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The Incentive to Declare Taxes and Tax Revenue: The Lottery Receipt Experiment in China[1]

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Abstract

Indirect tax such as sales tax collection is difficult as the government has difficulty monitoring the actual economic dealings. To bring out private information on transaction only known to a firm and a consumer, China's government has set up a lottery receipt system which has been tried out in many areas. This paper empirically examines the validity of this new system. Estimation is performed based on panel data for different periods during 1998–2003 from a total of 37 districts in Beijing and Tianjin. It is found that the lottery receipt experiment (LRE) has significantly raised the sales tax and the growth of sales tax and total tax revenues.

1. Introduction

Due to tax evasion,[2] it is difficult for China's government to capture the real economic activity; thus part of the economy does not reach into the national accountings but is driven underground. Fisman and Wei (2004) find that there is serious tariff evasion in mainland China by matching Hong Kong's reported exports to mainland China at the product level with mainland China's reported imports from Hong Kong. Bajada and Schneider (2005) find that the size of China's underground economy during 1991–95 and 2000–01 averaged 10.2% and 13.4% of the official GDP, respectively. Based on the report of the first census "China Economic Census 2004," the National Statistical Bureau of China adjusted national accounting in 2005. For example, it is reported that both GDP and the service industry in 2004 were undervalued to the tune of 14.4% and 13.3% of GDP, respectively.[3] Furthermore, the degree of economic inequality in China has been growing to a high level.[4]

Consequently, to sustain economic growth and stability, the implementation of an efficient and fair tax collection system is necessary to solve China's underground economy problems and the issue of rising economic inequality.[5] However, like the other countries in the world, China's government suffers the issue of tax evasion

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because of the asymmetry of information. For example, to collect the sales tax (very close to consumption tax, for example, about 5% of total sales),[6] the government needs to obtain financial records of transactions between a firm and a consumer, but the tax payers have an incentive to underreport the due tax amounts because it is very costly for the government to monitor each transaction between a firm and a consumer.

Up to date, the researches and policies on tax evasion in the current world have been focused on the effects of governmental monitoring, punishment, and consumers' attributes on the tax evaders.[7] By contrast, China has tried a new taxation system in many areas since the 1990s, to give the taxpayers an incentive to voluntarily declare the tax base by not inflicting punishment but giving a prize (public lottery) simultaneously. The government first issued a guideline requiring "an official receipt printed with a public lottery number" (*you jiang fa piao* in Chinese; hereafter we call this special official receipt "lottery receipt") as a means of controlling tax evasion in 1989. We here call this new system "lottery receipt system," which will be explained in detail in section 2. There still have been few theoretical and empirical studies on this new system.

Using a subsidy (e.g. issuing a lottery receipt), Wan (2009a) theoretically shows that the government can prevent indirect tax evasion caused by conspiracies between consumers and firms, then Pareto improve the economy, and collect tax effectively under some economic conditions. Wan (2009b) empirically finds that the lottery receipt system has significantly promoted Chinese consumers to declare tax based on individual data of the "China Household Survey on Consumer Preferences and Satisfaction," conducted by Osaka University in 2006 in six huge cities, i.e. Shanghai, Beijing, Chengdu, Guangzhou, Shenyang, and Wuhan.[8] However, there still has not been an empirical study on this system based on macro datasets.

Here this paper empirically examines the effect of this system on tax collection, using the "natural experiment" method based on macro panel data consisting of experimental and nonexperimental areas in Beijing and Tianjin. We find that the lottery receipt experiment (LRE, hereafter) has caused not only sales tax revenues but also the growth of sales tax and total tax revenues to increase significantly.

Section 2 contains a detailed description of LRE in China. Section 3 describes the data, the econometric method, and the estimation results. Finally, section 4 discusses the related policy implications and concludes.

2. LRE as an Innovation in China

For many years mainland China has been wrestling with the issue how to capture a fair tax base. The government first issued a guideline on lottery receipts in 1989 as a means of tax collection. According to the "China Taxation Act," a receipt is cleaved to be a certificate of the existence of monetary transaction; and hence is the primary proof of the financial accounting and tax audit, and is managed and printed, issued, and stored by the taxation bureau. The government incorporates a lottery ticket into an official receipt; hence the lottery receipt is not only an official receipt but simultaneously is also a public lottery ticket (information on the transaction and lottery number are printed on the lottery receipt).[9]

The lottery receipt system appeared and was used by Taiwan in the 1950s to improve tax collection efficiency; it is still operative. The Republic of Korea also "imported" this system from Taiwan in the 1990s, and the new revised system seems to work well. The

lottery receipt system has been revised to be a so-called "Korea Credit Card Tax Deduction System."[10] The Philippines also introduced the lottery receipt system in 2006.[11]

Mainland China's central government mentioned first on 4 March 1989 that LRE would be held in some areas so as to strengthen tax collection.[12] Then the central government spent 10 years on discussion and preparation prior to the launch of the experiment. On 1 January 1998, the new receipt system came into effect in Haikou City in Hainan Province, which is one of the most open cities in China. The central government evaluated the system's performance and has since increased the trial area incrementally across the nation. According to the research by the author of this paper in May 2003, via Google.com, by the end of 2002 there were over 80 big-city-level local tax bureaus countrywide (out of approximately 662) where the experiment was under way. In other words, 12% of local tax bureaus were conducting LRE (also see Table A1 in the Appendix).[13]

Accompanying LRE, the China Taxation Act was revised, and since 1 May 2001 the new China Taxation Act has been enacted. The detailed enforcement rules for the new Act came into effect on 15 October 2002. A new 23rd article has since been added to the new Act, which provides that "the equipment (issuing the lottery receipt) which prevents tax evasion should be actively installed." Specifically, this "equipment which prevents tax evasion" is a patented machine that issues an official receipt printed with a public lottery number.[14]

The experiments were conducted in depth in three of China's largest cities: Beijing, Shanghai, and Tianjin. In Beijing, one district (out of 18) has been conducting the experiment since 1 January 2001, seven additional districts since 1 August 2002, and the remaining 10 districts have been issuing lottery receipts since 1 October 2002. At first, mainly service industries (such as food service), issued lottery receipts. In Shanghai LRE began on 1 October 2002; however, since 1 January 2003 it has grown to include other service industries such as beauty salons and real estate agencies. In Tianjin, Tanggu (one district of Tianjin) began the experiment on 1 January 2003, and the other districts have started since January 2004. Today, the scope of areas conducting LRE has expanded to many.

As shown by Wan (2006, 2009a,b), LRE can work as an incentive mechanism that can mitigate the information asymmetry between the government and the taxpayer. LRE can also be considered as an institutional innovation in China. In the next section, we will use a macro dataset in Beijing and Tianjin, and the timing of LRE to empirically test the effect of LRE on tax revenues (implicitly on tax evasion).

3. Empirical Examination

Probability of Winning a Prize, Amount of Prize

To announce the amount of the prize beforehand can be considered a government strategy. For example, according to the pre-draw prize announcement by the Beijing Local Tax Bureau on 17 July 2002,[15] the total prize money amounted to three million yuan in August and September, and 10 million yuan between August and December, 2002. However, *ex post facto*, the total prize money paid out to the 67,129 winners in the whole city during 2002 was 1.67 million yuan. The total actual prize was therefore only 16.7% of the announced prize.[16] Moreover, the pre-drawing prize announcement of the

probability of winning the prize (namely, the ratio of the prize to the tax revenue) may be a government strategy.

According to a China Taxation Bureau report on 30 July 2002,[17] the total amount of prizes paid out in all China's experimental areas was 30 million yuan, and the additional increase in tax revenues brought about by the lottery receipts was 900 million yuan between 1 January and 30 June 2002. The ratio of the prize to tax revenues (which can be seen as a kind of input/output ratio) was about 1 : 30 (about 3%). In the experiment in the Huairou district of Beijing in 2001, 0.14 million yuan was paid out in prizes and the tax revenue of six million yuan was increased owing to providing lottery receipts. The ratio of prize to tax revenue was about 1 : 40. Many Chinese mass media outlets announce information regarding the prizes. We cannot obtain detailed information on prizes at the provincial or state level for the entire country, thus we cannot perform an econometric analysis at the provincial level.

There are 18 districts in Beijing: Huairou, Chaoyang, Shunyi, Fengtai, Fangshan, Pinggu, Shijingshan, and Miyun have been issuing lottery receipts since 1 August 2002. The other 10 districts began issuing receipts on 1 October 2002. Therefore, the effect of the experiment on tax revenues can be estimated by district-level panel data (18 districts, six years, before and after the experiments).

One district of Tianjin, Tanggu, has issued the lottery receipt since 1 January 2003; the other districts of Tianjin have issued them only since 2004. Tianjin is adjacent to Beijing both geographically and culturally. Both cities are under the direct control of the central government. The populations, city scale, and income of these two cities are very similar. For example, population, GDP, per capita GDP, growth rate of per capita GDP, and total tax revenues in Beijing and Tianjin in 2002 are as follows: 14.253 million vs 9.191 million, 321,270 million yuan vs 205,120 million yuan, 22,541 yuan vs 22,380 yuan, 8.0% vs 11.0%, 53,400 million yuan vs 37,590 million yuan, respectively.[18] Therefore, we used Tianjin as a control area for a comparative analysis of before and after LRE in Beijing.

The Dataset

We obtained detailed information on the experiments (such as prize amounts and tax revenues) from the Beijing Tax Bureau, the Beijing Statistics Bureau, the Tianjin Tax Bureau, the Tianjin Statistics Bureau, and the National Statistics Bureau of China. We use the *Beijing Public Finance Yearbook* (2002–04), the *Beijing Statistics Yearbook* (1999–2004), *Tianjin Statistics Yearbook* (1999–2004), and *China Statistics Yearbook* (1991–2005). Therefore, we used the six-year (the yearly data included in the yearbook of the next year, data for 1998–2003 included in yearbook 1999–2004) district-level data (18 districts in Beijing and 21 districts in Tianjin) to empirically examine the effect of the experiments. The information on prizes reported by the mass media or estimated by the author,[19] is shown in Table A2. In Tanggu of Tianjin, the prize was 75,800 yuan in 2003.

The definitions of variables are described in Table A3. Summary statistics of the data are reported in Table 1. The main information before and after LRE is summarized by district in Table 2. These two tables provide some indications of the effects of LRE. However, we can hardly detect the obvious effect of LRE on tax revenues; thus we need a more formal econometric method to identify the impact of LRE.

Table 1. Descriptive Statistics

Variable	*Obs.*	*Mean*	*Std. dev.*	*Min.*	*Max.*
tax_revenue	222	70,325.260	97,262.180	8,227.000	560,802.000
sales_tax	222	27,715.040	43,138.830	1,617.000	245,595.000
gdp	222	1,137,669.000	1,363,700.000	109,560.000	8,928,950.000
second_sector_gdp	216	409,170.800	528,147.500	10,879.000	3,548,992.000
third_sector_gdp	215	612,834.500	939,893.900	44,177.000	6,930,939.000
population	222	53.830	32.551	5.089	178.400
cpi	222	101.505	2.884	98.504	107.349
prize	222	53,790.270	255,712.400	0.000	2,459,359.000
real_revenue	222	1,488.189	2,322.491	191.177	16,869.070
real_sales_tax	222	495.480	547.150	37.868	3,023.158
real_gdp	222	28,483.260	52,472.840	1,809.553	446,171.000
real_secondary_gdp	216	9,243.280	19,429.170	249.309	151,936.700
real_third_gdp	215	11,060.130	14,152.650	1,506.524	113,644.900
real_prize	222	0.066	0.235	0.000	1.469
experiment	222	0.153	0.361	0.000	1.000
log_revenue	222	6.797	0.903	5.253	9.733
log_sales_tax	222	5.736	0.962	3.634	8.014
log_gdp	222	9.652	0.965	7.501	13.008
log_second_gdp	216	8.418	1.179	5.519	11.931
log_third_gdp	215	8.874	0.853	7.318	11.641
after	222	0.333	0.472	0.000	1.000
LRE	222	0.153	0.361	0.000	1.000
Δ*LRE*	185	0.092	0.290	0.000	1.000
Δ*Total tax revenue*	185	198.202	489.979	–2,299.958	3,884.141
Δ*Sales tax revenue*	185	72.134	136.415	–331.952	853.491
Δ*GDP*	185	4,592.539	11,585.370	–1,569.283	100,726.200
Δ*GDP of 2nd sector*	180	1,119.880	2,943.834	–5,249.051	20,467.800
Δ*GDP of 3rd sector*	178	1,689.647	2,723.033	–561.109	20,976.300
Δ*real_prize*	185	0.067	0.215	0.000	1.232
Δlog(*Total tax revenue*)	185	0.153	0.194	–0.274	0.827
Δlog(*Sales tax revenue*)	185	0.136	0.269	–0.774	1.604
Δlog(*GDP*)	185	0.150	0.065	–0.134	0.481
Δlog(*GDP of 2nd sector*)	180	0.114	0.206	–0.692	1.276
Δlog(*GDP of 3rd sector*)	178	0.155	0.069	–0.103	0.388

Source: Author's calculations based on *Beijing Statistics Yearbook* (1999–2004), *Tianjin Statistics Yearbook* (1999–2004), and *Beijing Public Finance Statistics Yearbook* (2002–04).

Empirical Specification and Estimation Method

According to Heckman and Hotz (1989), Papke (1994), and Wooldridge (2002), we used the following empirical models to capture the effect of the experiments, and first obtained a random trend model:

$$y_{it} = c_i + \beta LRE_{it} + \gamma Z_{it} + \theta_i t + u_{it}, \quad (1)$$

where y_{it} is the level value of per capita real sales tax revenue in district i, the information on experiment is denoted by LRE_{it}, the controlled variables with level values

Table 2. The Growth Rate of Per Capita Tax Revenue in Beijing and Tianjin Before and After the Experiment

District	*Time*	*Variable*	*Obs.*	*Mean*	*Std. dev.*	*Min.*	*Max.*
Beijing (excluding Huairou)	Before 2002	Δlog(*Sales tax revenue*)	51	0.134	0.280	–0.491	0.712
		Δlog(*Total tax revenue*)	51	0.229	0.181	–0.124	0.688
	2002, 2003	Δlog(*Sales tax revenue*)	34	0.263	0.273	0.006	1.604
		Δlog(*Total tax revenue*)	34	0.170	0.190	–0.246	0.794
Tianjin (excluding Tanggu)	Before 2002	Δlog(*Sales tax revenue*)	60	0.142	0.167	–0.163	0.757
		Δlog(*Total tax revenue*)	60	0.152	0.134	–0.274	0.540
	2002, 2003	Δlog(*Sales tax revenue*)	40	0.020	0.328	–0.774	0.505
		Δlog(*Total tax revenue*)	40	0.043	0.240	–0.232	0.827

Source: Author's calculations based on the processed data.

are expressed by Z_{it}, the specific trend in the district is denoted by θ_i, time is denoted by t, the specific time-invariant factor is written by c_i, and the white noise is denoted by u_{it}. In equation (1), c_i, θ_i, and u_{it} are all unobserved. When y_{it} and Z_{it} are log values, equation (1) becomes a random growth model.

The first difference of equation (1) becomes

$$\Delta y_{it} = \beta \Delta LRE_{it} + \gamma \Delta Z_{it} + \theta_i + \Delta u_{it}. \tag{2}$$

For a consistent estimator of β, the important condition is that the LRE_{it} is exogenous. As pointed out in Heckman and Hotz (1989) and Papke (1994), if there is a problem of self-selection regarding experiment participation, it is very hard to obtain a consistent estimator of β. Here, there are three reasons to bring LRE close to being exogenous. First, there are many preparations that must be made before LRE starts: the timing of LRE is mainly determined by the degree of the preparation. Second, as is well known, China is a centralized country, where policy changes cannot occur in a state or a city unless the central government grants permission, and almost no state or city has the freedom to accept or reject central government policy. Third, because all of the samples used in the econometric analysis are areas that participated in the experiment, by using experiment information for different periods we can avoid the problem of serious self-selection, and hence tend to obtain a consistent estimator. Therefore, it can reasonably be said that to a large degree LRE_{it} is exogenous.

Because error term Δu_{it} is the first difference of u_{it}, it becomes a series correlation.[20] The fixed effect of panel estimation considering this characteristic of the error term is used to estimate equation (2). This method is the fixed effect within regression with AR(1) disturbances explained in detail in Papke (1994) and Wooldridge (2002).

Construction of the Variables

The methods constructing the variables for estimation are summarized in Table A3. The one difference of y_{it} is denoted by Δy_{it}, where y_{it} is the level or log value of per capita real sales tax revenue in district i and is the dependent variable. The dummy variable ΔLRE_{it} is for an experiment district (1 for an experiment district, 0 for others)

multiplied by the dummy variable for the experiment time (1 for experiment time, 0 for other time).[21]

To obtain a difference-in-difference estimator for β, Huairou in Beijing and Tanggu in Tianjin are dropped from the sample, because they have different timing for LRE.[22] Thus, we finally use a dataset of 37 districts for six years.

Estimated Results

Table 3 provides the results of panel estimation based on information for 17 districts in Beijing (excluding Huairou) and 20 districts in Tianjin (excluding Tanggu). The dependent variables are the first differences of the level and the logarithm of sales tax and total tax revenues, and the independent variables are the first differences of LRE, GDP, GDP of the 2nd sector and GDP of the 3rd sector; thus the value of the estimated ΔLRE coefficient serves as the difference in the level between the experiment and nonexperiment areas. For sales tax revenue, the ΔLRE coefficients are significant, ranging from 84.355 to 105.676, and the elasticities of experiment from 0.171 to 0.213. In the case of total tax revenue, the effect of the experiment is not significant, although the coefficient is positive. These results imply that the experiment has significantly raised sales tax revenue by over 17.1% but has no significant effect on total tax revenue.[23]

Table 4 shows the results of panel estimation based on the random growth model. Variables here are made from the first differences of logarithm of those in Table 3, and from the first differences of LRE; thus the coefficient of ΔLRE serves as the difference in the growth rates. For sales tax revenues, there was about a significant 21.5%–24.2% increase in the growth rates of the experiment areas. In the case of total tax revenue, there was a 10.4%–11.6% increase.[24]

4. Conclusions

China's government has performed LRE to give the taxpayers an incentive to voluntarily declare the tax base by not inflicting punishment but giving a prize (public lottery) simultaneously. This paper empirically examined the effect of LRE on tax revenues (implicitly on tax evasion) in China. Our empirical examination of six-year data from 37 districts in Beijing and Tianjin indicated that sales tax revenue was significantly higher (over 17.1%), and the real growth rates of sales tax and total tax revenues were significantly higher (over 21.5% and over 10.4%, respectively) in experiment areas than those in nonexperiment areas. Moreover, because the datasets used were from all of areas that participated in the experiments, and because the estimations were based on different periods of participation, self-selection problems were avoided to a large degree. Thus, our analysis is similar to a kind of quasi-natural experiment.

Through the analysis of the datasets conducted in this study, LRE can be judged as somehow successful insofar as it increased sales tax revenues and the growths of business and total tax revenues. The results of this paper suggest that LRE may also contribute the national system of accounting by reducing the underground economy from tax evasion. The results here also imply that China's government are advised to continue with LRE; other countries should also apply this system. Expectedly, it is gratifying to hear that the China central government required all taxation bureaus to use the lottery receipt system on 6 February 2009.[25] I also believe that this new taxation

Table 3. The Effect of Lottery Receipt Experiment (LRE) on Tax Revenues (random trend model, 37 districts in Beijing and Tianjin, 1998–2003)

	Dependent variable = ΔSales tax revenue						*Dependent variable = ΔTotal tax revenue*		
	Fixed effect	*Elasticity*	*Fixed effect*	*Elasticity*	*Fixed effect*	*Elasticity*	*Fixed effect*	*Fixed effect*	*Fixed effect*
ΔLRE	105.676	0.213	102.416	0.207	84.355	0.171	118.031	115.324	94.548
	(36.758)***		(36.289)***		(36.915)**		(133.737)	(134.142)	(139.782)
ΔGDP			0.004					0.006	
			(0.002)**					(0.007)	
ΔGDP of 2nd sector					0.013				0.039
					(0.006)**				(0.023)
ΔGDP of 3rd sector					0.025				–0.010
					(0.010)**				(0.041)
Constant	44.496		30.786		–2.808		178.03	148.455	140.912
	(11.970)***		(13.901)**		(19.476)		(46.812)***	(52.278)***	(72.504)
Observations	148		148		142		148	148	142
Number of groups	37		37		36		37	37	36
R^2: within	0.070		0.101		0.165		0.070	0.013	0.032
between	0.166		0.117		0.257		0.105	0.294	0.073
overall	0.098		0.121		0.194		0.010	0.044	0.037
rho_ar	–0.147		–0.164		–0.176		0.352	0.349	0.347

Notes: Standard errors are in parentheses; *, **, *** denote significant at the 10%, 5%, 1% levels, respectively.

Table 4. The Effect of Lottery Receipt Experiment (LRE) on Growth Rates of Tax Revenues (random growth model, 37 districts in Beijing and Tianjin, 1998–2003)

	Dependent variable = Δlog(*Sales tax revenue*)			*Dependent variable* = Δlog(*Total tax revenue*)		
	Fixed effect	*Fixed effect*	*Fixed effect*	*Fixed effect*	*Fixed effect*	*Fixed effect*
Δ*LRE*	0.234	0.242	0.215	0.109	0.116	0.104
	(0.083)***	(0.085)***	(0.095)**	(0.055)*	(0.056)**	(0.062)*
Δlog(*GDP*)		–0.255			–0.206	
		(0.470)			(0.312)	
Δlog(*GDP of 2nd sector*)			0.041			–0.031
			(0.151)			(0.099)
Δlog(*GDP of 3rd sector*)			0.113			0.112
			(0.514)			(0.334)
Constant	0.080	0.112	0.058	0.130	0.160	0.109
	(0.027)***	(0.070)	(0.083)	(0.018)***	(0.046)***	(0.052)**
Observations	148	148	142	148	148	142
Number of groups	37	37	36	37	37	36
R^2: within	0.067	0.076	0.061	0.034	0.038	0.035
between	0.114	0.072	0.101	0.149	0.024	0.140
overall	0.080	0.076	0.071	0.044	0.030	0.042
rho_ar	–0.068	–0.070	–0.070	0.085	0.092	0.101

Notes: Standard errors are in parentheses; *, **, *** denote significant at the 10%, 5%, 1% levels, respectively.

system will have a significant influence on tax collection policies in the future, not only in China but also in other countries of the world.

Another implication of the results of this paper concerns the ratio of prize to tax revenue. The reason why LRE's impact on total tax revenue was not significant may be the too low ratio of prize to tax revenue. The ratio of prize to tax revenue in nationwide China was about 3%, but Wan (2009a) shows that an example for the optimal ratio would be about 30% under some conditions. Thus, to raise the efficiency of LRE, it is highly recommended for the government to raise the ratio of prize to tax. Instead of a lottery prize, an alternative method, i.e. the government directly gives the consumer cash back or subsidy based on the transaction volume reported by the receipts, would be preferred.

In future research, we must clarify more theoretically and specifically consumer preference on lottery ticket purchase, and empirically apply those data to the information from the experiment and nonexperiment areas after 2004. Moreover, we must obtain nationwide information and perform detailed analyses based on individual data, including attitudes toward the lottery receipt system, the additional cost for introducing new machines of the LRE, etc. Moreover, because playing lottery is a form of gambling, and tax evasion is also a form of gambling as it is penalized in every country when detected by the government, we must consider the social cost of gambling in relation to social welfare.

Appendix

Table A1. The Areas with Lottery Receipt Experiment (LRE) in China in 2002

	Number of districts (cities)	*Number of districts (cities) with lottery receipt experiment*	*Rate of experiment (%)*
Nationwide	2858	228	8.0
Beijing	18	18	100.0
Tianjin	18	0	0.0
Hebei	172	16	9.3
Shanxi	119	0	0.0
Neimenggu	101	0	0.0
Liaoning	100	28	28.0
Jiling	60	5	8.3
Heilongjiang	130	11	8.5
Shanghai	20	20	100.0
Jiangshu	108	0	0.0
Zhejiang	88	0	0.0
Anhui	106	4	3.8
Fujian	84	13	15.5
Jiangxi	99	18	18.2
Shandong	139	25	18.0
Henan	158	7	4.4
Huben	101	13	12.9
Hunan	122	9	7.4
Guangdong	122	26	21.3
Guangxi	110	0	0.0
Hainan	20	3	15.0
Congqing	40	1	2.5
Sichuan	180	0	0.0
Guizho	86	5	5.8
Yunan	128	4	3.1
Xizhuang	73	0	0.0
Sanxi	107	0	0.0
Ganshu	86	5	5.8
Qinghai	43	0	0.0
Ningxia	24	0	0.0
Xinjiang	96	0	0.0

Notes: This table is derived from the author's data using the search engine Google.com in May 2003. These are not statistical data; some notes are needed.

Table A2. Reported and Estimated Prize by District in 2002, 2003, 2004

District	*Prize (by period) reported by media (homepage, newspaper)*	*Prize in yuan in 2002*	*Prize in yuan in 2003*
Dongcheng	1/10/2002–31/12/2002: 212,500; 11/4/2003–18/4/2003: 62,500	212,500	*850,000*
Xicheng	1/10/2002–10/12/2002: 100,000; 1/10/2002–31/1/2003: 295,000; 1/1/2003–28/2/2003: 193,600; 1/1/2003–31/12/2003: 1,237,000	*198,200*	1,237,000
Congwen	1/10/2002–31/12/2002: 88,400; 1/1/2003–31/12/2003: 586,800	88,400	586,800
Xuanwu	1/10/2002–31/12/2003: 122,650	*24,530*	*98,120*
Chaoyang	1/8/2002–29/8/2002: 47,000; 1/1/2003–31/1/2003: 157,300; 1/1/2004–10/6/2004: 1,929,010	*455,388*	*2,459,359*
Fengtai	1/1/2003–30/6/2003: 332,960; 1/1/2004–31/12/2004: 1,780,000	*86,708*	*665,920*
Shijingshan	1/1/2003–31/10/2003: 320,150; 1/1/2003–31/12/2003: 385,950	*36,548*	385,950
Haidian	1/10/2002–31/12/2002: 297,800; 1/1/2003–31/12/2003: 2,256,300; 1/1/2005–31/1/2005: 1,230,000	297,800	2,256,300
Mentougou	1/10/2002–31/12/2002: 11,700; 1/1/2003–31/5/2003: 55,000	11,700	*132,000*
Fangshan	1/8/2002–9/9/2002: 8,400; 1/1/2003–30/9/2003: 78,860; 1/8/2002–19/7/2004: 238,000	*31,795*	*139,113*
Changping	8/10/2002–31/1/2003: 89,740; 8/10/2002–30/10/2003: 300,190; 8/10/2002–3/8/2004: 1,046,870	*65,703*	*283,858*
Shunyi	1/8/2002–26/12/2002: 100,900; 1/8/2002–22/4/2003: 170,000; 1/1/2003–14/7/2003: 122,430	*104,379*	*230,345*
Tongzhou	1/10/2002–6/11/2002: 7,700; 1/10/2002–29/9/2003: 162,400	*31,792*	*162,400*
Daxing	1/10/2002–25/12/2002: 33,000; 1/10/2002–21/11/2003: 261,950	*35,357*	*229,285*
Pinggu	1/8/2002–22/10/2002: 7,000; 1/10/2002–31/1/2003: 34,800; 1/8/2002–14/11/2003: 114,700	*26,557*	*89,265*
Huairou	1/1/2001–31/12/2001: 140,000; 1/8/2002–31/8/2002: 8,000; 1/1/2004–22/7/2004: 344,270	*40,000*	*358,133*
Miyun	1/1/2004–31/5/2004: 153,000	*19,575*	*210,058*
Yanqing	1/10/2002–16/1/2003: 11,000; 1/1/2005–31/3/2005: 93,400	*9,340*	*189,394*
Reported total prize (all districts)	1/8/2002–31/12/2002: 1,669,700; 1/1/2003–31/12/2003: 1,117,000; 1/1/2004–31/12/2004: 41,769,600	1,669,700	1,117,000
Estimated total prize (all districts)		*1,776,273*	*10,563,301*

Note: The values in italics are estimated by the author with the reported data in mass media.

Table A3. Construction of the Variables

Variable	*Definition (construction of the variables)*
tax_revenue	Nominal total tax revenues by district (10,000 yuan)
sales_tax	Nominal sales tax revenues by district (10,000 yuan)
gdp	Nominal GDP by district (10,000 yuan)
second_sector_gdp	Nominal GDP of the second sector by district (10,000 yuan)
third_sector_gdp	Nominal GDP of the third sector by district (10,000 yuan)
population	Population by district (10,000 persons)
cpi	Consumer price index (1998 = 100)
prize	Prize by district (yuan, per district)
real_revenue	= *tax_revenue/population/cpi* ∗ 100 (yuan, per capita)
real_sales_tax	= *sales_tax/population/cpi* ∗ 100 (yuan, per capita)
real_gdp	= *gdp/population/cpi* ∗ 100 (yuan, per capita)
real_secondary_gdp	= *second_sector_gdp/population/cpi* ∗ 100 (yuan, per capita)
real_third_gdp	= *third_sector_gdp/population/cpi* ∗ 100 (yuan, per capita)
real_prize	= *prize/population/cpi* ∗ 100 (yuan, per capita)
experiment	1 for the experiment district, 0 for the nonexperiment district
after	1 for the experiment period, 0 for the nonexperiment period
LRE	= *experiment* ∗ *after*
Δ*LRE*	= $LRE(t) - LRE(t-1)$
Δ*Total tax revenue*	= $real\_revenue(t) - real\_revenue(t-1)$
Δ*Sales tax revenue*	= $real\_sales\_tax(t) - real\_sales\_tax(t-1)$
Δ*GDP*	= $real\_gdp(t) - real\_gdp(t-1)$
Δ*GDP of 2nd sector*	= $real\_secondary\_gdp(t) - real\_secondary\_gdp(t-1)$
Δ*GDP of 3rd sector*	= $real\_third\_gdp(t) - real\_third\_gdp(t-1)$
Δ*real_prize*	= $real\_prize(t) - real\_prize(t-1)$
log(*Total tax revenue*)	= log(*real_revenue*)
log(*Sales tax revenue*)	= log(*real_sales_tax*)
log(*GDP*)	= log(*real_gdp*)
log(*GDP of 2nd sector*)	= log(*real_secondary_gdp*)
log(*GDP of 3rd sector*)	= log(*real_third_gdp*)
Δlog(*Total tax revenue*)	= log(*Total tax revenue*)(t) – log(*Total tax revenue*)$(t-1)$
Δlog(*Sales tax revenue*)	= log(*Sales tax revenue*)(t) – log(*Sales tax revenue*)$(t-1)$
Δlog(*GDP*)	= log(*GDP*)(t) – log(*GDP*)$(t-1)$
Δlog(*GDP of 2nd sector*)	= log(*GDP of 2nd sector*)(t) – log(*GDP of 2nd sector*)$(t-1)$
Δlog(*GDP of 3rd sector*)	= log(*GDP of 3rd sector*)(t) – log(*GDP of 3rd sector*)$(t-1)$

Note: $t, t-1$, means t period and $t-1$ period, respectively.

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Notes

1. This paper is based on Chapter 8 of the author's doctoral dissertation, Osaka University, December 2004. See Wan (2004) for details.
2. It is found that there was a taxation problem before the year 2100 BC and that there was a tax evasion problem before the year 650 BC in ancient China. See Wan (2010, sec. 1) for details.
3. GDP was re-estimated based on the information including the number of nationwide employees. In 2004, GDP was estimated to 15.99 trillion yuan, but as much as 2.3 trillion yuan was undervalued, of which 2.13 trillion yuan was the service industry (yuan is the Chinese currency). One US dollar was equal to about 6.82 yuan in August 2009.
4. The Gini coefficient that measures the degree of economic inequality has shown an upward trend in China. The Gini coefficient was 0.21 in the rural sector and 0.16 in the urban sector in 1978, 0.31 in the rural sector and 0.21 in the urban sector in 1990, and 0.37 in the rural sector and 0.32 in the urban sector in 2003. The nationwide Gini coefficient was 0.39 in 1995, 0.40 in 2000, and 0.47 in 2004.
5. For an optimal taxation problem, pointed out by F. Ramsey, an efficient and fair tax collection system is also necessary. However, Fujimoto and Wan (2009) show that the Ramsey "inverse elasticity rule" does not exist in any domain using Ramsey's taxation model, and the new result implies that no tradeoff exists between efficiency and equity for good even from among more than two-good markets.
6. According to *China Statistics Yearbook 2008*, the ratio of the business tax revenue (658 trillion yuan) to the total tax revenue (4562 trillion yuan) in China in 2007 was 14.4%. Thus, the business tax revenue is an important source of governmental revenue. According to the "Provisional Measure of Sales Tax in China" (*Ying Ye Shui Zan Xing Tiao Li* in Chinese, Guo Wu Yuan Ling 136 Hao), and State Administration of Taxation of China (2005), the rate of business tax is about 5% of transaction volume. See the following web page for details: http://www.gov.cn/banshi/2005-08/19/content_24808.htm.

7. There is much literature on this approach. See Andreoni et al. (1998) for a comprehensive survey.
8. This dataset, in which there is information on the requirements (and the reasons) for official receipts before and after the lottery receipt system in China, is a pseudo panel survey for 1500 households. See Wan (2009b) for details.
9. Figure 1 of Wan (2009c) shows the framework of the delivery of lottery receipts among the government, firms, and consumers.
10. If a consumer declares the total transaction volume (or spending statement)—for example, by credit card receipts—the government will give the consumer an income tax deduction based on the transaction volume stated in the receipts. Kim (2005) mentioned this system in the "tax reform issues in Korea."
11. See page 7 of the Morning Edition of *Nihon Keizai Shimbun* on 3 June 2006.
12. See Note of Mainland China Government by State Commission for Restructuring the Economic System (1989) for details. The original sentence is written in Chinese: "The State Council's notice on the main points of economic reform presented by the State Commission for Restructuring the Economic System in 1989." In this notice, it is suggested that "to strengthen the private firms' tax collection, the lottery receipt system can be tried out in some cities."
13. By the end of 2002, only Beijing and Shanghai had been experimental areas at the provincial or state level, according to data from the China Taxation Bureau. Information regarding the experiments in other areas has not yet been reported as formal statistical data. The figures in Table A1 were obtained from the news media. Because these are not government statistics, we have to use caution when interpreting the information. This table only approximates the state of the experiments throughout the country.
14. The lottery receipt machine was invented by Haiping Dai. He applied for a patent on 28 April 1998, and the China Patent Bureau authenticated the patent on 21 February 2001. This machine can issue an official receipt with a special number that is used for a random drawing. The transaction value stated in the receipt is reported to the consumer, the firm, and the tax bureau simultaneously. The consumer can use the lottery receipt and the special number to investigate the status of the prize by telephone or via the internet.
15. See *Beijing Evening*, 17 July 2002, for details.
16. The reason may also be that the planned sale of lottery receipts was not realized.
17. See *People's Daily*, 31 July 2002, for details.
18. The data are from *Beijing Statistics Yearbook 2003* and *Tianjin Statistics Yearbook 2003*.
19. The author has used the prize reported by the mass media to estimate the prize without being reported in the period by weighted average. The detailed information is available on request.
20. We can obtain that $\mathrm{Corr}(\Delta u_{it}, \Delta u_{it-1}) = -0.5$. See page 283 of Wooldridge (2002) for details.
21. In equation (1), ΔLRE_{it} is the independent variable. The one difference of per capita real lottery prize is denoted by $\Delta Prize_{it}$; it is considered a proxy for capturing the experiment effect (ΔLRE_{it}) and is an independent variable.
22. The estimation results are almost unchanged when Huairou and Tanggu are included in the sample; these results are also available on request.
23. The author also has used the first difference of prize as a proxy for ΔLRE, but he has not obtained a significant effect from the prize. There may be two reasons. First, the amount of prize is determined by the sales simultaneously, thus it is endogenous. Second, the data on prize is not statistical data but estimated by the author, thus there would be a large measurement error on the prize data. These estimation results are also available on request.
24. I have also used the first difference of prize as a proxy for ΔLRE, but was unable to obtain a significant prize effect. The same reasons as in note 23 are relevant here. These results are also available on request.
25. See Article 15 of the *Guidelines for Nationwide Taxation in 2009* (*2009 Quan Guo Shui Shou Gong Zhuo Yao Dian* in Chinese, Guo Shui Fa 2009 No. 1), and State Administration of Taxation of China (2009) for details. We can obtain the full document of the guidelines in Chinese from the following web address: http://www.ctax.org.cn/news/csyw/t20090216_567801.shtml.