is quite robust.

4.1.3 Marginal effect of intensities for price regulations

Compared with the average impact of all regulations since 1997 (Table 3), the effect of post-2001 regulations appears to be stronger, but persists for shorter periods (Table 4). More specifically, in contrast to the peak effects of 0.46 and 0.27 percentage points for RPI_medicine and CPI_health for all regulations, the peak effects for the post-2001 regulations are 0.52 and 0.29 percentage points, respectively. Nevertheless, the average duration of the effect for post-2001 regulations is one month shorter than that for all regulations.[19] A potential reason is that the regulations after 2001 are more intense and involve more varieties of medicine. For example, the reduction in sales grew from an average of 200 million yuan before 2001 to 500 million yuan after 2001.

In this section, we try to distinguish each regulation by its coverage and intensity. In particular, instead of only considering the dummy variable of price regulation in a given month, we estimate the effect of the price-cut ratio and sales reduction of a regulation policy. Table 5 gives the results for the benchmark model. Results for the HP fluctuations of these price indexes are quite similar. Columns 1 and 2 consider price-cut ratios and sales reductions simultaneously, allowing for four lags. They show that the coverage measured by sales reductions has significant negative effects on RPI_medicine and CPI_health, whereas the intensity measured by price-cut ratio has no significant effect on these two price indexes. One possible explanation is that, given the sales reductions, a larger price-cut ratio indicates a smaller market share of regulated medicines, implying that the regulation may have a weaker impact on the whole market.

[Insert Table 5 here]

One problem of controlling for sales reductions and price-cut ratios simultaneously is that these two variables are highly correlated (with a correlation coefficient of 0.85). Since "price-cut ratio" considers only the price cut of the regulated medicines while "reduction in

[19] To further test the differences in the effects caused by regulation policies implemented before and after 2001, we added interaction terms between the dummies indicating regulation status and the dummy of "the regulation implemented after 2001." Results indicated that the coefficients for the three interaction terms for regulations within the last three months were negative and significant, confirming that the effects of regulations implemented after 2001 were significantly stronger.

sales" takes into account both the price cut and the market share of the regulated medicines, we constrain our focus to the effects of "reduction in sales" throughout the rest of the table. It shows that when "reduction in sales" caused by regulation increases by 100 million yuan, RPI_medicine declines by 0.016 percentage points in the first month and 0.01 percentage points in the second month, and CPI_health declines by 0.008 percentage points in the first month and 0.005 percentage points in the second month. The effects fade away after two months.

Columns 5 through 7 focus on regulations after 2001, and columns 5 and 6 show weaker marginal effects of the coverage of post-2001 regulations. This appears to contradict the results in Table 4, where the average effect of the regulations becomes stronger although the effect lasts for shorter periods. One possible explanation is that pharmaceutical firms or hospitals may have learned how to counteract the price regulations over time, thereby weakening the marginal effects of increased regulation coverage; however, as more medicines are regulated after 2001, the average effect of regulations becomes stronger. Column 7 shows again that the marginal effect of regulation coverage is stronger for CPI_medicine than for CPI_health, though the difference is quite small.

4.1.4 Regulations on urban and rural price indexes

Some researchers suggest that the effect of regulations on prices could be stronger in rural areas than in urban areas. The reason is that pharmaceutical firms may dump regulated medicines onto rural areas, while in urban areas they stop selling these medicines and instead sell so-called "innovative medicines" that differ only slightly from the regulated medicines. We will assess these arguments quantitatively in this section.

Results with four regulation lags are reported in Table 6, and results with five lags are quite similar. Columns 1 and 2 give the effects of regulations on RPI_medicine for rural areas (part I) and urban areas (part II), respectively. Both methods of trend filtering show significant effects for no more than five months. However, these two methods give different results in terms of which effect—rural or urban—is stronger. Column 3 applies the Chow test to examine whether rural areas experience a larger reduction in RPI_medicine.[20] The result gives a negative answer: The difference between urban areas and rural areas is not significant at all.

[20] In particular, we first combine observations in rural areas with those in urban areas, and then control for $\{D_i\}$, where $i=t,t-1,t-2,t-3$, and the interaction terms between the dummy of urban area and $\{D_i\}$. The difference between urban and rural areas is represented by the coefficients of the interaction terms.

[Insert Table 6 here]

Columns 4 to 6 report the corresponding results for CPI_health. Both methods of trend filtering indicate that regulations have a negative effect on CPI_health in both rural and urban areas (except that the effect is not significant at the 10 percent level for the HP cyclical component of rural CPI_health). The decline in CPI_health appears to be stronger in urban areas than in rural areas in columns 4 and 5. However, column 6 shows that the difference is not statistically significant.

4.2 Effects of regulation on households

One objective of government intervention is to reduce household health expenditures. However, Tang and Zhang (2008) point out that the result is often disappointing even if the prices of regulated medicines are reduced. There are several potential reasons. First, physicians or hospitals may increase regulated-medicine doses, substitute unregulated medicines for regulated medicines, or increase the prices of medical examinations and/or medical services to maintain their profits. Second, expenditure on regulated medicines may be a small component of consumer medical expenditures. This component can shrink following regulations due to the disappearance of regulated medicines in the market. Third, consumers may increase their demand for regulated medicines, which become cheaper, and this drives up total expenditure. These reasons have different implications for consumer welfare: the consumer will be worse off in the first two cases but better off in the third.

Table 7 estimates the effects of regulation on health expenditures as a proportion of all expenditures, disposable income, and the natural logarithm of health expenditures. The first two measures can be viewed as the burden of health expenditure. Based on the scatter plots of these three dependent variables, we allow the trends to vary in January 2004 in the benchmark model. The covariates include the natural logarithm of per capita disposable income, the arithmetic mean of the CPI for goods and services other than health care, year, quarter dummies, SARS, and SARS2.[21] Since the second model—which takes HP fluctuations into account—delivers similar results, we report only the results for the benchmark model.

[Insert Table 7 here]

Because only quarterly data on health expenditures are available, we consider the effects

[21] The results here are less robust due to the small sample sizes. Definitions for urban and rural residents have changed since 2002. Urban residents included residents with nonagricultural Hukou and residents living in cities or suburban areas. However, the trend of healthcare expenditures shows no obvious changes in 2002. Based on the scatter plots, we exclude two outliers, fourth quarter 2002 data for urban residents, and third quarter 2004 data for rural residents.

of the number of regulations in a certain quarter and its one-period lag. Corresponding results are reported in the first part of Table 7, and it is shown that the number of regulations have no significant effect on household health care burdens measured in any term. In the second part, we consider an alternative measure of regulation—that is, a dummy variable representing "having at least one regulation in the current quarter" and its one-period lag. The results remain similar.

The third part of Table 7 considers the marginal effects of sales reduction. The results indicate that when regulations cover more medicines, consumer health expenditures are more likely to be reduced. However, we need to be cautious about this conclusion because the significance of the estimates is sensitive to the specifications, some of which fail to pass the stationarity tests.

4.3 Effects of regulation on pharmaceutical firms

The previous section indicates that pharmaceutical price regulations do not affect household health expenditures. In this section, we consider whether the regulations affect pharmaceutical firms adversely in two aspects: profitability and cost structures, particularly the administrative and marketing expenses of those firms. We employ monthly financial statement panel data of the pharmaceutical manufacturing industry and five subclass industries,[22] and the results are reported in Table 8.

[Insert Table 8 here]

We apply the fixed-effect model to control for the time-invariant differences among these industries. Because dependent variables such as the profitability of each industry may have different seasonal or nonlinear time trends, we run the seasonal adjustment and filter structural trends for each industry before pooling the industries together and running the fixed-effect regression. More specifically, we first run a regression for each industry that allows the dependent variable to have seasonal changes and different slopes and intercepts for different time intervals; we then pool the industries together and use the residuals as the dependent variables for the fixed-effect regression.[23] We also test the stationarity of the

[22] The five subclass industries are biochemistry, manufacturing chemical preparations, manufacturing synthesizing chemicals, manufacturing proprietary TCMs, and manufacturing TCM slices processed for decoction. All of these industries have no information in January of these years. There was a change in the category of industries at the end of 2002; the industry of manufacturing health and medical materials changed its content. However, since the industry is unlikely to be directly affected by pharmaceutical price regulations, we neglect this change in this paper. Besides, two industries—manufacturing proprietary Chinese medicines and manufacturing Chinese medicines slices processed for decoction—come from the industry of manufacturing Chinese herbal medicines and proprietary Chinese medicines, and have data only after 2003.

[23] The scatter plots show that for most industries, the break points of nonlinear trends for the profitability and

residuals in the fixed-effect regression to make sure that the estimates are reliable.[24] Based on the tests suggested by Wooldridge (2003), we find that the fixed-effect regression still has autocorrelation problems. Hence, we report the Newey-West standard deviations.

The first three columns of Table 8 show no significant regulation effects on average profitability (profits as a ratio to total sales revenue), the natural logarithm of sales revenue, and the natural logarithm of output. However, columns 4 and 5 indicate that these regulations have negative effects on firm profitability at the break-even edge: both the value of loss relative to total sales and the percentage of firms in loss increase in the second and third months after regulation implementation.

Although not reported, all of these results remain unchanged if we control for the same measure of profitability of industries that do not seem to be directly affected by the regulations, but are similar to the pharmaceutical industry to some extent.[25] Therefore, we conclude that although regulations tend to make firms at the break-even edge worse off, they do not change the average profitability of the pharmaceutical industry. This is possibly because surviving firms can benefit from the exit of low-end firms, and many pharmaceutical firms may quickly adjust their production or sales to counteract the adverse effects of regulations.

As mentioned previously, pharmaceutical firms may need to pay hospitals to promote new medicines. The payments are usually shown in administrative or marketing expenses in financial accounting statements. Column 6 indicates that regulations significantly increase the ratio of pharmaceutical firms' administrative expense to sales revenue in the first month of implementation. However, this effect is no longer significant at the 10 percent level when we consider the ratio of administrative expense to total expenditure (column 7). Columns 8 and 9 consider the sum of marketing and administrative expenses; however, adding marketing expenses may introduce some noise, since they may include other changes in marketing strategies in response to regulations (i.e., changes in advertisement strategies to

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administrative and marketing costs are around January 2002 and January 2003. Scatter plots for the loss measure variables show no obvious time trend changes. As a result, we assume the same break points for all industries in order not to be too arbitrary, and consider it reliable as long as the residuals pass the stationarity tests for panel data. The second method of filtering structural change—using the HP fluctuations in the fixed-effect regression—confirms the robustness of the results.

[24] The Fisher test suggested by Maddala and Wu (1999) and the LM test suggested by Hadri (2000) are applied here for stationary tests. The null hypothesis for the former test is that all series are nonstationary, which is an application of the IPS test to unbalanced panel data, whereas the null hypothesis of the latter test is that all series are stationary. The panel data is stationary if we can refuse the null hypothesis of the Fisher test and cannot refuse the null hypothesis of the LM test at the same time.

[25] More specifically, we consider the following medical treatment and pharmaceutical manufacturing industries: health and medical materials, chemical fibers, and chemical raw material and chemical products. Since it is possible that these three industries could also be affected by regulations and the comparability between these industries and the pharmaceutical industry is not testable, we use only the specifications controlling for these industries' corresponding measures as robustness tests.

attract consumers). It is shown that regulations have no significant effect on the share of marketing and administrating expense, regardless of whether they are measured in terms of total sales or total cost. In summary, we do not find robust evidence that regulations increased the marketing and administrative costs of pharmaceutical firms, which have incorporated the costs required to promote new medicines to hospitals and/or consumers.

We also apply the counterfactual test on two industries that are unlikely to be directly affected by the regulations: medical equipment manufacturing, and health and medical material manufacturing. We confirm that these regulations have no effect on the corresponding dependent variables of these two industries. Other sensitivity tests, such as consideration of only the five subclass industries or the total pharmaceutical industry, confirm that our conclusions are robust.

4.4 Regulations on medicine imports and exports

In this section we estimate the effects of regulations on medicine imports and exports and focus on three dependent variables: the natural logarithm of the value of imports and exports for pharmaceutical products, the average price level of imported pharmaceutical products, and the natural logarithm of these import quantities. We include two measures for the first dependent variable due to the different commodity classification systems in China's Customs Statistics: one from the Standard International Trade Classification (SITC) system, in which pharmaceutical products are under section 54, and the other from the Harmonized Commodity Description and Coding System (HS), in which pharmaceutical products are under section 30. The scatter plots show similar trends for these two measures. Because China became a member of the WTO in December 2001, we add a dummy called "before 2002" and its interaction term with a time trend to allow for the trend of imports or exports to change in January 2002. We also control for imports and exports of goods other than medicines within the same category for other macro factor influences.

Column 1 in Table 9 shows that these regulations increase the value of imports for pharmaceutical products (SITC system) significantly in the first month of implementation, though the effect lasts for only one month. The increase in the first month is about 7 percent in the baseline model. Using the alternative import measure (HS system) gives similar results (column 2), although both the magnitude and significance level decline. The change may be due to the fact that the pharmaceutical products in the HS system include some goods other than medicines (i.e., medical dressings) that are unaffected by pharmaceutical

price regulations.

[Insert Table 9 here]

Pharmaceutical product import values are equal to the product of the average price and the import quantity. Import quantity information is available only in the SITC system. Columns 3 and 4 indicate that regulations significantly increase the average price of the imported pharmaceutical products by 5.6 percent in the baseline model, while the total import quantity is not significantly affected. These conclusions are quite robust, even when we add other macro control variables such as exchange rates (units of one USD for RMB, or units of the special drawing right (SDR) for RMB). This implies that the increase in import values is probably a consequence of more expensive medicine imports substituting for cheaper ones. This could be driven by the fact that hospitals and retailers favored more expensive medicines after regulation due to the "no more than 15 percent mark-up in retail prices of medicines" policy, and that imported medicines are under a different system from that of domestic medicines (e.g., hospitals and retailers can have higher mark-up rates).

An intuitive conclusion is that regulations should have no effect on medicine exports. This is confirmed by the results listed in the Columns 5 and 6 of Table 9. Most of the regulation coefficients are negative, implying that the effects of regulations on medicine imports are not caused by any third factor affecting both exports and imports. Finally, we find no significant regulation effects on medical instrument imports, which is consistent with the finding that regulations have no significant effect on medical instrument prices.

5 Consumer perceptions on the pharmaceutical market

This section tries to relate previous findings to consumer perceptions of pharmaceutical policies, medicine prices, and health expenditures, using a micro survey.[26] The survey was administered to about 5,000 urban residents from 17 provinces in August 2008. We limited our analysis to adults between the ages of 18 and 65, reducing the sample to 4,521 observations. Among all residents, about 48 percent were male, and the average age was 45 years old. In addition, only about 7 percent of the adults had less than a primary school education, and 28.5 percent had at least attended a vocational college.

Table 10 presents the frequency statistics for the answers to the relevant questions. In particular, for the question "What is the main reason why medicines are so expensive?," about 49 percent of respondents stated that hospitals or drugstores had incentives to

[26] We are very grateful to Professor Qunhong Shen from the School of Public Policy and Management at Tsinghua University for sharing with us the descriptive statistics of this survey.

maximize profits, while 28 percent thought there were too many middlemen in the distribution system and 17 percent thought that pharmaceutical firm costs have increased substantially due to too many advertisement and/or marketing expenses. None of these three factors can be changed substantially by pharmaceutical price regulations.

[Insert Table 10 here]

For the question "What is your main determinant when choosing from various medicines with similar therapies in the pharmacy?," only 14 percent of the respondents chose "price." For the remaining population, 27.5 percent of respondents relied on their experience, 21 percent simply followed suggestions from physicians or pharmacists, and 14.6 percent relied on descriptions. This indicates that consumer price elasticity of medicine demand was probably quite low, which provides the microeconomic foundation for more expensive medicine supplies; hence, regulations are less likely to be effective.

Moreover, only 6 percent of respondents thought that commonly used medicines were the main reason for high health expenditures. In contrast, 38 percent, 29 percent, and 24 percent of respondents ascribed high health expenditures to medical examinations, innovative and/or special medicines, and doctor services and/or surgery, respectively. The term "innovative medicines" gave a first impression of "higher price" to 55 percent of respondents and a first impression of "new therapy" to 32 percent of respondents.

All of these results strengthen the argument that regulations on frequently used medicines hardly change consumer perceptions of high health expenditures. This is further confirmed by the finding that around 47 percent of respondents thought that health expenditures had increased in the past year, among which more than 12 percent thought health expenditures had increased substantially and were hardly affordable. Only 15 percent of respondents answered that health expenditures had declined in the last year.

6 Conclusions and policy implications

Many countries have exerted regulations on their health care markets to control rising pharmaceutical prices and medical expenditures. The Chinese government has imposed price regulations on the pharmaceutical market about 30 times since 1997. We find that although these regulations reduced the retail price index for medicines and the consumer price index for health care only in the short term, the negative effect was no more than 0.5 percentage points over one month, and the effects lasted no more than five months. Increasing regulation coverage can only transiently magnify the negative effects of

regulations on pharmaceutical prices.

In addition, we find that price regulations had no significant effect on consumer health expenditures. Regression results also indicate that whereas average pharmaceutical firm profitability was unaffected by the regulations, the value of loss and the percentage of firms in loss increased due to these regulations.

We find also that price regulations significantly increased the value of imported medicines, mainly as a consequence of a rise in average price levels rather than an increase in imported medicine quantities. Finally, we find that these regulations had no robust, significant effect on the prices of medicine substitutes and complements, including medical instruments and health care appliances and services. This could be due to physicians simply offsetting the negative effects of price regulation by changing the types or doses of prescribed medicines.

In summary, these findings indicate that the 30 price regulations failed to accomplish the aims of the intervention—that is, to reduce medicine prices and household health expenditures. At the same time, the regulations induced new behavior distortions in health care markets. The findings are consistent with household perceptions on pharmaceutical markets: From the point of view of most respondents, price regulations could hardly change the main reasons for expensive medicines; commonly used medicines were not the main contributor to high health expenditures; consumer insensitivity to medicine prices limited the effectiveness of price regulations; and pharmaceutical price regulations did not change household perceptions that health expenditures were far too high.

Despite the insufficiencies of direct price interventions, China's government can still play an important role in reforming the health care sector and alleviating household health care burdens. In fact, even direct price regulation can be improved by minimizing potential behavior distortions. For example, the government could eliminate the differences in the regulations imposed on different types of medicines to reduce substitution behavior, tighten the regulations on innovative medicines to reduce fake "new" medicines, and change the incentives of physicians or hospitals to encourage inexpensive medicine prescriptions. More generally, the Chinese government should try to control health expenditures from both the supply side and the demand side. From the supply side, the government could introduce more competition among pharmaceutical firms, hospitals, and pharmacy retailers, and reduce the layers of distribution to leave more surpluses to consumers. It is also important to change the incentive system so that physicians and hospitals will attempt to minimize health care costs without reducing health care quality. From the demand side, the government needs to improve the health insurance system to alleviate the health care burdens of citizens.

At the same time, the system should encourage households to use inexpensive but effective medicines by setting different reimbursement rates for different medicines.

References

Borrell, J. R. (1999).Pharmaceutical price regulation: A study on the impact of the rate-of-return regulation in the UK. *Pharmacoeconomics*, 15(3), 291–303.

Brekke, K. R., Grasdal, A. L., & Holmas, T. H.. (2008).Regulation and pricing of pharmaceuticals: reference pricing or price cap regulation? *European Economic Review*, 53(2), 170-185.

Breusch, T. S., Mizon, G. E., & Schmidt P. (1989). Efficient estimation using panel data. *Econometrica*, 57, 695–700.

Danzon, P. M., & Chao, L. W. (2000). Does regulation drive out competition in pharmaceutical markets? *Journal of Law and Economics*, 43(2), 311–357.

Dong, Z., Liu, G., Wu, J., & Wu, J. (2008). Effects of drug price control policies on antibiotics: Evidence from Beijing. *China Journal of Pharmaceutical Economics* (in Chinese), 3, 7–12.

Drummond, M., Jönsson, B., & Rutten, F. (1997). The role of economics evaluation in the pricing and reimbursement of medicines. *Health Policy*, 40, 199–215.

Gregory, A. W., & Hansen, B. E. (1996). Residual-based tests for cointegration in models with regime shifts. *Journal of Econometrics*, 70(1), 99–126.

Hadri, K. (2000). Testing for stationarity in heterogeneous panel data. *Econometrics Journal*, 3, 148–161.

Huang, Y., & Cao, W. (2008). Another research on China's drug price regulations. *China's Price* (in Chinese), 11, 17–20.

Lopez-Casasnovas, G., & Puig-Junoy, J. (2000). Review of the literature on reference pricing. *Health Policy*, 54, 87–123.

Lumsdaine, R., & Papell, D. (1997). Multiple trend breaks and the unit root hypothesis. *Review of Economics and Statistics*, 79, 212–218.

Maddala, G. S., & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and Statistics*, 61, 631–652.

Meng, Q., G. Cheng, Silver, L., Sun, X., Rehnberg, C., & Tomson, Göran. (2005). The impact of China's retail drug price control policy on hospital expenditures: A case study in two Shandong hospitals. *Health Policy and Planning*, 20 (3), 185–196.

Mrazek, M. F. (2002). Comparative approaches to pharmaceutical price regulation in the European Union. *Croatian Medical Journal*, 43(4), 453–461.

Rane, W. (1998). Price control on drugs is essential. *Economic and Political Weekly*, 33(42/43), 2697–2698.

Santerre, R. E., & Vernon, J .A. (2006). Assessing Consumer Gains from a Drug Price Control Policy in the U.S. *Southern Economic Journal*, 73(1), 233–245.

Scherer, F. M. (2000). The pharmaceutical industry. In *Handbook of Health Economics*, Vol. 1, ed. Anthony J. Culyer and Joseph P. Newhouse. Amsterdam: North-Holland, pp. 1298–1336.

Skinner, B. J. (2005). *Canada's Drug Price Paradox: The Unexpected Losses Caused by Government Interference in Pharmaceutical Markets*. Digital document available at http://www.fraserinstitute.org/commerce.web/product_files/CanadasDrugPriceParadox.pdf.

Sood, N., de Vries, H., Gutierrez, I., Lakdawalla, D. N., & Goldman, D.P. (2009). The Effect of regulation on pharmaceutical revenues: Experience in nineteen countries. *Health Affairs*, 28(1), 125–137.

Tang, S., & Zhang, X. (2008). Consideration on the medicine price and medicine expenditure. *Chinese Health Economics* (in Chinese), 27(3), 53–55.

Vernon, J. A., Santerre, R. E., & Giaccotto, C. (2004). Are drug price controls good for your health? *Medical Progress Report*, No. 1, December, by Manhattan Institute for Policy Research, Center for Medical Progress.

World Bank. (2004). *Taking Stock of China's Rural Health Challenges*. Briefing note series newsletter 33231, October. Washington, DC: World Bank.

Wooldridge, J. M. (2003). Introductory econometrics: A modern approach, 2nd ed. Cincinnati, OH: South-Western, Division of Thomson Learning.

Yu, L., Yu, Z., & Tian, K. (2007). Puzzle for high medicines prices in China. *Research on Economics and Management* (in Chinese), 9, 10–17.

Zivot, E., & Andrews, D.W.K. (1992). Further evidence on the Great Crash, the Oil-Price Shock, and the unit root hypothesis. *Journal of Business and Economic Statistics*, 10(3), 251–270.

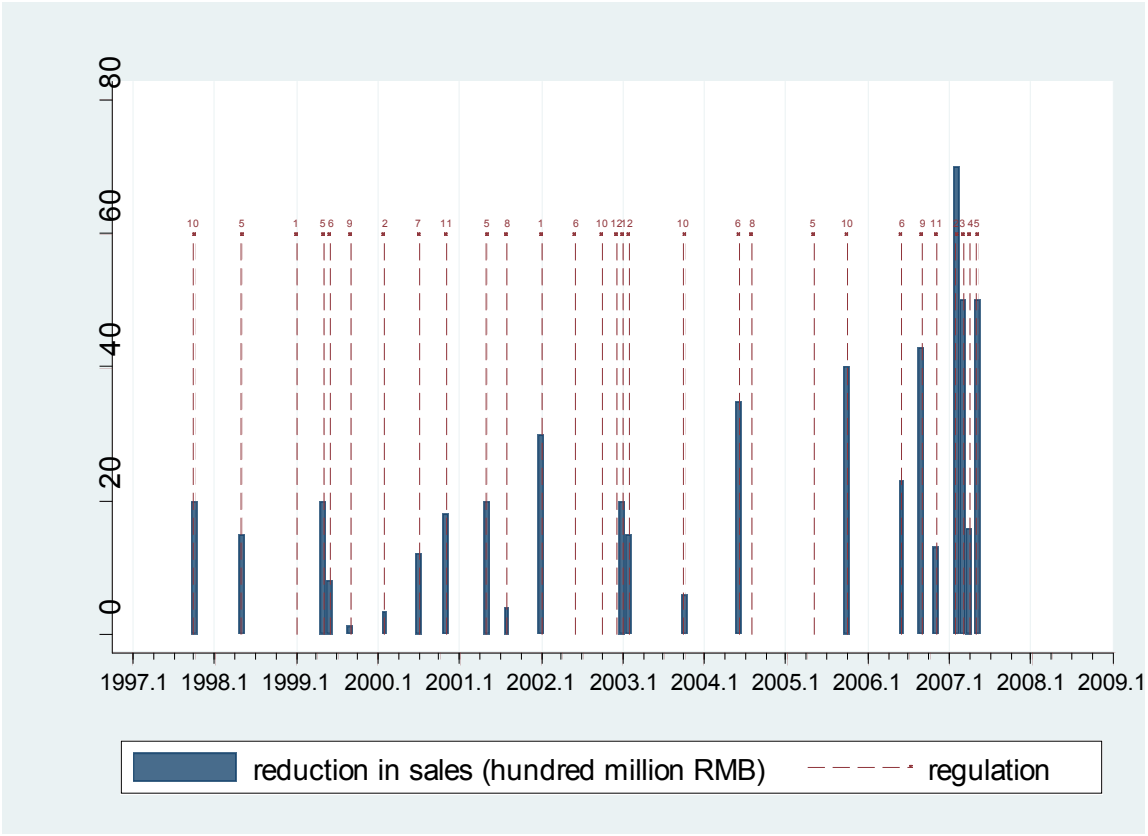
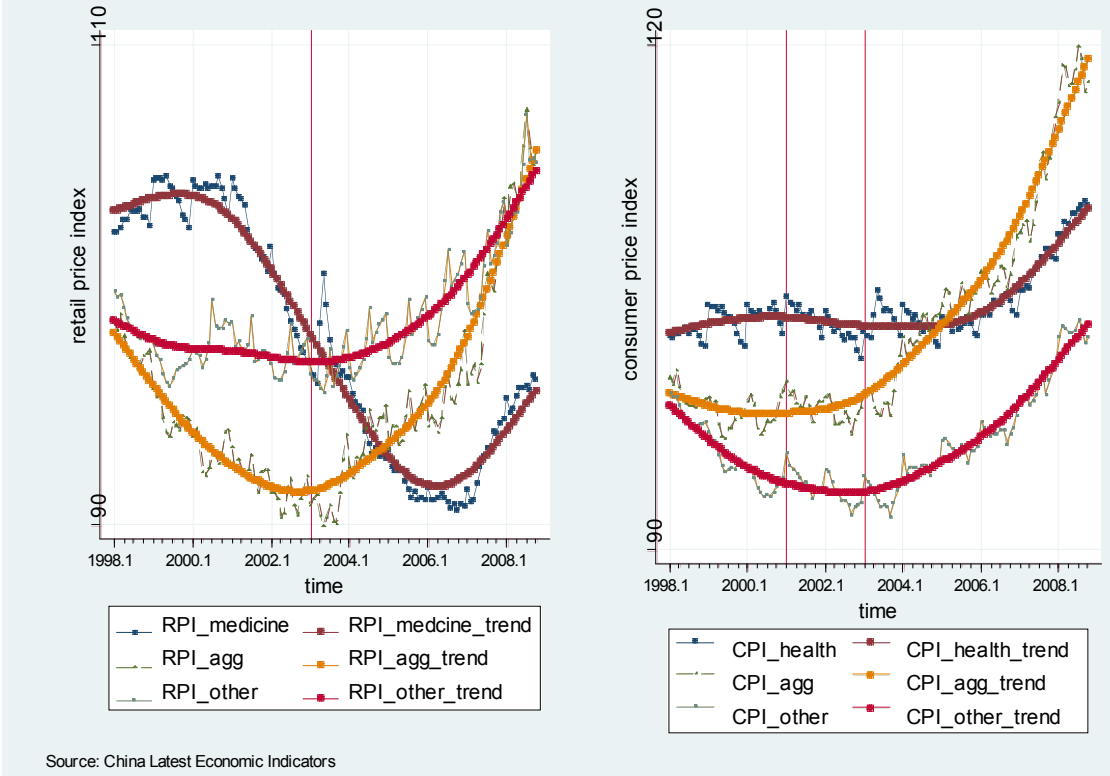


Figure 1 Timing of regulations and the reduction in sales due to the regulations



Source: China Latest Economic Indicators

Figure 2 Price indexes

Table 1 Pharmaceutical price regulations between 1997 and 2008

No.	Announce time	Effective time	Details of regulations	Price-cut ratio and sales reductions	
				Ratio: %	Sales reduction: 100 million RMB
1	1997.10.6	1997.10.10	Downward adjustments for 15 antibiotics and 32 biological medicines	15	20
2	1998.4.18	1998.5.5	Downward adjustments for 38 drugs	10	15
	1998.5.21	1998.5.21	Set ceiling prices for 4 drugs		No information
3	1998.12.11	1998.12.30	Downward adjustment for penicillin sodium		No information
4	1999.4.14	1999.4.25	Change prices for 45 drugs and reduce prices for 21 drugs	20	20
5	1999.6.3	1999.6.20	Reduce prices for 11 imported medicines	5	8
6	1999.8.10	1999.9.1	Reduce prices for 2 biochemical drugs	15	1.2
7	2000.1.5	2000.2.10	Downward adjustments for 12 biological drugs	10	3.4
8	2000.6.26	2000.7.10	Reference price adjustments for 9 drugs	15	12
9	2000.10.26	2000.11.5	Reduce prices for 21 anti-infectious medicines	20	18
10	2000.11.21	2000.11.21	Adjustments for Type B medicines		No information
11	2001.4.19	2001.5.20	Adjustments for 69 antibiotic chemical drugs	20	20
12	2001.7.3	2001.7.23	Adjustments for 49 Chinese medicines	15	4
13	2001.12.12	2001.12.28	Adjustments for 383 drugs for antitumor and circulatory system	20	30
14	2001.12.15	2002.1.5	Adjustments for 30 antibiotics and 4 complementary dosage forms of antibiotics		No information
15	2002.5.24	2002.6.15	Adjustments for 262 supplementary dosage forms of drugs		No information
16	2002.9.24	2002.10.20	Adjustments for 4 anesthesia and Type I spirit drugs		No information
17	2002.12.10	2002.12.20	Reduce prices for 24 drugs		No information
18	2002.12.20	2003.1.15, 2003.1.30	Set ceiling prices for 92 Type A and 107 Type B Western drugs, effective on January 15 and January 30, respectively	15	20
19	2003.1.21	2003.2.18	Adjustments for 267 Chinese medicines	14	15
20	2003.9.19	2003.10.15	Adjustments for 107 Chinese medicines	14	6
21	2004.5.31	2004.6.7	Reduce prices for 24 anti-infectious and antibiotics drugs	30	35
22	2004.7.15	2004.7.28	Change prices for 18 drugs		No information
23	2005.4.15	2005.4.25	Adjustments for pre-tax manufacturer prices for several planned immunization medicines		No information
24	2005.9.18	2005.10.10	Reduce prices for 22 drugs	40	40
25	2006.5.18	2006.6.12	Set ceiling prices for 67 antitumor drugs	23	23
26	2006.8.3	2006.8.28	Set ceiling prices for 99 antimicrobic drugs	30	43
27	2006.10.30	2006.11.20	Set ceiling prices for 32 Chinese medicines for treating tumors	14.5	13
28	2006.12.30	2007.1.26	Set ceiling prices for 354 drugs	20	70
29	2007.2.12	2007.3.15	Set ceiling prices for 278 Chinese medicines	15	50
30	2007.3.23	2007.4.16	Set ceiling prices for 188 Chinese medicines	16	16
31	2007.4.5	2007.5.15	Set ceiling prices for 260 Western medicines	19	50

Table 2 Definitions for price indexes

	Consumer Price Index for health care and personal articles (CPI_health)[a]			Retail Price Index for medicines and health care articles (RPI_medicine)[a]	
Name	Consumer price index for health care	Consumer price index for health care and individual articles	Consumer price index for health care and individual articles	Retail price index for medicines	Retail price index for medicines and health care articles
Time	Before December 2000	January 2001–December 2002	After January 2001	Before December 2002	After January 2003
By category	Health care (CPI_medicine) • Medical instruments, health care appliances, and articles • Traditional Chinese medicines • Western medicines	Health care (CPI_medicine) • Medical instruments and articles[b] • Health care appliances and articles[b] • Traditional Chinese medicines • Western medicines • Health care services Personal articles and services • Cosmetics • Hygiene articles • Personal ornaments • Personal services	Health care (CPI_medicine) • Medical instruments and articles[b] • Health care appliances and articles[b] • Traditional Chinese medicines • Western medicines • Health care services Personal articles and services • Cosmetics • Cleansing articles • Personal ornaments • Personal services	• Health care instruments • Traditional Chinese medicines • Western medicines	• Medical instruments and health care appliances • Traditional Chinese medicines • Western medicines

Source: China Statistical Yearbooks over years.

a. For the CPI, each subcategory has 1–25 representative products. CPI information is usually collected two or three times each month. For products whose prices are quite sensitive and are used frequently by consumers, their prices are collected once every five days. The category of the current CPI started in January 2001. The representative goods in each category and weights for each category are adjusted once every five years, although there are minor changes each year. The RPI has a similar adjustment procedure. The new system started in January 2003, so the base for the new system is 2002. Later on, the representative goods and weights of RPI are adjusted in the years ending in 0 or 5, although there can be minor changes each year.

b. Medical instruments and articles include household expenditures on medical examinations in hospitals. Health care appliances and articles include household expenditures on health supplements, appliances, or articles such as blood-pressure meters, thermometers, injector syringes, bandages, absorbent cotton, weighting scales, and health classes.

Table 3 Effects of regulation on RPI_medicine and CPI_health

Specifications	Baseline model: Control for nonlinear trend		Baseline model: Control for nonlinear trend		HP fluctuations		HP fluctuations	
Dependent variables	RPI_ medicine	CPI_ health	RPI_ medicine	CPI_ health	RPI_ medicine	CPI_ health	RPI_ medicine	CPI_ health
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Having regulations in the current month	-0.457***	-0.199**	-0.428***	-0.234***	-0.423***	-0.167*	-0.370***	-0.198**
	(0.141)	(0.093)	(0.102)	(0.072)	(0.140)	(0.089)	(0.118)	(0.079)
Having regulations in the last month	-0.453***	-0.269***	-0.397***	-0.305***	-0.332**	-0.183**	-0.341***	-0.249**
	(0.140)	(0.093)	(0.110)	(0.095)	(0.129)	(0.083)	(0.125)	(0.097)
Having regulations in the month before last	-0.282**	-0.216**	-0.294***	-0.277***	-0.228*	-0.169*	-0.221*	-0.215**
	(0.120)	(0.089)	(0.096)	(0.097)	(0.130)	(0.087)	(0.123)	(0.098)
Having regulations three months ago	-0.265**	-0.232***	-0.153	-0.268***	-0.174	-0.144**	-0.109	-0.166
	(0.123)	(0.064)	(0.108)	(0.085)	(0.135)	(0.071)	(0.133)	(0.100)
Having regulations four months ago	-0.204	-0.173**	-0.044	-0.157*	-0.090	-0.101	0.023	-0.092
	(0.123)	(0.077)	(0.117)	(0.083)	(0.141)	(0.086)	(0.165)	(0.113)
Having regulations five months ago	-0.064	-0.107	0.115	-0.050	0.065	-0.043	0.142	-0.031
	(0.109)	(0.083)	(0.110)	(0.087)	(0.121)	(0.084)	(0.141)	(0.102)
Arithmetic mean of price indexes for other goods	0.015	0.195	0.340***	0.366***	0.085	0.139	0.294*	0.211
	(0.134)	(0.132)	(0.119)	(0.097)	(0.186)	(0.146)	(0.152)	(0.143)
Log (GDP)			10.243**	-1.891			17.28***	3.401
			(4.045)	(3.180)			(4.626)	(3.579)
CCI			0.003	-0.002			-0.058	-0.020
			(0.061)	(0.043)			(0.091)	(0.061)
ADF test	-4.70	-4.52	-4.66	-4.81	-3.61	-3.97	-4.57	-4.38
Pperron test	-4.81	-4.73	-5.30	-5.14	-3.80	-4.32	-4.35	-4.35
Observations	130	130	118	118	130	130	118	118

Notes: Newey-West standard deviations are in parentheses. *, **, and *** are significant at 10%, 5%, and 1%, respectively. The price indexes in the same month in 1997 are normalized to be 100. The first four columns use the Baseline model, namely by directly allowing for different slopes and intercepts for different time intervals. The break points for the intervals are January 2001 and January 2006. The last four columns use HP filtering (λ =14400) to filter the trend component of the macro variables, and use the cyclical component in the regression. All regressions include variables controlling for changes in price index definition (one dummy for "time before January 2003" for RPI_medicine, and two dummies for "time before January 2001" and "time before January 2003" for CPI_health, respectively), year, month dummies, SARS (a dummy for "months for the last three quarters of 2003") and SARS2 (a dummy for "April, May, and June 2003").

Table 4 Effects of regulation on CPI_health subcategories (base year Is 2000): the baseline model

Dependent variables	CPI of personal articles	CPI_health	CPI_medicine	RPI_medicine	CPI_medicine subcategories				
					Chinese medicine	Western medicine	Health care service	Medical instruments	Health care appliance
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Having regulations in the current month	0.054	-0.204**	-0.276**	-0.511***	-1.217***	-0.132*	0.006	-0.499	0.023
	(0.089)	(0.086)	(0.117)	(0.099)	(0.331)	(0.069)	(0.255)	(0.430)	(0.094)
Having regulations in the last month	0.010	-0.294**	-0.428**	-0.524***	-1.498***	-0.214*	-0.310	-0.786	-0.069
	(0.107)	(0.126)	(0.175)	(0.130)	(0.564)	(0.108)	(0.324)	(0.521)	(0.094)
Having regulations in the month before last	-0.067	-0.265**	-0.333*	-0.372**	-0.835	-0.203**	-0.418*	-0.608	0.030
	(0.091)	(0.119)	(0.182)	(0.149)	(0.527)	(0.080)	(0.241)	(0.399)	(0.082)
Having regulations three months ago	-0.161	-0.187**	-0.136	-0.098	-0.147	-0.130	-0.173	-0.379	-0.061
	(0.183)	(0.078)	(0.147)	(0.132)	(0.506)	(0.080)	(0.301)	(0.281)	(0.078)
Having regulations four months ago	-0.250	-0.087	0.070	0.004	0.253	-0.016	0.161	-0.120	-0.046
	(0.264)	(0.063)	(0.128)	(0.123)	(0.438)	(0.128)	(0.411)	(0.216)	(0.108)
Having regulations five months ago	0.836***	0.427***	0.354**	0.319**	0.745**	0.442***	-0.996***	0.686*	0.565***
	(0.213)	(0.104)	(0.145)	(0.120)	(0.369)	(0.069)	(0.249)	(0.366)	(0.069)
ADF test	-3.22	-4.75	-4.46	-3.56	-3.90	-3.70	-4.05	-3.71	-4.10
Pperron test	-3.09	-5.35	-4.69	-4.24	-4.43	-3.46	-5.22	-3.17	-4.87
Observations	94	94	94	94	94	94	94	94	94

Notes: Newey-West standard deviations are in parentheses. *, **, and *** are significant at 10%, 5%, and 1% respectively. The trends are allowed to change in January 2001 and January 2006. All regressions include variables controlling for the arithmetic mean of price indexes for goods other than medicines or health care, changes in price index definition (one dummy for "time before January 2003" for RPI_medicine, and two dummies for "time before January 2001" and "time before January 2003" for CPI_health, respectively), year, month dummies, SARS, and SARS2.

Table 5 Effects of the intensity and coverage of regulations on price indexes: the baseline model

Dependent variable	Price indexes 1998–2008 (base year: 1997)				Price indexes 2001–2008 (base year: 2000)		
	RPI_medicine (1)	CPI_health (2)	RPI_medicine (3)	CPI_health (4)	RPI_medicine (5)	CPI_health (6)	CPI_medicine (7)
Sales reduction in the current month	-0.022***	-0.013***	-0.016***	-0.008**	-0.011**	-0.005*	-0.006
	(0.005)	(0.004)	(0.005)	(0.003)	(0.005)	(0.003)	(0.004)
Sales reduction in the last month	-0.009	-0.006	-0.010***	-0.005*	-0.010***	-0.004	-0.008**
	(0.008)	(0.005)	(0.003)	(0.002)	(0.004)	(0.002)	(0.003)
Sales reduction in the month before last	-0.006	-0.009**	-0.002	-0.002	-0.004	-0.001	-0.001
	(0.008)	(0.004)	(0.003)	(0.003)	(0.004)	(0.002)	(0.003)
Sales reduction three months ago	0.003	-0.004	0.002	-0.003	0.005	-0.002	0.003
	(0.009)	(0.006)	(0.004)	(0.002)	(0.004)	(0.002)	(0.003)
Sales reduction four months ago	-0.004	-0.009	-0.006	-0.007**	0.003	-0.003	0.004
	(0.008)	(0.007)	(0.004)	(0.003)	(0.004)	(0.002)	(0.003)
Ratio of price cut in the current month	0.011	0.011					
	(0.011)	(0.008)					
Ratio of price cut in the last month	-0.000	0.006					
	(0.017)	(0.010)					
Ratio of price cut in the month before last	0.005	0.014					
	(0.021)	(0.013)					
Ratio of price cut three months ago	-0.000	0.004					
	(0.018)	(0.009)					
Ratio of price cut four months ago	-0.004	0.003					
	(0.015)	(0.010)					
ADF test	-4.42	-4.31	-4.45	-4.29	-3.10	-3.63	-3.77
Pperron test	-4.44	-4.68	-4.43	-4.68	-3.18	-4.00	-3.56
Observations	97	97	97	97	66	66	66

Notes: Newey-West standard deviations are in parentheses. *, **, and *** are significant at 10%, 5%, and 1% respectively. The trends are allowed to change in January 2001 and January 2006. All regressions include variables controlling for the arithmetic mean of price indexes for goods other than medicines or health care, changes in price index definition (one dummy for "time before January 2003" for RPI_medicine, and two dummies for "time before January 2001" and "time before January 2003" for CPI_health, respectively), year, month dummies, SARS, and SARS2.

Table 6 Effects of regulation on price indexes: urban vs. rural

Dependent variables	RPI_medicine			CPI_health		
Specifications	Baseline model	HP fluctuations	Baseline model: Chow test	Baseline model	HP fluctuations	Baseline model: Chow test
	(1)	(2)	(3)	(4)	(5)	(6)
Rural						
Having regulations in the current month	-0.43***	-0.45**	-0.43***	-0.19*	-0.12	-0.19**
	(0.16)	(0.18)	(0.16)	(0.10)	(0.10)	(0.10)
Having regulations in the last month	-0.39**	-0.34*	-0.39**	-0.29***	-0.16	-0.29***
	(0.16)	(0.18)	(0.16)	(0.11)	(0.10)	(0.11)
Having regulations in the month before last	-0.22	-0.17	-0.22	-0.24**	-0.14	-0.24**
	(0.13)	(0.16)	(0.13)	(0.09)	(0.10)	(0.09)
Having regulations three months ago	-0.13	-0.07	-0.13	-0.20***	-0.09	-0.20***
	(0.13)	(0.16)	(0.13)	(0.07)	(0.07)	(0.07)
Having regulations four months ago	-0.07	-0.01	-0.07	-0.11	-0.02	-0.11
	(0.13)	(0.17)	(0.13)	(0.07)	(0.08)	(0.07)
ADF test	-4.95	-4.07		-4.26	-4.05	
Pperron test	-5.25	-4.29		-4.51	-4.77	
Observations	130	130		130	130	
Urban			Urban ×			Urban ×
Having regulations in the current month	-0.48***	-0.38***	-0.06	-0.24**	-0.19**	-0.05
	(0.14)	(0.13)	(0.21)	(0.10)	(0.08)	(0.14)
Having regulations in the last month	-0.48***	-0.32**	-0.09	-0.26**	-0.18*	0.03
	(0.16)	(0.13)	(0.23)	(0.11)	(0.09)	(0.15)
Having regulations in the month before last	-0.32**	-0.27**	-0.10	-0.17*	-0.15	0.07
	(0.13)	(0.12)	(0.18)	(0.10)	(0.09)	(0.14)
Having regulations three months ago	-0.32**	-0.20	-0.19	-0.25***	-0.16**	-0.04
	(0.14)	(0.14)	(0.19)	(0.07)	(0.08)	(0.10)
Having regulations four months ago	-0.28**	-0.15	-0.21	-0.21**	-0.15	-0.11
	(0.14)	(0.14)	(0.19)	(0.09)	(0.09)	(0.11)
ADF test	-4.69	-3.70		-4.28	-4.03	
Pperron test	-4.50	-3.63		-4.21	-4.05	
IPS test			0.00			0.00
Hadri-LM test			0.86			0.87
Observations	130	130	260	130	130	260

Notes: Newey-West standard deviations are in parentheses. *, **, and *** are significant at 10%, 5%, and 1% respectively. The trends are allowed to change in January 2001 and January 2006. Columns 3 and 6 pool the urban and rural observations and implement the Chow test to determine whether the effect of regulations on price indexes differs between urban areas and rural areas. The coefficients in the second part are for the interaction terms between the dummy of urban observations and the corresponding regulation variables. For the IPS test and Hadri-LM tests, we report the P-values. All regressions include variables controlling for the arithmetic mean of price indexes for goods other than medicines or health care, changes in price index definition (one dummy for "time before January 2003" for RPI_medicine, and two dummies for "time before January 2001" and "time before January 2003" for CPI_health, respectively), year, month dummies, SARS, and SARS2.

Table 7 Effects of regulation on household health care expenditures: the baseline model

Dependent variables	Ratio of health care expenditure over disposable income (%)		Ratio of health care expenditure over total consumption expenditure (%)		log(health care expenditure)*100	
	Urban	Rural	Urban	Rural	Urban	Rural
	(1)	(2)	(3)	(4)	(5)	(6)
Measure 1						
Number of regulations in the current quarter	-0.030	-0.002	-0.033	-0.018	-0.711	-0.396
	(0.037)	(0.049)	(0.055)	(0.071)	(0.868)	(1.028)
Number of regulations in the last quarter	-0.032	-0.045	-0.040	-0.038	-0.457	0.112
	(0.044)	(0.047)	(0.058)	(0.084)	(0.924)	(1.412)
ADF test	-4.06	-3.30	-4.17	-3.17	-4.27	-3.46
Pperron test	-5.14	-4.54	-4.90	-4.30	-4.85	-4.48
Observations	33	38	33	38	33	38
Measure 2						
Having regulations in the current quarter	-0.058	0.043	-0.065	0.045	-1.254	0.358
	(0.040)	(0.063)	(0.057)	(0.098)	(0.896)	(1.464)
Having regulations in the last quarter	-0.091	-0.050	-0.118	-0.016	-1.678	0.774
	(0.061)	(0.058)	(0.078)	(0.102)	(1.255)	(1.688)
ADF test	-4.42	-3.23	-4.61	-3.19	-4.65	-3.57
Pperron test	-5.31	-4.29	-4.96	-4.23	-4.96	-4.55
Observations	33	38	33	38	33	38
Measure 3						
Total sales reduction in the current quarter	-0.002	0.000	-0.003*	0.001	-0.044*	0.020
	(0.001)	(0.001)	(0.001)	(0.002)	(0.022)	(0.027)
Total sales reduction in the last quarter	-0.002	-0.003**	-0.002	-0.004*	-0.025	-0.054
	(0.001)	(0.001)	(0.002)	(0.002)	(0.028)	(0.035)
ADF test	-4.39	-2.30	-2.96	-2.33	-4.53	-2.59
Pperron test	-5.08	-4.12	-5.29	-3.67	-5.31	-3.48
Observations	24	25	24	25	24	25

Notes: Newey-West standard deviations are in parentheses. *, **, and *** are significant at 10%, 5%, and 1% respectively. The trends are allowed to change in January 2004. The sample size of the third part in this table declines due to missing data for the sales reductions. All regressions include variables controlling for the natural logarithms of per capita urban or rural household disposable income, the arithmetic mean of price indexes for goods other than medicines or health care, year, quarter dummies, SARS, and SARS2.

Table 8 Effects of regulation on pharmaceutical firms: the baseline model

Dependent variables	Profit / sales revenue	Log (sales revenue)	Log (output)	Amount of loss / sales revenue	Number of firms in loss / total number of firms	Adminis trative cost / sales revenue	Adminis trative cost / total cost	(Admini strative + sales) cost / sale revenue	(Admini strative + sales) cost / total cost
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Having regulations in the current month	-0.35	1.33	4.68	0.12	0.14	0.43*	0.47	0.11	0.54
	(0.24)	(1.30)	(3.44)	(0.09)	(0.11)	(0.24)	(0.33)	(0.40)	(0.42)
Having regulations in the last month	-0.10	-1.14	-1.58	0.31***	0.29*	0.18	0.01	-0.25	-0.46
	(0.27)	(1.49)	(4.86)	(0.11)	(0.16)	(0.30)	(0.25)	(0.41)	(0.43)
Having regulations in the month before last	-0.54	0.16	-1.10	0.32**	0.43***	0.05	-0.20	0.27	-0.36
	(0.35)	(1.88)	(4.88)	(0.13)	(0.13)	(0.35)	(0.21)	(0.50)	(0.44)
Having regulations three months ago	0.16	0.54	4.93	0.16	0.01	0.35*	-0.23	0.68	0.30
	(0.28)	(1.54)	(4.97)	(0.12)	(0.13)	(0.19)	(0.22)	(0.45)	(0.43)
Having regulations four months ago	-0.33	0.51	-2.77	0.25*	0.32**	-0.02	0.46	-0.40	0.21
	(0.29)	(1.36)	(4.43)	(0.13)	(0.13)	(0.21)	(0.40)	(0.39)	(0.50)
IPS test	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hadri-LM test	0.58	0.09	0.11	0.87	0.81	0.02	0.37	0.31	0.20
Observations	445	446	434	441	434	446	446	446	446

Notes: Newey-West standard deviations are in parentheses. *, **, and *** are significant at 10%, 5%, and 1% respectively. Based on the scatter plots, the trends are allowed to change in January 2003 for profit ratio over sales revenue and in January 2002 for variables about the cost structures. All other dependent variables do not show significant structural changes in the trends. For the IPS test and Hadri-LM tests, we report the P-values. All regressions include variables controlling for the natural logarithms of GDP, the arithmetic mean of price indexes for goods other than medicines or health care, year, month dummies, SARS, and SARS2.

Table 9 Effects of regulation on medicine imports: the baseline model

Dependent variables	Value of imported pharmaceuticals products (SITC)	Value of imported pharmaceuticals products (HS)	Average price of imported pharmaceuticals products (SITC)	Quantity of imported pharmaceuticals products (SITC)	Value of exported pharmaceuticals products (SITC)	Average price of exported pharmaceuticals products (SITC)	Value of imported medical instruments (SITC)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Having regulations in the current month	7.01*	4.96	5.62*	-0.65	-2.17	-1.89	0.22
	(4.06)	(3.85)	(3.38)	(3.57)	(1.71)	(1.72)	(3.02)
Having regulations in the last month	1.66	0.64	-2.75	3.39	-1.51	-1.81	1.56
	(3.55)	(3.54)	(2.76)	(3.55)	(1.80)	(1.85)	(3.07)
Having regulations in the month before last	-3.41	-4.34	-1.52	-2.82	-1.48	-0.30	-0.53
	(2.87)	(3.04)	(3.37)	(3.24)	(1.51)	(1.29)	(3.10)
Having regulations three months ago	4.83	3.04	5.01	-1.97	-0.28	1.09	-2.06
	(3.08)	(3.20)	(3.42)	(4.55)	(1.80)	(1.38)	(3.45)
Having regulations four months ago	-1.42	-0.42	-0.91	0.49	-3.62*	1.40	-2.37
	(4.53)	(4.16)	(3.84)	(3.04)	(1.94)	(1.84)	(3.45)
ADF test	-3.17	-3.21	-4.52	-5.19	-4.55	-4.91	-6.47
Pperron test	-6.11	-6.11	-9.05	-9.49	-7.92	-8.20	-9.26
Observations	138	138	138	138	138	138	138

Notes: Newey-West standard deviations are in parentheses. *, **, and *** are significant at 10%, 5%, and 1% respectively. Based on the scatter plots, the trends are allowed to change in January 2002. All other dependent variables do not show significant structural changes in the trends. All regressions include variables controlling for the natural logarithms of imports (Columns 1–4) or exports (Column 5 and 6) of goods in the same category other than pharmaceutical products, the arithmetic mean of price indexes for goods other than medicines or health care, year, month dummies, SARS, and SARS2.

Table 10 Consumer perceptions on regulations, pharmaceutical prices, and medical expenditures

What is the main reason why medicines are so expensive?

Observations	Hospitals' incentive to maximize profit	Drug stores' incentive to maximize profit	Too many middlemen in the distribution system	Too much advertisement and/or marketing expense	Patent medicines are too expensive	There is a monopoly in the pharmaceutical industry
4,506	44.2%	5.1%	27.6%	17.1%	1.2%	4.9%

What is your main determinant when choosing from various medicines with similar therapies in the pharmacy?

Observations	Price	Brand (pharmaceutical firm)	Reputation of the medicine	Introductions of the medicines	Experience of using the medicines	Suggestions by physicians or pharmacists	Arbitrary
4,520	14.1%	8.9%	13.1%	14.6%	27.5%	21.1%	0.8%

What is the most expensive component of health care expenditure?

Observations	Expenditure on common medicines	Expenditure on innovated and/or special medicines	Expenditure on doctors' services and/or surgery	Expenditure on medical examinations	Expenditure on inpatient services	Expenditure on nondurable medical materials
4,514	5.9%	29.3%	24.1%	38.1%	0.8%	1.8%

What is your first impression of the term "innovative medicines"?

Observations	Higher price	New therapy	Imported medicines	Unsafe
4,517	54.9%	30.8%	5.0%	9.3%

Compared with health expenditures in the last year, how have health expenditures changed this year?

Observations	Declined substantially	Declined moderately	No change	Increased somewhat	Increased substantially but are still affordable	Increased substantially and are hardly affordable
4,520	1.2%	13.4%	38.8%	27.4%	7.0%	12.0%