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Contents

Abstract

In the early 1990s, the People's Republic of China opened its urban water sector to nonstate capital to help meet increasing urban water demand under severe water resource constraints. By 2007, more than 30% of urban water utilities had attracted private sector participation (PSP). To understand the factors that drive PSP in urban water supply, and to answer the key policy questions whether PSP has boosted investment and improved the efficiency in water supply, we assembled and analyzed a unique dataset consisting of more than 200 urban water utilities covering 1998–2007. Our estimations indicate that, except for the utility's profitability and urban road infrastructure in the prior year, the characteristics of the utility or city were not strong drivers of PSP. One interpretation is that private investors participating in this newly opened sector were less concerned with short-term factors. For utility performance, we find that PSP has reduced employment, has lowered managerial expenses relative to sales revenues, and has increased profitability significantly, in both the economic and statistical sense. PSP has positively affected utilities in other ways, although the estimates are not statistically significant. Further analysis indicates that most of the changes occurred in utilities with private shareholders in the majority rather than the minority.

I. Introduction

Water shortages, aggravated by extensive water pollution, could seriously challenge the People's Republic of China's (PRC) sustainable growth in the next few decades. Estimates in 2007 put the country's per capita water availability at 2,156 cubic meters (m^3) per year, just a quarter of the world average. Degradation of water quality in most water bodies has lowered supply even as demand grows. Given this serious water resource constraint, urbanization in the PRC, which has been rapid in the past 30 years, is only expected to speed up in the next 10 years. By 2020, city dwellers are expected to number 900 million, up from 550 million in 2005. Ensuring an adequate urban water supply is therefore a formidable task. Water supply capacity needs to be continuously enhanced and the quality of water services must be improved, calling for significantly greater investment in the urban water sector and considerable efficiency improvement in water utilities.

As in many other countries, urban water utilities were traditionally owned and run by local governments in the PRC, with fiscal transfers the major source of investment. Utility managers are appointed by the government and report to supervising government officials. Consequently, investment in water services often lags urban development in many cities, and water utilities generally lack incentives to lower costs and improve operational efficiency. A recent report suggests that a quarter of water utilities in the PRC are unable to provide adequate water pressure to more than 40% of their service area, and leakage rates (water loss per kilometer of pipeline) are extraordinarily high (World Bank 2009).

Encouraging participation of the private sector in urban water supply to address these issues has been considered an effective solution since the early 1990s. The PRC opened its urban water sector to private investors on a pilot basis in 1992, officially allowing private entry on a nationwide basis in 2002. The reform stimulated considerable private interest and participation. According to the data assembled for this study, one third of 208 urban water utilities across the country had private shareholders by 2007. Private investors hold major ownership in two thirds of these utilities. But until now, no systematic evidence has been produced to assess the impact of this dramatic change. This study aims to fill the gap.

We assembled panel data from water utilities in nearly 200 cities in the PRC from 1998 to 2007. We first examined what factors at the utility and city levels drive private sector participation (PSP) in water supply services. This is important not only for correctly

measuring the impact of PSP, but is also of interest to the public and policy makers. The study focuses on the effects of PSP on water utility performance measured in various aspects, including inputs and outputs, financial performance, and efficiency. We use temporal and geographical variations in PSP, controlling for utility and city-lagged variables, to identify and estimate PSP effects on the performance indicators. We also explore the differing effects of PSP on utilities under a majority private shareholding (PSP-major) and a minority (PSP-minor).

There is a sizable body of empirical literature on privatization[1] in noncompetitive industries in both developed and developing economies. Most studies on water sector privatization in developing economies employ cross-country data, one issue of which is that a great deal of heterogeneity is usually unobservable to the researchers. The legal, institutional, and cultural contexts in which water utilities operate are much more distinct across countries than cities within a country. The economic and political motivations for privatization can also differ markedly from country to country. Without taking these factors into account, the estimation of the impact of PSP on water services is essentially spurious. This paper contributes to the literature by presenting evidence based on a large, longitudinal, within-country sample. The results are purged of confounding effects caused by country-specific heterogeneity and, hence, should be more reliable.

The remainder of the paper is organized as follows. Section II briefly reviews the literature on water services privatization. Section III describes the data used for the analysis. Section IV provides an overview of PSP in urban water utilities in the PRC and investigates the drivers of PSP. The econometric models for PSP impact assessment are introduced in Section V. Section VI presents estimates of the effects of general PSP, as well as PSP-major and PSP-minor, on water utility performance. Section VII concludes with policy implications and future work.

II. Literature Review

While letting the private sector play a major role in competitive sectors where the market functions well is widely accepted by economists and policy makers, there is still notable resistance to private participation in sectors such as water supply and power generation and distribution, where the provision of goods or services is primarily seen as a government responsibility. The underlying reasoning is that market failure involving externality, natural monopolies, etc. in these sectors prevents private firms from providing socially optimal goods or services. Nevertheless, Shleifer (1998) argues compellingly

[1] The definition of privatization is not always clear-cut in the literature. In monopoly sectors, private investors normally obtain full or partial ownership of the firm. Therefore, privatization in the water sector may refer both to cases where state capital withdraws completely or exists alongside private capital. We use privatization and private sector participation interchangeably in this paper.

that government-owned firms are not the appropriate solution even in the presence of market failure.

Shleifer contends that given a benevolent government, if products can be perfectly described in the contract or regulation, such as the number of water connections or water cleanliness, there is no difference between public and private provision. If some desired quality is noncontractible, the choice of public versus private provision depends on relative incentives to invest in cost reduction and quality improvement. In many cases, private firms demonstrate a stronger tendency to deliver the same, or even superior, quality of goods at lower cost than public firms. For a nonbenevolent government pursuing its own interests or those of a special interest group over the public's, the argument for government ownership is further undermined. In this case, eliminating political distortions to resource allocation is the crucial reason for privatization in the first place.

Megginson and Netter (2001) provide a comprehensive survey of the empirical literature on privatization. Parker and Kirkpatrick (2005) and Estrin, Hanousek, Kocenda, and Svejnar (2009) focus their reviews on the effects of privatization on economic performance in developing and transition economies, respectively. Although the general finding is favorable to privatization, its impact is more diverse in transition and developing economies than in developed economies. Evidence also suggests that the effectiveness of privatization in noncompetitive markets in improving economic performance is ambiguous. Parker and Kirkpatrick (2005) argue that the institutional requirements that ensure privatized monopolies perform well—an effective system of state regulation and supporting governance structures—are likely to be missing in many developing countries.

A growing number of studies look specifically at privatization in water services in both developed and developing countries. Bhattacharyya, Parker, and Raffiee (1994) estimated a generalized variable cost function with cross-sectional data from 225 public and 32 private water utilities in the United States. The results showed that the public water utilities were more efficient than private utilities on average, but were more widely dispersed between best and worst practices. Saal and Parker (2001) compared the productivity, price, and financial performance of each water and sewerage company in England and Wales before and after privatization. They found that after privatization, labor productivity increased due to substantial reductions in labor usage, while total factor productivity (TFP) growth across the industry did not improve relative to the pre-privatization period. They attributed the increase in profitability since privatization largely to increases in output prices outstripping increases in input costs. However, it was hard for the authors to completely disentangle the impact of privatization from that of the new regulatory regime implemented right after sector privatization in 1989.

Studies focused on developing economies rely mostly on cross-country data. Estache and Rossi (2002) analyzed survey data collected by the Asian Development Bank in

1995 on 50 water enterprises (22 involving PSP in some form) in 29 countries in the Asia and Pacific region. Adopting the stochastic cost frontier technique and applying error components and technical efficiency effects models, the authors found no significant efficiency differences between the private and state water enterprises. Estache and Kouassi (2002) used unbalanced panel data from 21 African water utilities during 1995–1997 to estimate a production function and applied Tobit modeling to relate the resulting inefficiency scores to governance and ownership variables. The study found that private ownership was associated with a lower inefficiency score. However, only three firms in the sample had any private capital, and levels of corruption and governance were far more important than the ownership variable in explaining efficiency differences between firms.

While earlier studies suffer from small samples, more recent studies were able to employ larger samples as more data became available. Kirkpatrick, Parker, and Zhang (2006) conducted a cross-sectional analysis based on 110 water utilities in Africa, among which 14 utilities reported private sector involvement. While the data envelopment analysis results pointed tentatively to private sector superiority, the stochastic cost frontier analysis showed that cost performance at state-owned utilities was better, though statistically insignificant. More recently, Gassner, Popov, and Pushak (2009) examined 977 water utilities in 48 countries from 1980 to 2005 using econometric techniques of difference-in-differences combined with matching. The results showed that PSP in water services led to increases in residential connections, connections per workers, and water sold per worker and a decline in employment. But the authors found no evidence of an increase in investment or retail tariffs following PSP.

As some authors point out, the selection problem makes estimation of the causal impacts of privatization on economic performance more difficult. If governments turned to private capital for the worse-performing water utilities, simple regression estimation would find privatization ineffective. On the other hand, if private investors choose to invest only in those utilities performing better or having brighter prospects, positive estimates of the effects of privatization are not necessarily evidence of the superiority of private ownership. The selection problem is exacerbated in the presence of unobservable sample heterogeneity. As stated, most empirical work on water sector privatization in developing economies has used cross-country data. Nevertheless, the factors that lead to privatization and affect utility performance vary greatly across countries, many of which are not observable to researchers. Extra caution may therefore be needed in interpreting cross-country results.

Galiani, Gertler, and Schargrodsky (2005) based their analysis on a large sample of cities from a single developing country—Argentina. Instead of water utility performance, however, the paper focused on the impact of the privatization of water services on child mortality. First, the authors showed that the decision to privatize was uncorrelated with economic shocks, a baseline mortality rate, or with lagged changes to mortality. The study

found that child mortality fell 8% in municipalities that privatized their water services, with the effect biggest in the poorest areas. The authors argued that one of the pathways was that privatization expanded access to water services. Galiani et al. (2005) and Estache, Gomez-Lobo, and Leipziger (2003) presented some supporting evidence in case studies of Buenos Aires and Bolivia, respectively.

III. Data and Variables

The main data used in the current study come from Annual Industrial Firm Surveys from 1998 to 2007 conducted by the National Bureau of Statistics (NBS). The annual survey covers all registered industrial firms that are either state-owned or nonstate-owned, with sales above 5 million yuan (CNY). It includes 39 two-digit industries and more than 600 four-digit industries from three big categories—mining, manufacturing, and public utilities. There are three four-digit industries related to water industry—water production and supply (4610); wastewater treatment and reuse (4620); and other water treatment, utilization, and distribution (4690). This study focuses on water production and supply firms with an industry code equal to 4610.[2] Since urban water utilities servicing large populations are our primary interest, we further restrict the samples to large or medium-sized water utilities in prefecture-level cities rather than small ones in counties or towns.[3]

The surveys provide basic information about the firms, such as firm identification (ID), name, location, etc., with which we construct a panel of water utilities. Since a water utility in a city is generally characterized as a natural monopoly, entry and exit are much less likely to occur in water utilities than in manufacturing firms. Hence, a balanced panel should be available from the survey data. When firm ID is first used to track utilities, the panel is highly unbalanced. This is mainly because a number of water utilities changed their IDs over the period. Considering that a change in firm ownership is one of the main causes of ID change, we make substantial effort to match the same firms with different IDs. The criteria used for matching firms include firm name, size, address at the city district or county level, manager's name, etc. For instance, a firm ID is identified for 1998 through 2003. We locate all water utilities in the same city since 2004 and further narrowed it down to the one showing continuity in name, size, address, and/or manager's name. The latest firm ID is then assigned as the utility's unique identifier.

This matching process was effective in extending the panel to include an additional 60 water utilities, which were missing in the panel constructed with firm ID only. The final

[2] The old industry code system before 2003 was taken into account in selecting relevant firms.

[3] Utility size definition follows the official firm classification based on three parallel criteria—employment, assets, and sales revenue. A medium-sized firm has 300 or more employees, total assets above CNY40 million, and sales revenue exceeding CNY30 million. A large firm has employees over 2,000; total assets above CNY400 million; and sales revenue above CNY300 million.

data set includes an almost balanced panel[4] of 208 urban water utilities in 192 cities.[5] Among these, 188 cities, for which data were available, had a total population of more than 900 million, of which 300 million were living in cities' urban areas in 2007. The latter number may approximate the population serviced by utilities in the sample, although the firm data did not provide this information. Note that our sample covers cities, such as in Shanghai (Pudong district), Lanzhou, Kunming, Qingdao, Sanya, etc., which have received enormous media attention for being well-known cases of water utility ownership diversification.

The firm surveys collect detailed financial information about firms, based on which we classify utilities into different ownership types and construct performance indicators. First of all, a utility's capital sources are categorized and reported as

(i) state

(ii) collective

(iii) legal entity

(iv) individual

(v) Hong Kong, China; Macau, China; or Taipei,China

(vi) foreign[6]

Traditionally, public utilities were all owned by governments of different levels with capital from state or collective investments. For large urban public utilities, state rather than collective investment was the dominant capital source. Therefore, we define PSP in a water utility as having any capital contribution from nonstate sources.[7] Further, if the nonstate sources account for more than 50% of total capital, the utility is classified as PSP-majority, as opposed to PSP-minority where the state share is 50% or higher. This classification based on a utility's actual capital composition is superior to the notional

[4] In a couple cases we could not find the same firms for the entire period but could tell that an ownership change was not the cause for the missing observation in that all basic characteristics of the utility did not change before and after the missing years. In another case, Shanghai Water Utility Company in 2000 was divided into a few independent water companies operated by respective city districts. The data indicates that this separation did not involve ownership changes (state-owned versus PSP) and therefore we followed the district water utilities from 2000.

[5] Sample includes multiple urban water utilities in the four municipalities under the direct governance of the central government, i.e., Beijing, Chongqing, Shanghai, and Tianjin.

[6] Legal entity is a highly ambiguous term for defining capital source. It could be a firm owned by another state enterprise, private firms, or a mix of them. Provided that these investors are profit-driven and have goals and means common with the private investors, they are generally regarded as nonstate capital sources.

[7] The collective firms may be more similar to other types of ownership than to state-owned firms in terms of accountability and decision making. However, in a robustness check, we define PSP firms alternatively as those with any capital investment from nonstate and noncollective sources.

ownership defined by a firm's registration type, according to Dollar and Wei (2007). They found that in about 15% of firms in their survey the registration type did not match their actual ownership.

This study examines water utility performance in response to PSP. We develop 12 indicators to assess utility performance in three aspects. First, we look at how PSP affects utilities' inputs and outputs, as measured by investments, (logarithm of) total employment, (logarithm of) gross sales revenues, and (logarithm of) value added. Second, we examine the indicators for a utility's financial performance and profitability. Specifically, they are ratios of liability to assets, managerial expenses to sales, financial expenses to sales, profits to sales, taxes paid to sales, and subsidies to sales. Finally, we explore whether PSP improves utility efficiency in terms of average revenue product of labor and TFP. Province–year specific deflators are applied wherever appropriate to obtain 1998 constant values.

To compare TFP across firms within the same industry, we follow Caves, Christensen, and Diewert (1982) to calculate the logarithm of TFP of water utility *i* in year *t* as

$$\ln TFP_{it} = \left(\ln VA_{it} - \overline{\ln VA_t}\right) - s_{it}^{*}\left(\ln L_{it} - \overline{\ln L_t}\right) - (1 - s_{it}^{*})\left(\ln K_{it} - \overline{\ln K_t}\right), \quad (1)$$

where *TFP*, *VA*, *L*, and *K* stand for TFP, value added, employment, and fixed capital, respectively; $\overline{\ln X_t}$, $X = VA, L, K$, equals industry average of logarithm of variable *X* in year *t*; and $s_{it}^{*} = (s_{it} + \bar{s}_t)/2$ with s_{it} being share of wage bill in value added of individual utility and $\bar{s}_t$ being industry average of wage bill shares. This specification is flexible enough to allow heterogeneity in technology across utilities and time.

Finally, we assemble a rich set of city information from *China City Statistical Yearbooks* 1999–2008 (National Bureau of Statistics, various years) and merge them with the water utility panel. These city-level variables are used to explain the choices of cities in diversifying their water supply companies, as well as to control for additional variations in utility performance. The Appendix provides definitions of all dependent and explanatory variables.

IV. Private Sector Participation in Urban Water Utilities and Its Drivers

A. Background and Overview

Starting in the early 1990s, the opening of urban water supply to the private sector has occurred in two phases: the trial phase in 1992–2001, and the formal opening in 2002 up to the present. In 1992, the French Suez Group's investment in the water utility of the city of Zhongshan, Guangdong province, was the first case of foreign capital participating in the PRC's urban water supply sector. Foreign and domestic investors were thereafter actively engaged in a dozen urban water utilities, mainly through build–operate–transfer (BOT) and capital share transfer arrangements. In this early pilot phase, however, the sector seemed to show a lack of guidance on and rules or regulations governing PSP.

In December 2001, the former State Planning Committee publicized its guidance on nongovernment investment (State Planning Committee 2001) to encourage foreign and domestic nongovernment investors to participate in constructing and operating infrastructural facilities and public utilities in various business models. In December 2002, the Ministry of Construction issued "Quickening the Process of General Adoption of Market Principles for the Municipal Public Utilities Sector"; and in March 2004, the "Management Measures for Concession of Urban Public Utilities" (Ministry of Construction 2002 and 2004). The former officially acknowledged the eligibility of foreign and domestic capital to participation, on the basis of fair competition, in urban public projects, including water and gas supply and public transport. The latter further defined the respective rights and duties of enterprises and government agencies in the concessionary operation of public utilities. With the ground leveled by the series of government documents, the urban water sector entered its second phase of opening and reform.

The influx of nonstate investment in urban water supply was led by top worldwide water companies, such as the Veolia Water and Suez of France, and Thames Water of the United Kingdom, whose abundant resources in capital, technology, and experience made them front-runners in the market. Inspired by foreign investors, domestic investors also showed great interest in the urban water market. A number of publicly listed companies have started or enhanced their participation in this market since early 2000, and hundreds of private water companies have emerged in various sizes with a specialization in water supply and wastewater treatment projects of corresponding scale (Xie 2009).

Market-oriented reform of urban water supply in the PRC is a quite complicated and diverse process. There are more than 10 forms of PSP in the water supply sector, with share transfer, joint venture, divestiture, BOT, and transfer–operate–transfer (TOT) among the major types (Zhang 2006). Under share transfer, the municipal government sells part of the water utility's ownership to private investors. This form of public–private

partnership has attracted considerable attention because private investors are often paid an extraordinarily high premium to acquire the shares. In one of the most famous cases, Veolia Water obtained a 50% share of Shanghai Pudong Water Company for CNY2 billion in 2002, the purchasing price three times of net assets. Joint venture is another popular form in which the government and private investors set up a joint company to own and run the water utility. Private investors generally need to bring cash to the joint company. The primary difference between a share transfer and joint venture is that the funding brought by the private investors will go to the local government in a share transfer and stay in the joint company in a venture.

In a divesture, the government sells some utility facilities to the private company, which is responsible for financing, operating, and maintaining them. In a BOT arrangement, a private company under concession finances, builds, owns, and operates the facilities for a specified time, and transfers the facilities to the water utility when it ends. In a TOT arrangement, the private company pays a transfer fee to the water utility for operating the existing facilities for a contracted period and returns the facilities when that ends. Revenues from operating the facilities constitute the main source of income of the private company.

Because we define PSP by the capital structure of the water utilities, we mainly focus on the share transfer and joint venture forms. For cities that have engaged private investors through divesture, BOT, or TOT, the water utility retains its original ownership and is still classified as state-owned. To the extent that these forms of PSP affect the performance or efficiency of the water utilities,[8] our comparison of utilities with PSP to state-owned utilities would generate biased results. A recent survey by Tsinghua University showed that among 129 water supply projects surveyed that involved private investors, 107 (83%) adopted share transfer or joint venture. In contrast, BOT or TOT are the dominant PSP forms in the wastewater sector (World Bank 2007). If this is the case for urban water supply, then potential biases in our estimates should be very limited.

We now present some quantitative facts on PSP in urban water utilities based on the data assembled. As seen in Table 1, by 1998, 6 years after the first PSP case done by the Suez Group in Zhongshan city, only nine utilities involved nonstate capital, accounting for 4.4% of the sample. By 2001, the end of the first phase of sector opening, the number reached 22 or 11% of the sample. When the policies were made clear and favorable beginning 2002, the pace of PSP in the sector was obviously expedited. By 2007, the number of PSP utilities had tripled to one third of the total.

[8] The effects of PSP through divesture or build–operate–transfer on a water utility may be positive, e.g., increasing competition; or negative, e.g., lowering the stability of the water supply system under guaranteed supply volumes (Fu, Zhong, and Chang 2006).

Table 1: Numbers of Water Utilities with Private Sector Participation, 1998–2007

Year	All	State-Owned	Private Sector Participation (percent)	Private-Major (percent)	Private-Minor (percent)
1998	205	196	9 (4.4)	3 (1.5)	6 (2.9)
1999	205	193	12 (5.9)	5 (2.4)	7 (3.4)
2000	208	191	17 (8.2)	7 (3.4)	10 (4.8)
2001	207	185	22 (10.6)	12 (5.8)	10 (4.8)
2002	208	182	26 (12.5)	14 (6.7)	12 (5.8)
2003	208	176	32 (15.4)	18 (8.7)	14 (6.7)
2004	208	168	40 (19.2)	24 (11.5)	16 (7.7)
2005	208	162	46 (22.1)	30 (14.4)	16 (7.7)
2006	208	151	57 (27.4)	37 (17.8)	20 (9.6)
2007	208	140	68 (32.7)	45 (21.6)	23 (11.1)

Source: Data assembled from National Bureau of Statistics' Annual Industrial Firm Surveys.

The last two columns of Table 1, interestingly, show that while PSP-major utilities and PSP-minor utilities both grew faster after 2001, the growth of PSP-major utilities exceeded that of PSP-minor utilities in this second phase. Prior to 2001, there were more water utilities in which private investors held minority rather than majority status. By 2007, however, PSP-major utilities had increased to 45, from 12 in 2001, twice the PSP-minor utilities. This suggests that the private sector invested more aggressively in the sector once policy barriers or vagueness were removed.

Table 2 looks at urban water sector dynamics through utility capital, assets, employment, and sales. Its upper half shows aggregate capital, assets, employment, and sales, including the annual growth rates of all water utilities in 1998–2007; the lower half only for the PSP utilities. In the whole sector, total capital grew 67% in the period, assets 113%, and sales 80% (in 1998 constant prices). The corresponding average annual growth rates are 5.9%, 8.8%, and 7.3%. Employment increased slightly, by 6%, with annual average growth less than 1%. By contrast, the PSP utilities grew 20 times in capital, 17 times in assets, 13 times in employment, and 15 times in sales, with average annual growth rates of 40%, 38%, 35%, and 37%, respectively. The sharp gap can be attributed to at least three potential causes. First is the increase in the number of water utilities that attracted private investors, which has been verified in Table 1. Second, the PSP utilities are bigger, on average, than the remaining state-owned utilities. Third, the PSP utilities grew faster than the non-PSP ones. It will be shown in the following sections that the third explanation is more likely to hold than the second one.

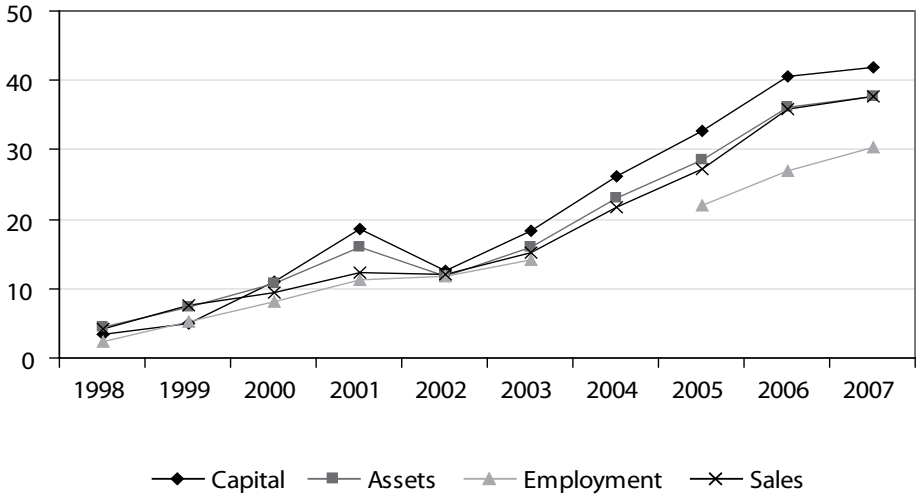
Table 2: Aggregate Capital, Assets, Employment, and Sales of Water Utilities, 1998–2007

Year	Capital (billion CNY)	Growth (percent)	Assets (billion CNY)	Growth (percent)	Employment (1,000 persons)	Growth (percent)	Sales (billion CNY)	Growth (percent)
All Utilities								
1998	26.39	–	68.50	–	187.92	–	14.16	–
1999	29.73	12.6	81.33	18.7	197.58	5.1	15.67	10.7
2000	35.87	20.7	96.02	18.1	202.93	2.7	18.11	15.5
2001	35.08	-2.2	100.79	5.0	202.67	-0.1	18.26	0.9
2002	37.44	6.7	115.71	14.8	198.54	-2.0	19.91	9.0
2003	42.80	14.3	127.04	9.8	200.45	1.0	21.51	8.0
2004	41.15	-3.9	131.22	3.3	–	–	21.94	2.0
2005	41.85	1.7	135.44	3.2	198.59	–	23.00	4.9
2006	45.14	7.9	142.63	5.3	199.61	0.5	25.41	10.5
2007	44.13	-2.2	145.86	2.3	198.59	-0.5	26.77	5.4
PSP Utilities								
1998	0.88	–	2.99	–	4.19	–	0.61	–
1999	1.46	65.5	6.05	102.2	10.58	152.7	1.17	92.3
2000	3.91	167.6	10.24	69.2	16.53	56.3	1.70	45.0
2001	6.54	67.2	16.09	57.1	22.64	37.0	2.24	31.8
2002	4.67	-28.6	13.56	-15.7	23.42	3.4	2.40	6.9
2003	7.86	68.4	20.20	49.0	28.59	22.1	3.28	36.8
2004	10.79	37.3	30.39	50.5	–	–	4.74	44.3
2005	13.67	26.7	38.73	27.4	43.58	–	6.28	32.5
2006	18.37	34.4	51.39	32.7	53.74	23.3	9.10	45.0
2007	18.52	0.8	54.88	6.8	60.23	12.1	10.06	10.5

– means data not available.
Note: Capital, assets, and sales are deflated to province-specific 1998 prices. Employment data is missing for 2004.
Source: Data assembled from National Bureau of Statistics' Annual Industrial Firm Surveys.

Figure 1 presents shares of the PSP utilities in the whole sector. The proportions of total capital, assets, and sales owned or made by the PSP utilities rose from below 5% in 1998 to about 40% in 2007. The employment proportion increased from 2% to 30%. Figure 1 clearly shows that the PRC has moved fast to open its urban water supply sector, and the role the PSP utilities play in the sector grew quickly.

Figure 1: Shares of PSP Utilities, 1998–2007



Finally, an intriguing phenomenon is observed in the data. PSP in urban water supply is not just one-way. In any given year in which a number of water utilities changed from state-owned firms to PSP firms, a few utilities moved in the opposite direction. Table 3 summarizes this "private sector exiting" phenomenon. For instance, while there were 15 cities that newly absorbed private capital in their water utilities in 2004, seven cities saw the private sector leave their water utilities. Although the number of new PSP utilities always outweighed the number of private-exiting utilities, the latter was considerable, and accounted for nearly half of the former in some years.[9]

Table 3: Numbers of Water Utilities with Private Sector Participating and Exiting

Year	Private Participating	Private Exiting	Incremental Private Sector Participation
1998	–	–	–
1999	5	2	3
2000	8	5	3
2001	6	1	5
2002	9	5	4
2003	10	4	6
2004	15	7	8
2005	11	5	6
2006	13	2	11
2007	15	4	11

– means data not available.
Note: Private participating utilities refer to those newly involved in nonstate capital in a given year. Private exiting utilities refer to those newly turning to pure state ownership.
Source: Data assembled from National Bureau of Statistics' Annual Industrial Firm Surveys.

[9] Data error may not be a main driver here. First, the data come directly from financial statements subject to official regulation and regular auditing. Capital from different sources adds up to the total capital perfectly for every firm in the data. Second, even if we remove those cases where utilities' PSP categorization switched back and forth in three consecutive years, assuming they are more likely caused by data input errors, there are still a number of exit cases left.

The phenomenon, which has not been noticed much in the literature, reveals one more dimension of the sector's dynamics. It may also imply the complex reality associated with PSP in the provision of public services. Practically, private investors may be allowed to withdraw their investment conditional on certain economic or collaborative issues that arise. The government may also face political pressure to terminate the participation of private investors. While we point out this empirical regularity and think it is important in certain contexts, accounting for underlying causes separately is beyond the scope of this study. To the extent that the PSP and private sector exiting following the same decision-making processes of private investors and the government, our panel estimations, presented below, may shed some light on both.

B. Drivers of Private Sector Participation in Urban Water Utilities

PSP is likely to be the outcome of an interactive process between private investors and local government. Profit-maximizing investors would choose those utilities and cities with great potential for short- or long-term profits. Meanwhile, those local governments under enormous pressure to supply more water to meet increasing demand would be interested in PSP for greater investment and efficiency improvement. Given these hypotheses, we identify a number of factors at both the utility and city levels that may influence the PSP decision made jointly by the investors and local governments.

First of all, we use total employment, assets, and sales revenues as a proxy for a utility's scale and capacity. We further construct ratios of managerial expense to sales revenues, liability to assets, and profit to sales to capture a utility's characteristics in management efficiency, access to external financing, and profitability, which private investors are likely to care about the most. Second, a shortage in public finance will result in inadequate investment in water supply and hence push the city government to seek external investors. We use the difference between public expenditure and tax revenues to measure public financial conditions. Further, the local government may be more pressed to improve water supply efficiency through PSP if water demand is higher. We calculate per capita residential water consumption and per gross domestic product water use as proxies for water demand. Third, basic city characteristics, such as population, population density, income level, industrial structure, fixed asset investment, and infrastructure, may affect both private investors and city government with respect to PSP in water supply.

We first estimate a random-effects probit panel model of the probability of a water utility involving nonstate capital in a given year.[10] In the baseline, 1-year lags of the utility and city characteristics are used for explaining PSP. In alternative specifications, we also include longer lags of the utility variables, as well as changes in these variables, to reflect that the private investors may select their investment targets based on mere dynamics of water utilities. These results could inform us of any correlation between PSP and utility's

[10] A binary panel model is more appropriate than a hazard model here since a number of water utilities were observed to change from (partially) private-owned to purely state-owned in the data period.

past performance and thus help us assess potential bias in panel estimation of the effects of PSP. Finally, we estimate a fixed-effects linear panel model of PSP probability as a comparison to the random-effects probit estimates.

Table 4 reports the estimation results. Baseline estimates in column (1) show that a utility's profitability in the prior year is the most important factor that leads to PSP. An increase of 10 percentage points in profit–sales ratio will increase the probability of PSP by 0.7 percentage point on average. The liability ratio has marginally significant coefficient estimate, which suggests that utilities with better access to external finance or higher leverage capability are more attractive to private investors. Utility scale, its sales, or managerial costs do not play a big role in engaging private investors. City-level variables do not have much weight in the PSP decision, except for urban road area per capita, which is a proxy for infrastructure. The public financial deficit has a positive but statistically insignificant impact on PSP likelihood. The water demand indicators do not have consistent and significant impacts either.[11]

Table 4 columns 1–4 present marginal effects (standard errors in the parentheses) estimated by random-effects probit panel models. Column 5 values are estimates of fixed-effects linear panel model with standard errors clustered at the utility level.

Columns 2–4 present estimates for alternative specifications, adding more lags of utility variables and changes in these variables over the last 3 years as explanatory variables. The main finding is that utility performance 2 or 3 years previously; as well as the development path of the utility, do not affect PSP, conditional on the performance a year prior to PSP. Reduction in sample size due to more lagged variables added to the model could reduce the precision of the estimates. However, the coefficients of 2- or 3-year lags are much smaller than those of 1-year lags, which suggests that a utility's latest profitability, and the leverage level to some extent, play a much more decisive role in PSP than the same and other indicators of earlier years. Finally, the fixed-effects estimates reported in column 5 confirm those in column 1: the utility's profitability in the most recent year and urban transport infrastructure are the only statistically significant factors that drive PSP, even when time-invariant utility characteristics are accounted for.

[11] Galiani, Gertler, and Schargrodsky (2005) find that larger and less well-off municipalities were more likely to privatize water provision in Argentina. This result is not replicated in the People's Republic of China. Population size and gross domestic product per capita are not statistically significant explanatory variables for the PSP. The difference indicates that factors driving PSP or privatization could vary greatly across countries. Pooling utilities from different countries could introduce considerable unobserved heterogeneity into the analysis, which potentially confounds the causal estimates.

Table 4: Explaining Private Sector Participation in Urban Water Utilities

	(1)	(2)	(3)	(4)	(5)
Utility-Level Variables[a]					
Employment (lag 1)	-0.00557	-0.0128	-0.000594	-0.0176	-0.0741
	(0.0143)	(0.0296)	(0.0173)	(0.0204)	(0.0574)
Assets (lag 1)	0.00814	-0.00207	-0.0107	-0.0122	-0.0166
	(0.0119)	(0.0191)	(0.0133)	(0.0168)	(0.0325)
Liability ratio (lag 1)	0.0595*	0.0950**	0.0396	0.0645*	0.0992
	(0.0320)	(0.0450)	(0.0303)	(0.0392)	(0.0842)
Sales (lag 1)	-0.00241	-0.00112	-0.0157	0.0436	0.0229
	(0.0151)	(0.0256)	(0.0182)	(0.0295)	(0.0508)
Managerial expense ratio (lag 1)	-0.0684	-0.0691	-0.0900	-0.0548	-0.0504
	(0.0653)	(0.0942)	(0.0827)	(0.0923)	(0.177)
Profit–sales ratio (lag 1)	0.0743**	0.0873**	0.0675	0.119**	0.164**
	(0.0343)	(0.0430)	(0.0447)	(0.0560)	(0.0712)
Employment (lag 2)		-0.00615	0.00390		
		(0.0303)	(0.0194)		
Assets (lag 2)		-0.00421	0.00219		
		(0.0188)	(0.0126)		
Liability ratio (lag 2)		-0.0166	-0.00641		
		(0.0352)	(0.0208)		
Sales (lag 2)		0.0310	0.0341		
		(0.0274)	(0.0263)		
Managerial expense ratio (lag 2)		0.0321	-0.0120		
		(0.0864)	(0.0617)		
Profit–sales ratio (lag 2)		0.0143	0.00473		
		(0.0349)	(0.0300)		
Employment (lag 3)			-0.0130		
			(0.0185)		
Assets (lag 3)			-0.0131		
			(0.0157)		
Liability ratio (lag 3)			0.0166		
			(0.0219)		
Sales (lag 3)			0.0177		
			(0.0203)		
Managerial expense ratio (lag 3)			0.0576		
			(0.0636)		
Profit–sales ratio (lag 3)			-0.0350		
			(0.0312)		
Δ Employment				-0.00230	
				(0.0223)	
Δ Assets				-0.00523	
				(0.0164)	
Δ Liability ratio				0.00413*	
				(0.00226)	
Δ Sales				-0.0176	
				(0.0206)	
Δ Managerial expense ratio				0.00448	
				(0.0154)	
Δ Profit–sales ratio				-1.48e-05	
				(1.05e-05)	

continued.

Table 4: *continued.*

	(1)	(2)	(3)	(4)	(5)
City-Level Variables[b]					
Population	-0.0187	-0.0278	-0.0121	-0.0301	0.240
	(0.0156)	(0.0187)	(0.0111)	(0.0189)	(0.208)
Population density	5.03e-06	4.60e-06	-2.73e-06	-2.42e-06	-4.87e-06
	(1.11e-05)	(1.20e-05)	(8.07e-06)	(1.17e-05)	(1.33e-05)
GDP per capita	-5.34e-07	-1.26e-06	-1.93e-07	-7.01e-07	-8.77e-07
	(5.71e-07)	(8.39e-07)	(5.43e-07)	(7.99e-07)	(1.01e-06)
Share of industry in GDP	-0.000125	-0.00187	-0.00148	-0.00269*	0.00165
	(0.000712)	(0.00130)	(0.00106)	(0.00153)	(0.00185)
Share of services in GDP	7.97e-06	-0.00116	-0.00184	-0.00279	0.000192
	(0.000985)	(0.00158)	(0.00134)	(0.00174)	(0.00238)
Fixed assets investment relative to GDP	-0.00508	0.0571**	0.0206	0.00288	-0.00263
	(0.00899)	(0.0289)	(0.0229)	(0.0236)	(0.0304)
Public financial deficit	2.99e-08	4.92e-08	3.09e-08	4.82e-08	7.00e-08
	(2.75e-08)	(3.48e-08)	(2.60e-08)	(3.48e-08)	(1.01e-07)
Residential water consumption per capita	-0.000259	-0.000117	4.21e-05	-0.000107	-2.97e-05
	(0.000160)	(0.000189)	(0.000114)	(0.000167)	(2.00e-05)
Water density	0.246	-1.209	-1.184	-2.326	0.366
	(0.171)	(1.132)	(0.995)	(1.546)	(0.469)
Urban road area per capita	0.00297*	0.00512**	0.00218	0.00333	0.0123***
	(0.00165)	(0.00214)	(0.00153)	(0.00209)	(0.00429)
Year dummy	Yes	Yes	Yes	Yes	Yes
Utility random effects	Yes	Yes	Yes	Yes	No
Utility fixed effects	No	No	No	No	Yes
Observations	1547	1173	772	948	1547

*** significant at 1% level, ** at 5% level, * at 10% level.

GDP = gross domestic product, PSP = private sector participation.

[a] Lags 1, 2, and 3 indicate that the utility-level explanatory variables are measured in 1-, 2-, and 3-year lags to the PSP variable, respectively. Δ variable refers to changes in the variable over the last 3 years. For instance, Δ sales equals the logarithm of the ratio of sales of the last year to sales 3 years ago.

[b] City-level variables are all measured in 1-year lag to the PSP variable.

Note: The dependent variables are PSP dummy equal to 1 if there is nonstate capital in a utility's capital structure.

Source: Authors' estimation.

Overall, our models do not identify, among a relatively rich, dynamic set of utility and city characteristics, strong drivers of PSP in urban water utilities. One possible explanation for this is that, in view of the PRC's rapid urbanization and increasingly constrained water resources, investors see its urban water sector as an opportunity with great long-term potential. Participation in this newly opened sector is more strategic than short-term, and thus driven mainly by long-term factors. These factors can hardly be captured in the sample data. To the extent that they are fixed (such as geography, river basin) or less time-variant, the fixed-effects panel estimation of the impacts of PSP on utility performance should be less subject to selection bias.

V. Econometric Models

The focus of this paper is to estimate the average effects of PSP in urban water utilities on utility performance. Given the 10-year panel data of urban water utilities, we rely primarily on the temporal and geographical variations in PSP to identify the impact of PSP. As stated earlier, private investors do not engage in a city's water sector randomly. They would select utilities and entry timing carefully to achieve their profit-maximizing goals. At the same time, city governments, which have adequate control over the water utilities before PSP, would also choose whether, when, and to what extent to involve private stakeholders in the water utilities. Therefore, there may be some time-variant utility and city characteristics correlated with PSP and utility performance after PSP. Guided by the results in the previous section, we include as control variables 1-year lags of utility variables and city characteristics to account for these potential correlations.[12]

Formally, we estimate the following two-way fixed-effects panel model:

$$y_{it} = \beta_0 + \beta_1 PSP_{it} + \sum_k \phi_k x_{itk} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

where y_{it} is one of the 12 performance indicators of utility *i* in year *t*; PSP_{it} is a binary variable that takes on the value 1 if water utility *i* involves private investment in year *t* and 0 otherwise; x_{it} is the set of control variables mentioned above to capture time-variant utility and city characteristics; $\propto_i$ is the fixed effect of utility *i*; and λ_t is a time effect common to all utilities in year *t*. To the extent that unobserved factors persistently affect utility performance, the error, ε_{it}, will be correlated over time within utilities, which would result in biased estimates of the standard errors. To address this issue, we allow for an arbitrary covariance structure within utilities over time by computing the standard errors clustered at the utility level.

The parameter β_1 measures the average effects of PSP on urban water utilities. The key assumption for the model to produce unbiased estimates of β_1 is that conditional on time-variant control variables, as well as utility and year fixed effects, PSP is not correlated with any unobservable factors that affect utility performance. The assumption seems plausible as the estimation of PSP drivers indicates that, except for 1-year lags of profitability and leverage rate, lagged utility variables and their changes over the last 3 years and most city characteristics do not affect PSP effectively.

A question of equal interest is: with everything else equal, does a private-dominant firm do better than a state-owned or state-dominant firm? State ownership is often thought to be the major source of inefficiency in pre-reform water utilities. Private investors holding a minor position may have limited influence on the incentive structure, governance, and

[12] While some variables such as 1-year lag of utility profitability are consistently found to influence PSP in urban water supply, it is hard to argue that these variables affect water utility performance only through affecting PSP. Hence, it is more appropriate to use them as control variables than as instruments for PSP.

decision making in a utility that remains under the control of traditional state capital. On the other hand, given mutual interests and proper agreement between the state owner and private shareholders, minority status may not preclude private investors from injecting their advantages, such as efficient management and profit-making incentives, into utility operation. While the two scenarios may both exist in practice, we attempt to find out which scenario prevails in a large sample using models depicted by equation (3):

$$y_{it} = \beta_0 + \beta_1 PSP - major_{it} + \beta_2 PSP - \text{minor}_{it} + \sum_k \phi_k x_{itk} + \mu_i + \lambda_t + \varepsilon_{it} \quad (3)$$

where β_1 and β_2 estimate the effects of PSP as a major owner and a minor one, respectively, on utility performance relative to the state utility's performance. Again, the identification assumption is that variables $PSP - major_{it}$ and $PSP - \text{minor}_{it}$ are not correlated with ε_{it} conditioning on $\mathbf{x}_{it}$, $\propto_i$, and λ_t.

VI. Impact of Private Sector Participation on Water Utility Performance

A. Effects of General Private Sector Participation

We first estimate equation (2) for the impact of PSP in general on water utility performance. Utility performance is examined through 12 indicators under three categories: inputs and outputs, financial performance and profitability, and efficiency. Table 5 reports the estimation results of equation (2). Beside the variable column are the means and standard deviations of the dependent variables. The baseline specification, where no time-varying variables, x_{it}, are controlled for, is presented in column 1. Specifications including lagged utility variables and city variables as controls are presented in columns 2 and 3, respectively.

The estimated effects of PSP on utilities' performance are, by and large, as expected. First of all, PSP increased utilities' investment, sales revenues, and value added, and reduced the numbers of people employed. Second, managerial and financial expenses relative to sales revenues declined with PSP, while liabilities as a percentage of total assets rose. In addition, PSP led to greater profitability accompanied by a slight increase in the tax–sales ratio and substantial reduction in the subsidy–sales ratio. Finally, PSP improved labor productivity and TFP.

Table 5: Impacts of Private Sector Participation on Urban Water Utility Performance

Dependent Variables	Mean [Std. Dev.]	(1)	(2)	(3)
Investment	38373.05	12201	9026	11328
	[228129]	(21725)	(21038)	(19841)
	1865	1865	1863	1752
		0.013	0.053	0.062
Employment (log)	959.143	-0.0909*	-0.0829**	-0.0896**
	[958.797]	(0.0468)	(0.0388)	(0.0403)
	1863	1863	1654	1547
		0.023	0.080	0.102
Sales (log)	98812.61	0.0418	0.0422	0.0475
	[149847.8]	(0.0472)	(0.0365)	(0.0395)
	2072	2072	1863	1752
		0.317	0.414	0.408
Value-add (log)	49377.84	0.0168	0.00999	0.0173
	[71923.28]	(0.0614)	(0.0465)	(0.0473)
	1840	1840	1636	1530
		0.186	0.246	0.247
Liability ratio	0.413	0.0161	0.0176	0.0169
	[0.211]	(0.0238)	(0.0189)	(0.0197)
	2072	2072	1863	1752
		0.353	0.469	0.450
Managerial expense ratio	0.217	-0.0234*	-0.0258*	-0.0274*
	[0.110]	(0.0124)	(0.0135)	(0.0144)
	2072	2072	1863	1752
		0.021	0.022	0.027
Financial expense ratio	0.050	-0.0122	-0.0119	-0.00652
	[0.113]	(0.0115)	(0.0110)	(0.00835)
	2072	2072	1863	1752
		0.011	0.045	0.041
Profit–sales ratio	-0.0266	0.0701***	0.0631***	0.0632***
	[0.186]	(0.0213)	(0.0209)	(0.0222)
	2072	2072	1863	1752
		0.032	0.076	0.076
Tax–sales ratio	0.073	0.00140	0.00125	0.00217
	[0.0378]	(0.00271)	(0.00253)	(0.00302)
	1864	1864	1655	1548
		0.034	0.030	0.033
Subsidy–sales ratio	0.0245	-0.0164	-0.0156	-0.00891
	[0.127]	(0.0104)	(0.0106)	(0.00866)
	2072	2072	1863	1752
		0.007	0.018	0.028
Average revenue product of labor	51.340	7.986	6.420	6.292
	[48.542]	(5.474)	(4.995)	(5.152)
	1863	1863	1654	1547
		0.145	0.200	0.218
TFP (log)	4.90e+16	0.119	-0.0489	0.0545
	[2.10e+18]	(0.427)	(0.481)	(0.477)
	1838	1838	1634	1528
		0.000	0.022	0.146
Lags of utility variables		No	Yes	Yes
City control variables		No	No	Yes

*** significant at 1% level, ** at 5% level, and * at 10% level.

PSP = private sector participation, TFP = total factor productivity.

Note: The second column presents sample mean, standard deviation (in brackets), and number of observations of each dependent variable. The four figures of each block under columns 1–3 are coefficient estimate of PSP, standard errors (in parentheses) clustered at utility level, number of observations, and R-square, respectively, of estimating a fixed-effects panel model for one utility performance indicator.

Source: Authors' estimation.

Speaking of statistical significance, effects of PSP on employment, managerial expense ratio, and profit–sales ratio are significantly different from zero. Specifically, PSP reduced employment by 9%, lowered managerial expense as a share of total sales by 2–3 percentage points or 11% of the average, and increased the profit–sales ratio by 6-7 percentage points. Considering that the average profit–sales ratio is negative at –2.7%, PSP could turn a water utility from money-losing to profit-earning.[13] While estimates for other indicators are not statistically distinguishable from zero, the magnitude of the coefficients suggests that PSP may actually have sizable impact on these indicators too, except for the tax–sales ratio, and the statistical insignificance is likely due to the imprecision of the estimation.

Estimation in the earlier section indicates that 1-year lags of profit–sales ratio, liability ratio, and per capita urban road area are the main statistically significant factors driving PSP in water utilities. The 2–3-year lags or development trends of utility variables do not play a role in the PSP status once the 1-year lags are controlled for. Therefore, we add to the baseline model 1-year lags of a utility's assets, sales, liability ratio, and profit–sales ratio alone or jointly with all lagged city characteristics used in the models of PSP status. Estimation results for these alternative specifications are reported in columns 2 and 3 of Table 5. The estimated impacts are highly stable with these additional controls. For instance, conditional on the prior year's profit–sales ratio and other lagged variables, a utility's profit–sales ratio increased by 6.3 percentage points as a result of PSP, as compared to 7 percentage points in the baseline model. The impact on TFP appears the most sensitive to the augmented controls, but the resulted *t*-statistics are close to zero.

We further conduct a falsification test to assess the possibility that utility's profit increase after PSP was due to some positive business shock, which occurred to cities where PSP came about. We construct the average profit–sales ratio of all industrial firms in urban areas using data from the *China City Statistical Yearbooks*, and estimate equation (2) with and without lagged control variables with the average profit–sales ratio as the dependent variable. The results indicate that the PSP in a water utility had no impact on the average profitability of the entire industry of the city,[14] suggesting that the profit increase in PSP utilities is not because PSP took place alongside a booming city economy.

Table 6 provides two sets of robustness checks. First, we treat collective capital the same as state capital and redefine PSP as nonstate, noncollective shareholders participating in the water utilities. The new definition reclassifies 2–4 utilities into non-PSP utilities in various years. Columns 1–3 of Table 6 present fixed-effects panel estimates of the redefined PSP on utility performance indicators with and without time-variant control variables. The results are highly similar to those under the initial PSP definition. Nonstate,

[13] We create a dummy variable equal to 1 if the utility made positive profits in a given year, and 0 otherwise. Estimation of a fixed-effects linear panel model or a random-effects profit model shows that PSP has significant effects on the probability of a utility making profits. The estimation results are available from the authors.

[14] The coefficient estimates, available upon request, are small and negative with *t* values far below the significance cutoff.

noncollective investors reduced utilities' employment size and managerial expenses and improved profitability significantly. They also affected utilities' performance in other ways, though these were not statistically significant. The results are not surprising given the small number of collectively owned utilities. On the other hand, the results may imply that collectively owned public utilities are similar to the state-owned ones in terms of incentive system, management, etc.

The second robustness check concerns the potential coding errors for capital sources in the raw data. As mentioned earlier, the ownership of urban water utilities in the past decade in the PRC have not moved only in one direction. Private investors were seen withdrawing from several utilities every year when a number of other utilities involved private investors. In a few cases, the private shareholders entered, left, and then returned in consecutive years. While such cases may actually happen in reality and it is difficult to get a clear idea of why they happened from the information available, one may be concerned that they are simply some errors in coding capital sources. We take this concern seriously and investigate how the impact estimates may be altered if these less intuitive cases are indeed data errors. For a utility that was non-PSP during a given year, yet was PSP-involved in years before and after that year, we recode it into PSP in that year.[15] Columns 4–6 of Table 6 show that overall, the recoding has little effect on the impact estimates. Meanwhile, the magnitude of the estimates for investment, sales, and managerial expense ratio is moderated by the recoding, implying that the recoding may actually misrepresent the non-PSP with PSP.

[15] There are 2–3 such cases per year in several years.

Table 6: Robustness Check on Private Sector Participation Impacts on Urban Utility Performance

Dependent Variables	(1)	(2)	(3)	(4)	(5)	(6)
Investment	13290	8603	7503	3632	3960	5755
	(21929)	(21330)	(19420)	(19468)	(19777)	(19053)
	1865	1863	1752	1865	1863	1752
	0.013	0.053	0.062	0.013	0.053	0.062
Employment (log)	-0.0944**	-0.0882**	-0.0891**	-0.0866*	-0.0798*	-0.0881**
	(0.0459)	(0.0387)	(0.0391)	(0.0484)	(0.0409)	(0.0425)
	1863	1654	1547	1863	1654	1547
	0.024	0.081	0.103	0.022	0.078	0.102
Sales (log)	0.0332	0.0389	0.0430	0.0136	0.00185	0.00654
	(0.0480)	(0.0362)	(0.0385)	(0.0436)	(0.0301)	(0.0314)
	2072	1863	1752	2072	1863	1752
	0.316	0.414	0.408	0.316	0.413	0.406
Value-add (log)	0.0163	0.0110	0.0206	0.0373	0.0299	0.0364
	(0.0591)	(0.0443)	(0.0456)	(0.0661)	(0.0493)	(0.0517)
	1840	1636	1530	1840	1636	1530
	0.186	0.246	0.247	0.186	0.246	0.247
Liability ratio	0.0192	0.0195	0.0172	0.0215	0.0225	0.0223
	(0.0237)	(0.0187)	(0.0191)	(0.0253)	(0.0196)	(0.0205)
	2072	1863	1752	2072	1863	1752
	0.353	0.469	0.450	0.353	0.469	0.451
Managerial expense ratio	-0.0189	-0.0216	-0.0236*	-0.00499	-0.00444	-0.00531
	(0.0126)	(0.0135)	(0.0142)	(0.0129)	(0.0138)	(0.0140)
	2072	1863	1752	2072	1863	1752
	0.020	0.020	0.026	0.017	0.017	0.021
Financial expense ratio	-0.0111	-0.0119	-0.00692	-0.0127	-0.0114	-0.00564
	(0.0115)	(0.0112)	(0.00839)	(0.0120)	(0.0111)	(0.00838)
	2072	1863	1752	2072	1863	1752
	0.011	0.045	0.041	0.011	0.045	0.041
Profit–sales ratio	0.0670***	0.0614***	0.0624***	0.0904***	0.0838***	0.0851***
	(0.0211)	(0.0207)	(0.0217)	(0.0217)	(0.0209)	(0.0222)
	2072	1863	1752	2072	1863	1752
	0.031	0.075	0.076	0.039	0.082	0.083
Tax–sales ratio	0.000503	0.000157	0.00107	0.00168	0.00183	0.00288
	(0.00276)	(0.00259)	(0.00304)	(0.00279)	(0.00261)	(0.00312)
	1864	1655	1548	1864	1655	1548
	0.034	0.030	0.033	0.034	0.030	0.033
Subsidy–sales ratio	-0.0161	-0.0153	-0.00891	-0.0168	-0.0164	-0.00969
	(0.0103)	(0.0107)	(0.00847)	(0.0108)	(0.0111)	(0.00910)
	2072	1863	1752	2072	1863	1752
	0.007	0.018	0.028	0.007	0.018	0.028
Average revenue product of labor	9.772	8.973	9.058	8.511	6.867	6.841
	(5.930)	(5.866)	(6.152)	(6.010)	(5.481)	(5.632)
	1863	1654	1547	1863	1654	1547
	0.148	0.203	0.221	0.146	0.201	0.218
TFP (log)	-0.144	-0.304	0.0412	-0.0296	-0.228	-0.156
	(0.469)	(0.529)	(0.459)	(0.438)	(0.507)	(0.493)
	1838	1634	1528	1838	1634	1528
	0.000	0.022	0.146	0.000	0.022	0.146
Lags of utility variables	No	Yes	Yes	No	Yes	Yes
City control variables	No	No	Yes	No	No	Yes

*** significant at 1% level, ** at 5% level, and * at 10% level.

PSP = private sector participation, TFP = total factor productivity.

Note: Columns 1–3 are estimation results of redefining PSP as any nonstate, noncollective capital in utility's capital structure. Columns 4–6 are estimation results of recoding some non-PSP cases into PSP. The four figures of each block are coefficient estimate of PSP, standard errors (in parentheses) clustered at utility level, number of observations, and R-square, respectively, of estimating a fixed-effects panel model for one utility performance indicator.

Source: Authors' estimation.

B. Differential Effects of PSP in Majority and Minority

Table 7 reports the estimation results of equation (3), where PSP is distinguished in terms of its majority versus minority status. We find that PSP-major utilities performed differently from non-PSP and PSP-minor utilities. First, the statistically significant results found on PSP in general—lower employment and managerial expenses as a share of sales and the increase in profitability—mainly accrued to the PSP-major utilities. PSP-minor utilities experienced a reduction in employment and increase in profits as well, but on a smaller, statistically insignificant scale.

As for the other indicators, both impacts of PSP-major and PSP-minor are statistically insignificant. However, there are some discernible differences between the two as far as the magnitude of point estimates is concerned. PSP-major utilities tend to increase investment and the liability ratio more than PSP-minor utilities. The latter, however, is more aggressive in producing outputs measured in sales revenues and value added. With respect to productivity, PSP-minor results in slightly higher labor productivity, probably because of improvement in value added. PSP-major has a positive effect on TFP, while PSP-minor has a negative effect.

The estimation results are consistent across models with additional time-variant controls in columns 2 and 3 of Table 7. They are also robust to the alternatively defined PSP and recoding of some non-PSP utilities, which were discussed in more detail in the previous subsection.[16] The evidence generally supports the idea that private investors are more likely to bring pronounced changes to the water utility if they acquire more than 50% ownership, and thus possess institutional power over the strategic and operational decision making. Private shareholders in the minority could also affect a utility's performance, especially in output expansion and labor productivity improvement. However, the estimates are not statistically significant and are less conclusive.

[16] The results are available upon request from authors.

Table 7: Differential Effects of PSP-Major and PSP-Minor on Urban Water Utility Performance

Dependent Variables	(1)		(2)		(3)	
	PSP-Major	PSP-Minor	PSP-Major	PSP-Minor	PSP-Major	PSP-Minor
Investment	19621	0.581	16755	-3563	20230	-4353
	(17713)	(42140)	(19528)	(38549)	(19792)	(32847)
	1865		1863		1752	
	0.013		0.054		0.063	
Employment (log)	-0.111***	-0.0597	-0.103***	-0.0510	-0.111***	-0.0527
	(0.0393)	(0.0798)	(0.0338)	(0.0616)	(0.0342)	(0.0657)
	1863		1654		1547	
	0.025		0.081		0.105	
Sales (log)	0.0173	0.0805	0.0102	0.0942	0.0169	0.101
	(0.0436)	(0.0779)	(0.0329)	(0.0620)	(0.0347)	(0.0674)
	2072		1863		1752	
	0.318		0.416		0.410	
Value-add (log)	-0.00577	0.0514	-0.0272	0.0691	-0.0169	0.0761
	(0.0674)	(0.0895)	(0.0524)	(0.0688)	(0.0549)	(0.0665)
	1840		1636		1530	
	0.186		0.247		0.248	
Liability ratio	0.0204	0.00929	0.0248	0.00597	0.0248	0.00296
	(0.0282)	(0.0307)	(0.0230)	(0.0228)	(0.0234)	(0.0237)
	2072		1863		1752	
	0.353		0.469		0.451	
Managerial expense ratio	-0.0188*	-0.0307	-0.0197*	-0.0357	-0.0212**	-0.0381
	(0.00953)	(0.0207)	(0.0102)	(0.0231)	(0.0107)	(0.0251)
	2072		1863		1752	
	0.022		0.023		0.028	
Financial expense ratio	-0.0106	-0.0146	-0.00465	-0.0238	-0.00132	-0.0157
	(0.0110)	(0.0192)	(0.00823)	(0.0209)	(0.00760)	(0.0144)
	2072		1863		1752	
	0.011		0.046		0.042	
Profit–sales ratio	0.100***	0.0225	0.0841***	0.0290	0.0833***	0.0278
	(0.0214)	(0.0298)	(0.0190)	(0.0300)	(0.0195)	(0.0334)
	2072		1863		1752	
	0.038		0.079		0.079	
Tax–sales ratio	0.000984	0.00203	0.00110	0.00150	0.00120	0.00383
	(0.00324)	(0.00476)	(0.00319)	(0.00441)	(0.00335)	(0.00558)
	1864		1655		1548	
	0.034		0.030		0.033	
Subsidy–sales ratio	-0.0136	-0.0209	-0.0123	-0.0211	-0.00932	-0.00820
	(0.0107)	(0.0164)	(0.0104)	(0.0177)	(0.0108)	(0.00937)
	2072		1863		1752	
	0.007		0.018		0.028	
Average revenue product of labor	7.743	8.354	5.073	8.537	5.528	7.588
	(6.318)	(7.245)	(5.511)	(6.769)	(5.715)	(6.872)
	1863		1654		1547	
	0.145		0.201		0.218	
TFP (log)	0.530	-0.510	0.369	-0.713	0.448	-0.621
	(0.490)	(0.589)	(0.548)	(0.707)	(0.509)	(0.579)
	1838		1634		1528	
	0.002		0.023		0.148	
Lags of utility variables	No		Yes		Yes	
City control variables	No		No		Yes	

*** significant at 1% level, ** at 5% level, and * at 10% level.

TFP = total factor productivity.

Note: Each block is a set of estimation results of a fixed-effects panel model for one utility performance indicator. The first row are coefficient estimates of PSP-major and PSP-minor, respectively. The second are standard errors (in parentheses) clustered at utility level. The third is number of observations, and the fourth is R-square.

Source: Authors' estimation.

VII. Conclusions

To meet the rising demand for urban water amid rapid urbanization, the PRC began opening its urban water sector to foreign and domestic investors in the early 1990s. The opening was further formalized in 2002. The reform has inspired strong private investors' interest in the sector. By 2007, more than 30% of urban water utilities in our sample involved private ownership, with the numbers of utilities in which private shareholders held majority status picking up after 2002. At the same time, however, concerns arose that privatizing water utilities had weakened the state's control over strategic assets and pushed up water tariffs. These are concerns that policy makers have to address in pushing the reform forward.

In evaluating the benefits and costs of opening water sector, one key policy question is whether PSP has led to investment increase and efficiency improvement in water supply and services. This paper attempts to answer this question with concrete empirical evidence. Through its examination of utility-level data over the past decade, the study finds that PSP has reduced utility employment, has lowered managerial expenses relative to sales revenues, and has increased profitability significantly, in both the economic and statistical sense. PSP has also increased utility investment, sales revenues, value-added, and liability ratio; has lowered financial expenses to sales and subsidies to sales; and has improved labor productivity and TFP—although the estimates are not statistically significant. Further analysis indicates that most of the changes have occurred to utilities with private shareholders in the majority, while PSP in the minority has moderate to little effect on utility performance.

The finding that PSP (in the majority) increases utility's profits substantially while other improvements lack statistical significance may arouse controversy in PSP policy. Opponents would argue that PSP has mainly benefited private investors but has done no good or even harmed water service customers. While these points may have some validity, we would counter that PSP increased utility profitability largely through cost reductions, which promotes optimal resource allocation. There are, potentially, many ways for water utilities to reduce their operational losses and increase profits, including reducing costs, raising efficiency, lowering service quality, and increasing output prices, among others. Our results show clearly that PSP has cut back operational costs in employment and managerial expenses. Take the estimates in column 3 of Table 5 as an example. A 9% decline in employment, suggesting a reduction of 1.8 percentage points in the wages–sales ratio,[17] plus a 2.7 percentage points reduction in the managerial expense ratio, jointly account for more than two thirds of the 6.3 percentage points increase in profit–sales ratio. The results also suggest that other sources of cost reduction (e.g., financial expenses) and efficiency upgrading could contribute to profit increase too, although the evidence is not statistically strong enough to be conclusive.

[17] Here, we apply the industry average, about 20% of the sales revenues going to wages.

Second, the cost reductions are not necessarily accompanied by impairment of service quality. Bai, Lu, and Tao (2009) find similar results across different industries following privatization in the PRC. To the extent that indicators of water service quality, such as water pressure, leakage rate, interruption frequency, and water quality, are relatively easy to measure and monitor, lowering service quality to bring down costs does not seem to be the optimal strategy for PSP utilities in the long term. Of course, how PSP has affected water service quality is eventually an empirical question and more research in this respect is warranted given data availability. Lastly, profit increase of water utilities also benefited the governments and the interest they represent in that the governments usually remain in the PSP utilities as important shareholders.

A popular view against water utility PSP is that private investors push up water tariffs in order to obtain adequate investment returns. There are even rumors of a conspiracy between investors and local governments, the latter accepting water tariff increases from investors to attract extra funding for economic growth and urban development. In reality, the determination of water tariffs is a complex process involving multiple stakeholders. Although local governments could initiate a new tariff, they increasingly have to take feedback from consumers into account. Even though government administration that negotiated with the private investors on PSP may have agreed to raise water tariffs, any incoming administration is likely to express reservations about such agreements if those water tariff increases would result in political pressure. Finally, every new tariff is subject to the approval of the provincial governments. Preliminary analysis of city water tariffs from 2007 to 2010 shows that neither the degree of privatization of the whole water sector nor PSP in the largest water utilities in a city is associated with water tariff increases. Nevertheless, the impact of PSP on water tariffs and the mechanism for setting them is still an open area for more research.

Appendix: Variable Definitions

Variables	Definitions
Water Utility Variables	
Private sector participation (PSP)	Dummy variable = 1 if state capital share in total capital is less than 1
PSP-major	Dummy variable = 1 if state capital share in total capital is equal to or less than 50%
PSP-minor	Dummy variable = 1 if state capital share in total capital is less than 1 and greater than 50%
Assets (log)	Logarithm of total assets in 1,000 CNY, in 1998 constant prices
Investment	Difference between assets in the end of current year and assets in the end of previous year, both in 1998 constant prices
Employment (log)	Logarithm of number of employees
Sales (log)	Logarithm of sales revenues in 1,000 CNY, in 1998 constant prices
Value-add (log)	Logarithm of value added in 1,000 CNY, in 1998 constant prices
Liability ratio	Ratio of liability to total assets
Managerial expense ratio	Ratio of managerial expenses to sales revenues
Financial expense ratio	Ratio of financial expenses to sales revenues
Profit–sales ratio	Ratio of profits to sales revenues
Tax–sales ratio	Ratio of tax paid to sales revenues
Subsidy–sales ratio	Ratio of subsidy to sales revenues
Average revenue product of labor	Value added in 1998 constant prices divided by total employment
TFP (log)	Logarithm of total factor productivity as calculated by equation (1)
City Variables	
Population	Logarithm of total population of the city
Population density	Population per square kilometers
GDP per capita	Per capita gross regional product in CNY, in 1998 constant prices
Share of industry in GDP	Percentage of industry in total GDP
Share of services in GDP	Percentage of services in total GDP
Fixed assets investment relative to GDP	Ratio of fixed assets investment to GDP
Public financial deficit	Difference between public expenditure and revenues in 10,000 CNY, in 1998 constant prices
Residential water consumption per capita	Annual per capita water consumption of urban residents in cubic meters per person
Water density	Total water supply divided by GDP in cubic meters per CNY
Urban road area per capita	Total urban road areas divided by population in square meters per person

CNY = yuan, GDP = gross domestic product.

Sources: Water utility variables are constructed from Annual Industrial Firm Surveys. City variables come from *China City Statistical Yearbooks.*

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About the Paper

Yi Jiang and Xiaoting Zheng study a unique panel of more than 200 urban water utilities of Chinese cities from 1998 to 2007. They find that utility's profitability and city's road infrastructure in the prior year play a positive role in attracting or keeping private investors to the urban water sector. Private sector participation, especially as major shareholders, has substantially reduced employment, lowered managerial expenses, and increased the profitability of the utility.

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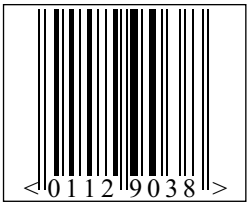

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