PEOPLE'S REPUBLIC OF CHINA: DO PRIVATE WATER UTILITIES OUTPERFORM STATE-RUN UTILITIES?

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Xiaoting Zheng is an associate professor at the Institute of Industrial Economics at Jinan University. Yi Jiang is a senior economist with ADB's Economic Research and Regional Cooperation Department. Craig Sugden is a principal private-public partnership specialist with ADB's East Asia Department. Comments from Yun Huang, an independent consultant specializing in the water and wastewater sector, are gratefully acknowledged. Julie Ann Chua provided excellent research support.

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ABSTRACT

Since 1992, private investors have been acquiring part ownership in water supply utilities in the People's Republic of China (PRC). The impacts of public–private partnership (PPP) on urban water utilities' performance and water supply in the PRC are evaluated using data from more than 300 prefecture city water utilities from 2000–2007. The key findings are that PPPs significantly improve water utilities' performance by reducing subsidy ratio, number of employment, and improving total factor productivity. The findings support the PRC government's promotion of PPPs in water supply. They make a case for extending competition into other infrastructure sectors via the promotion of PPPs.

Keywords: Urban water utilities, PPPs, water supply, PRC

JEL Classification: Q25, L33, L38

EXECUTIVE SUMMARY

Rapid economic development and industrialization have a major impact on the demand for water in the People's Republic of China (PRC). As the economy changed over the 1980s and into the 1990s, substantial investment became necessary in water and wastewater treatment facilities, pipe networks, and other components of the water sector. A large shortfall quickly became evident in the capacity of the PRC's local governments—who were responsible for the water sector—to invest in and run water utilities. Reform was needed. Introducing private investors to public water utilities offered a way of both financing investment and correcting the widely criticized, poor performance of the public water utilities.

In line with the transition to a socialist market economy, a transformation of the water sector began in the early 1990s. The central government issued a series of incentive policies and programs aimed at creating a competitive water market. A blanket coverage of local government monopolies has been replaced by an open and diverse market. This has delivered more and better quality services. Water is probably now the most market-oriented infrastructure sector within the PRC.

Public-private partnerships (PPPs) provided the tool for reform. Foreign investors led the initial PPPs along with local private operators and investors. As the local market matured, independent, commercialized state-owned enterprises (SOEs) also moved into the water sector.

This paper quantifies the impact of PPPs on the efficiency and effectiveness of the water sector. It reexamines whether the opening of the water market to competition and dismantling of local monopolies did indeed offer the hoped-for benefits. The paper does so by comparing the performance of state-run urban water utilities with utilities run as PPPs.

The paper is based on the experience from 2000 to 2007 of 300 of the PRC's prefecture cities. In these cities, the number of PPPs increased from 24 in 2000 to 92 by 2007, while the number of state-owned water utilities decreased from 310 to 232. In 2000, only 8% of water utilities in prefecture cities included private participation. This ratio had risen to almost 40% by 2007. The share of these PPPs in total capital, assets, and sales rose from about 10% in 2000 to nearly 40% in 2007, and the employment share increased from 8% to 28%.

The average value of capital and assets of the PPPs is much higher than that of state-owned utilities, while the average numbers employed is similar. Average sales revenue per employee of PPP utilities are higher than those of state-own utilities. The management cost share is a little lower in PPP utilities, and the average subsidy of the PPPs is lower. The average value added per employee of PPPs is higher in most years. The PPPs have a positive total factor productivity (TFP) on average, while TFP is on average negative for the state-owned utilities.

For cities with PPP water utilities, the average supply areas were found to be larger, leakage is lower, growth rate in the tap water population after 2002 is faster, and water meters in total number and number of residential users higher.

Econometric techniques are used to explore the impact of the PPP mode in urban water by examining a range of financial and water supply indicators. The key findings are that urban water utilities run as PPPs are more efficient than state-run urban water utilities, while both are equally effective. PPPs significantly raises TFP, and reduce subsidies and labor costs. PPPs are estimated to reduce

employment by at least 6%, lower the subsidy ratio by 1 percentage point, and improve TFP by 5% to 16%. Many of the PPPs in the PRC's water sector have mixed private-state ownership. PPPs with majority private ownership had better impacts than those with minority private ownership.

There is also some marginal improvement in other efficiency indicators, including bill collection and distribution energy consumption. Most indicators of effectiveness are however, not affected by adoption of PPPs. In general, running a water utility as PPP has no effect on the coverage of water supply or other indicators of water quality.

PPPs are being pursued in the PRC because they are expected to improve the delivery of public services. A past emphasis on the use of PPPs as financing vehicles has been replaced by an emphasis on their role in public sector reform. The State Council, for example, has explained that the "PPP mode is an important innovation of the public services supply mechanism. PPP mode can give full play to the market mechanism to improve the quality and efficiency of the supply of public services, and maximize public interests."

This paper provides empirical evidence that PPPs can indeed provide the hoped-for improvements in the PRC. While the evidence is from within a single sector, it is in line with the widespread perception in the PRC that the private sector is outperforming the SOEs, and the international experience of the benefits of well-managed private participation in infrastructure. While some PPPs will fail and poorly prepared PPPs should always be avoided, the paper provides confidence that in the PRC, PPPs will generally outperform state-run infrastructure monopolies.

The findings also point to a need to better understand why the water utility PPP, although confirmed as more efficient, has not also generated dividends in effectiveness. One plausible explanation is that more attention is required to the output specifications included in PPP agreements. Specifically, PPPs may need clearer obligations to improve the effectiveness of urban water supply networks.

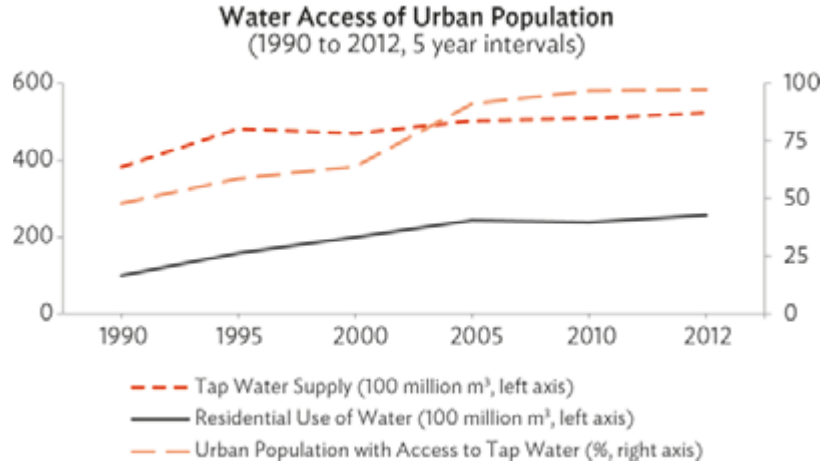
Tariffs for both treated water and wastewater generally remain below cost recovery, despite many years of tariff reform. Water industry revenue reforms will be central to efforts to expand private participation in the water sector. Better revenue flows, in terms of both higher tariffs and more reliable payment, are needed to make investment affordable to government or to ensure that investments are commercially viable for private operators. Revisions of water tariffs could be usefully joined in efforts to improve the effectiveness of water utilities. Matching such efforts will help address reservations from the community in higher tariffs, as they would see the benefits of paying more for water supply.

I. INTRODUCTION

1. Rapid economic development and industrialization pushed up the demand for clean water in the urban areas of the People's Republic of China (PRC). Especially in the 1980s and 1990s, substantial investment was needed in water and wastewater treatment facilities, pipe networks, and other components of the water sector. But a large shortfall became evident in the capacity of the PRC's local governments—who were responsible for the water sector—to invest in and run water utilities. Reform was needed. Introducing private investors into the public water utilities offered a way of both financing investment and improving the widely criticized, poor performance of the public water utilities.

2. In line with the initiation of a transition to a socialist market economy, a transformation of the water sector began in the early 1990s. The central government issued a series of incentive policies and programs aimed at creating a competitive water market. A blanket coverage of local government monopolies was progressively replaced by an open and diverse market that has delivered more and better quality services (Figure 1). Water is now the most market-oriented infrastructure sector within the PRC.

Figure 1: PRC Water Access



m^3 = cubic meter.

Source: National Bureau of Statistics (2014).

3. Public–private partnerships (PPPs) is one vital option for reform. Foreign investors led the initial PPPs along with local private operators and investors. As the local market matured, independent, commercialized state-owned enterprises (SOEs) also moved into the water sector.

4. The PRC's positive experience with PPPs in the water sector is in line with the experience of many countries with private participation in infrastructure. The 2015 *OECD Investment Policy Review* concluded:

> "By delegating the construction and often times the management of infrastructure projects to private investors, governments are also likely to reap cost and efficiency gains. Evidence collected from the performance of more than 1,200 water and energy utilities in 71 developing and transition economies between 1990 and 2002 indicates that greater degrees of private participation are associated with stronger gains in productivity and service quality. These gains include a 12% increase in the average number of residential water connections, a 32% rise in electricity sold per worker, a 19% increase in the residential coverage of sanitation services, a 45% improvement in the electricity bill-collection rate, an 11% drop in electricity distribution losses, and a 41% increase in hours of daily water service." [1]

5. This paper seeks empirical evidences of the impact of PPPs on the water sector. It re-examines whether the opening of the water market to competition and the dismantling of local monopolies did indeed offer the hoped-for benefits. The paper does so by comparing the performance of state-run urban water utilities with utilities run as PPPs.

6. The paper is based on the experience from 2000 to 2007 of 300 of the PRC's prefecture-level cities. Econometric techniques are used to explore the impact of the PPP mode on urban water sector by examining a range of financial and water supply indicators. The key findings are that urban water utilities run as PPPs are more efficient than state-run urban water utilities, while both are becoming more efficient.

7. PPPs significantly raise total factor productivity (TFP), and reduce subsidies and labor costs. PPPs are estimated to reduce employment by at least 6%, lower the subsidy ratio by 1 percentage point, and improve TFP by 5% to 16%. Some of the PPPs in the PRC's water sector have mixed private–state ownership. PPPs with majority private ownership had better impacts than those with minority private ownership.

8. Other efficiency indicators also marginally improved, including bill collection and distribution, and energy consumption.

9. Most indicators of effectiveness are, however, not significant. In general, running a water utility as a PPP is not superior than as an SOE on the coverage of water supply or other indicators of water quality after controlled for the city variables.

10. These findings support the promotion of PPPs in the water sector by the PRC government. The findings make a case for extending competition into other infrastructure sectors by promoting PPPs.

11. The findings also point to a need to better understand why the water PPP, although confirmed as more efficient, has not also generated dividends in effectiveness. One plausible explanation is that local governments focused their reform effort on improving efficiency and reducing financial losses, and the need for government subsidies. It may now be timely to extend the scope of reforms by paying more attention to the output specifications included in PPP agreements. Specifically, PPPs may need clearer obligations to improve the effectiveness of urban water supply networks.

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[1] OECD. 2015.

II. THE PRC'S WATER SECTOR

A. Water Supply and Demand

12. The PRC is a country with poor water resources—with water resources per capita about only one-quarter of the world's average. According to the United Nations, an area is under water stress when annual water supplies drop below 1,700 cubic meters (m^3) per person. The PRC's per capita water resources were close to this water stress line in 2004, 2009, and again in 2011.[2] It is estimated that by 2030 there will be 1.5 billion people in the PRC, and per capita water resources could fall to 1,750 m^3, barely above the 1,700 m^3 measurement that defines a water-scarce nation.[3]

13. Aside from short supply, water resources are unevenly distributed. The Yangtze River basin and territory south of the river account for 37% of the PRC's land area, yet have about 81% of total water resources.[4] The distribution of water resources in the PRC does not match the spatial distribution of the population and economic development. Extreme weather conditions have intensified the effects of the uneven distribution of water resources, and water shortages have become more frequent and prominent.

14. The PRC's extended period of high economic growth has increased water usage, with the country's total water usage lifted from 444.0 billion m^3 in 2000 to 618.3 billion m^3 in 2013 (Table 1 and Figure 2). Out of the total, household water consumption accounted for 12.1%, industrial water accounted for 22.7%, agriculture accounted for 63.4%, and ecological uses accounted for 1.7%. The rapid rate and vast scale of urbanization has underpinned a rise in household water demand. The household domestic water consumption rose from 28.0 billion m^3 in 1980 to 75.0 billion m^3 in 2013, an annual compound growth rate of 2.1%.[5] Continuing rapid urbanization and rising living standards, and ongoing demand from industrial users, is likely to see further increases in total water consumption.

15. High demands on water resources and pollution from industrial activities, urbanization, agricultural, and other activities led to deterioration of water quality in PRC. In the PRC's seven major rivers, for example, 3.0% were rated poor in 2001 and unsuitable for drinking or swimming. By 2007, this ratio had risen to 50.8% (Figure 3). Declining water quality has threatened urban water security and posed a constraint to the achievement of sustainable economic development.

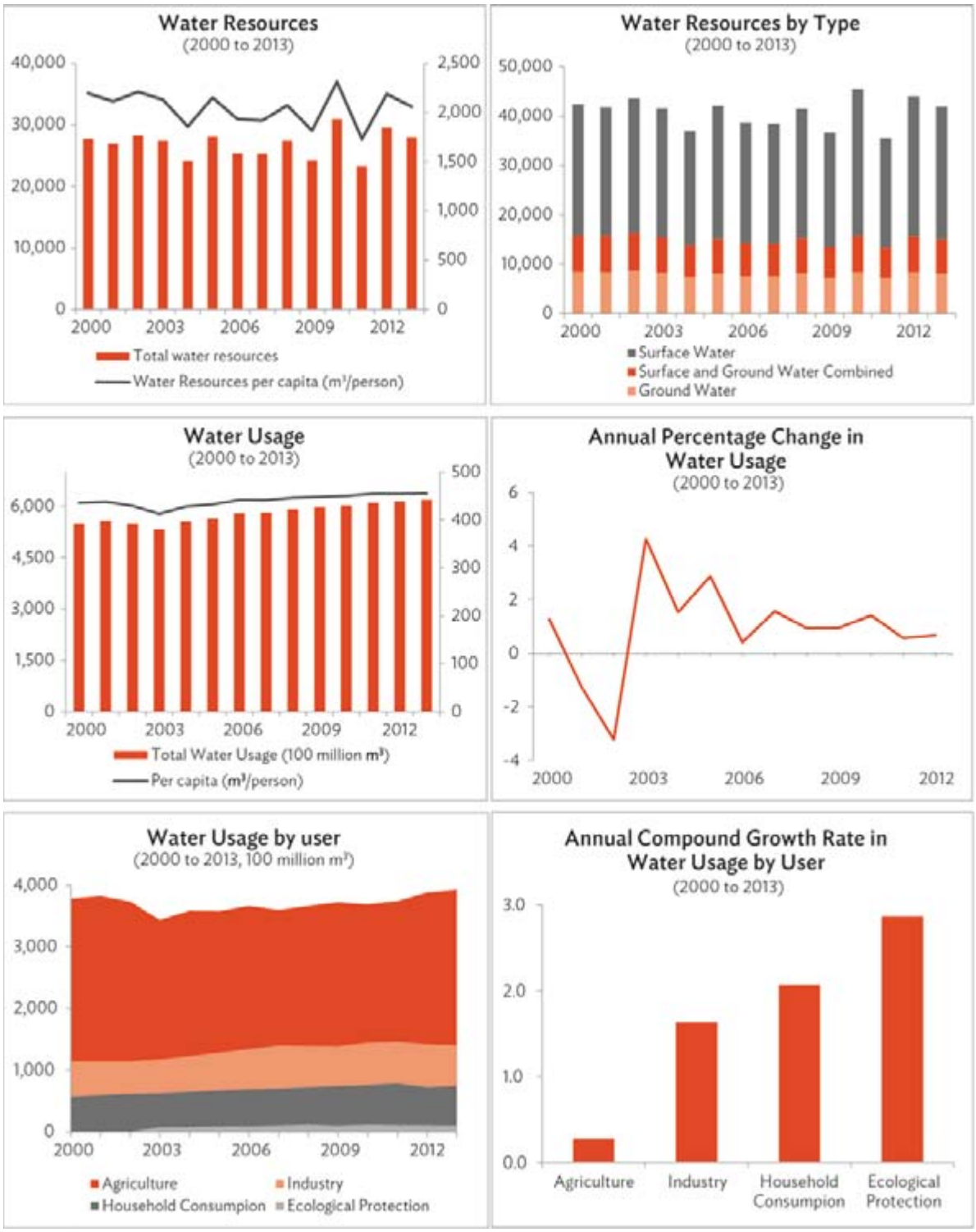
Table 1: Water Use, by Sector
(2008–2013)

Sector	1980 (in 100 m^3)	2013 (in 100 m^3)	Average Growth Rate 1980–2013 (% p.a)
Agricultural	370	392	0.175
Industrial	46	141	3.337
Domestic	28	75	2.941
Total	**444**	**618**	**0.997**

Source: International Institute for Applied Systems Analysis (1999) and National Bureau of Statistics (2014).

[2] National Bureau of Statistics (2014).
[3] Henry (2004).
[4] Ministry of Water Resources (2011).
[5] NBS (2014).

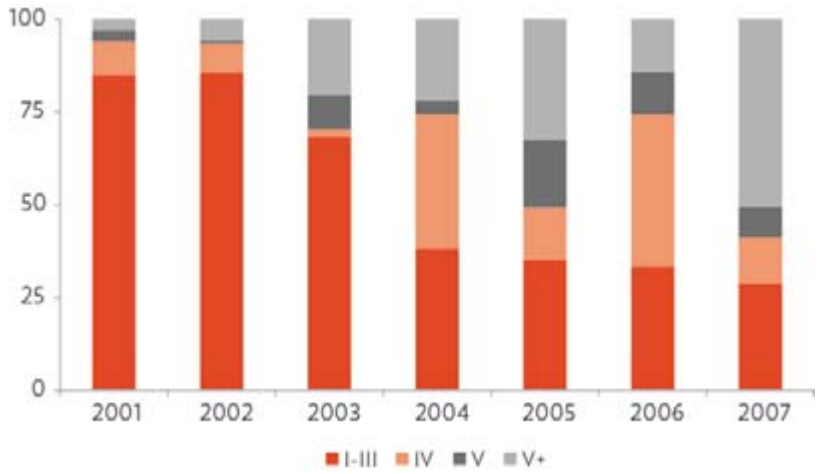
Figure 2: PRC Water Statistics
(2000–2013)



m^3 = cubic meter.

Source: National Bureau of Statistics (2013).

Figure 3: Water Quality of PRC's Seven Major Rivers



Note: In the PRC, water quality is graded I to V+. Grades I, II , and III are described as "good" and grades IV, V and V+ are "poor" and cannot support drinking or swimming.

Source: [The People's Republic of] China's Water Environmental Status Report (2008). Responsible Research (2010).

16. At the same time, heightened public sensitivity to environmental issues underpinned increased government attention to the water sector. Many local governments had paid insufficient attention to the negative impact of economic development on the environment. However, there is a growing awareness of the need for improved environmental protection, including a better performance from the water sector.

B. Avoiding a Water Crisis

17. The combined effect of a widening gap between water demand and supply and deteriorating water quality was a looming water crisis. Policy and regulatory amendments were required, and were introduced along with important institutional reforms. The focus was on securing drinking water supplies, improving water conservation, and preventing water pollution. A continuous reform process by a wide range of government agencies saw a modernized water management system take shape.

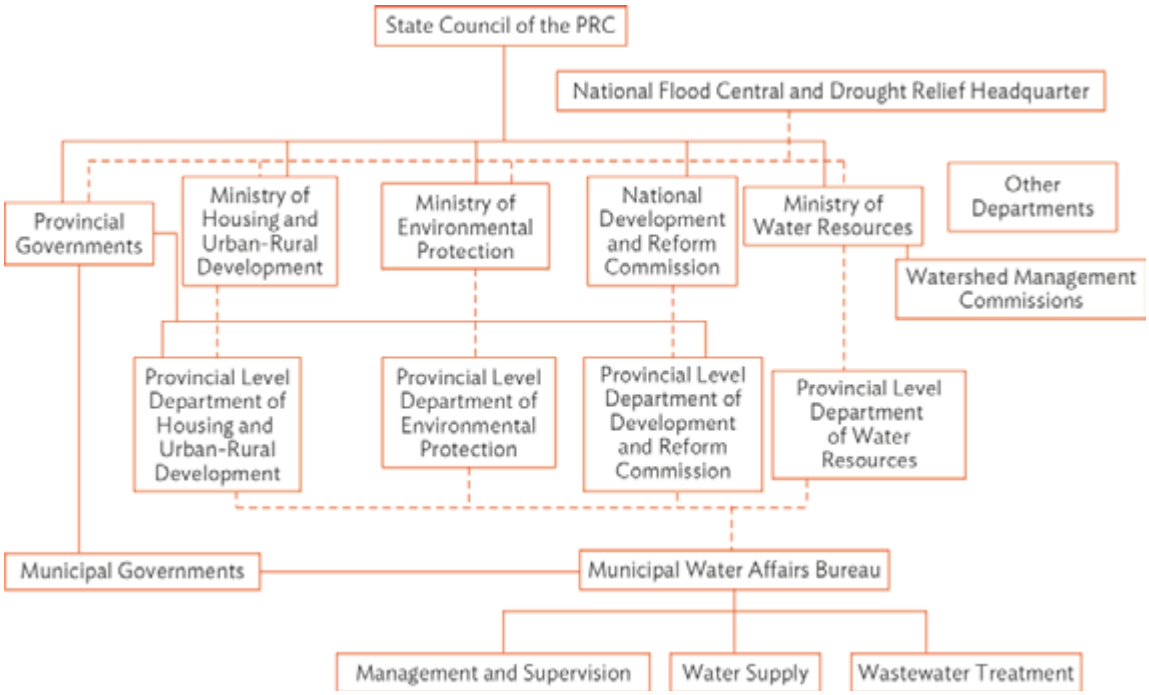
18. The PRC's current water management system is built on the 2002 Water Law, and a series of implementing regulations and documents. Notably, the State Commission for Public Sector Reform issued the Notice on Issues of the Local Water Institutions in September 2002 and March 2003. The General Office of the Ministry of Water Resources issued the Notice on Major Tasks for Year 2003 in Water Resources, then later introduced for the first time the concept of management of "water affairs." In February 2005, the Ministry of Water Resources issued the Notice on Deepening the Reform of Water Management System and Guiding Principles. This was the first regulation to define water management in the PRC; "the unified management of water resources in both urban and rural area, based on a jurisdiction concept, comprehensive management of flood control, water supply, water resources utilization, water conservation, sewage, wastewater treatment and recovery, water and soil conservancy, conservation, rural hydropower and other water administrative affairs."

19. Institutional reforms under the 2002 Water Law established new, integrated local water bureaus. Their functions were modeled on the water bureau in Shenzhen City, the PRC's first. Before 2002, it was typical for the Municipal Construction Bureau, Municipal Environmental Protection Bureau, and Municipal Planning Department to manage the development of water supply enterprises, and sewage treatment, and water pollution prevention and control. These functions were transferred to an integrated municipal water bureau, which took over all administrative and supervisory functions as a unified body of municipal water management (Figure 4).

20. A wide range of laws and regulations are now in place for the water sector, including water standards, and industrial wastewater discharge standards for different industries issued by a range of ministries and departments (Box 1). Many have been progressively refined through amendments.

21. The reforms supported a solid expansion in the water sector. Growing at an average rate of 1.9% per annum from 2000 to 2012, total water supply production capacity had reached 272 million m^3 per day by the end of 2012. The length of urban water supply pipes grew at an average rate of 7.3% per annum from 2000 to 2012 to reach a total of 591,900 kilometers (km), more than double the length as of the end of 2000. By the end of 2012, the PRC's urban water coverage rate had reached 97.2%.[6]

Figure 4: Institutional Framework of Water Management



PRC = People's Republic of China.

Source: Adapted by the authors from the State Council of the People's Republic of China (2014).

[6] National Bureau of Statistics of [the People's Republic of] China (2010).

Box 1: Key Laws and Regulations for the Water Sector

"Water Law," August 2002, National People's Congress.

"Water Pollution Prevention Law," February 2008, National People's Congress.

"Marine Pollution Prevention Law," November 1999, National People's Congress.

"Drinking water pollution prevention regulations," November 2007, State Environmental Protection Administration.

"Urban Drainage and Wastewater Treatment," October 2013, State Council.

"Water Diversion Project for Water Management Regulations," February 2014, State Council.

"Rural drinking water safety project construction management approach," December 2013, the National Development and Reform Commission, Ministry of Water Resources, Ministry of Health and Family Planning Commission, Ministry of Environmental Protection, Ministry of Finance.

"Prevention of Pollution from Ships Marine Environment Management Regulations," September 2009, State Council.

"Water permits and water fee collection regulations," February 2006, State Council.

"Livestock farming pollution Prevention Act," November 2013, State Council.

"Drinking water health standards," July 2007, Ministry of Health, National Standardization Management Committee.

"Urban Water Quality Standards," June 2005, Ministry of Construction.

"Urban sewage treatment plant operation supervision and management of technical specifications," September 2014, Ministry of Environmental Protection.

"Rural drinking water sources Environmental Technical Guide (HJ 2032–2013)," July 2013, Ministry of Environmental Protection.

"Urban sewage treatment plant emission standards," July 2003, State Environmental Protection Administration, State Administration of Quality Supervision, Inspection and Quarantine.

"Sewage discharged into the city sewer water quality standards," November 2014, Ministry of Housing and Urban Construction.

"Urban recycling of industrial water quality," April 2006, National Quality Supervision and Inspection and Quarantine; National Standardization Management Committee.

"Reused water quality standards," June 2007, Ministry of Water Resources.

"Municipal Wastewater Recycling Technical Guide (Trial)," Ministry of Housing and Urban Construction.

"Municipal Wastewater Treatment Plant Sludge Treatment and Disposal Technical Guide (Trial)," March 2011, Ministry of Housing and Urban Construction; National Development and Reform Commission.

"Urban water supply facilities construction and renovation Technical Guide," October 2012, Ministry of Housing and Urban Construction.

"Anaerobic expanded granular sludge bed reactor wastewater treatment engineering and technical specifications," March 2013, Ministry of Environmental Protection.

"Completely mixed anaerobic wastewater treatment tank engineering and technical specifications," March 2013, Ministry of Environmental Protection.

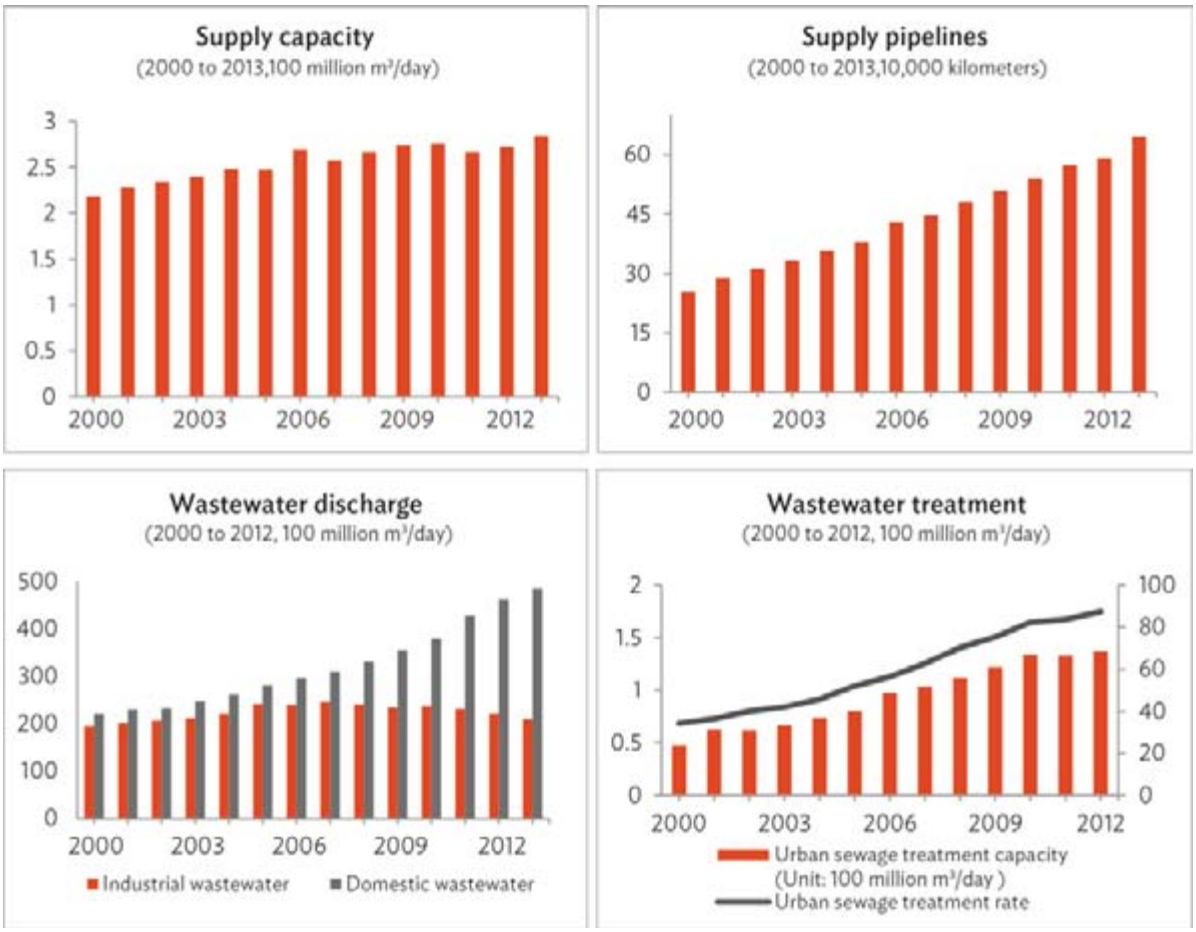
"Membrane biological wastewater treatment engineering and technical specifications," January 2012, Ministry of Environmental Protection.

"Bio-contact oxidation wastewater treatment engineering and technical specifications," January 2012, Ministry of Environmental Protection.

"Coking wastewater treatment project technical specifications," March 2013, Ministry of Environmental Protection.

22. Substantial investment also took place in sewage treatment facilities. Both the national Eleventh Five–Year Plan, 2006–2010 and the Twelfth Five–Year Plan, 2011–2015[7] listed target city-specific sewage treatment rates, and in April 2012 the State Council issued the Twelfth Five–Year Plan, 2011–2015; and National Urban Sewage Treatment and Recycling Facilities Construction Plan.[8] This construction plan set targets for 2015 of a centralized sewage treatment capacity rate of 85% for cities and counties and 30% for towns. Urban sewage treatment capacity grew at an average rate of 8.4% per annum from 2003 to 2012 to reach a total of 136.93 million m^3 per day, more than double the capacity as of end 2003. By the end of 2012, the city sewer system had reached 439,000 km and the urban sewage treatment rate was 84.9%.[9]

Figure 5: A Snapshot of the PRC's Urban Water



m^3 = cubic meter.

Source: Ministry of Environment Protection of PRC (2013).

[7] Government of the People's Republic of China (2010).
[8] State Council of the People's Republic of China (2012).
[9] National Bureau of Statistics of [the People's Republic of] China. 2013.

23. The urban recycling water industry is in its infancy. But the rapid development of the sewage treatment industry has provided favorable preconditions and market opportunities for water recycling. Water conservation strategies are being promoted, with renewable water resource initiatives adopted in some of the major cities, including Beijing, Tianjin, and Qingdao. Recycled water is widely used for agricultural irrigation, in industrial uses, and in urban landscaping.

III. ENTRY OF THE PRIVATE SECTOR

C. The Broader Setting

24. The PRC economy has undergone fundamental change as it transformed from relying completely on state-owned and collective enterprises with little foreign investment and international trade, to a mixed economy where fully commercialized state-owned and private enterprises play an increasing role. Private participation in the water sector has reflected these broader changes in the economy, and is likely to remain tied to efforts to further marketize the economy.

25. The goal of achieving a socialist market economy was endorsed in 1992 by the 14th Communist Party Congress, and in 1993 a "grand strategy" was adopted of a transition to a market economy with an emphasis on a rule-based system and building market-supported institutions. Private sector development was boosted by intensive efforts initiated by the 15th Party Congress in 1997 to reorganize the SOEs, and the recognition, of the private sector as an important component of the PRC's socialist market economy. A dual-track approach was pursued that encouraged the development of the private sector in tandem with reform of the state sector. Efforts to establish a foundation for equal treatment of the private sector began, which continued through the early part of the next decade. In 1999, private ownership and the rule of law were incorporated into the constitution. Accession to the World Trade Organization in 2001, which removed restrictions to foreign investment in many sectors of the economy, provided further impetus.

26. The private sector expanded as the government forged improvements in the enabling environment. Over the 2000s, revisions to the Company Law made it significantly easier to start new businesses, the Bankruptcy Law and Partnerships Law were revised, and efforts were made to simplify investment procedures and foster greater transparency in investment regulations. The 2007 Property Law improved the legal basis for protecting private property as well as allowing financing of secured transactions with assets such as accounts receivable and business inventory. To improve access to finance, banks were encouraged to lend more to small- and medium-sized enterprises, measures were promulgated to support financial leasing, reforms to public equity markets made it easier and more attractive for private firms to list, and the building blocks for a domestic private equity industry were developed.[10]

27. The potential of the private sector was demonstrated by developments in the industry sector. The number of medium and large private enterprises in the sector expanded from around 100,000 to more than 330,000 from 1998 to 2013, while the ratio of private enterprise assets in the industry to gross domestic product rose from 40% to 89% over the period. Private employment in the industry sector rose from 24 million persons to 74 million persons from 1998 to 2011. Private enterprises have

[10] The early development of the PRC's private sector is set out in ADB. 2003. *People's Republic of China: Private Sector Assessment*. Manila; and ADB. 2011. *Country Partnership Strategy: People's Republic of China, 2011–2015*. Manila. (Linked document: Private Sector Assessment).

expanded at a much faster rate than SOEs and other state-controlled enterprises, which in the industry sector declined from about 65,000 in 1998 to less than 20,000 by 2013. Private enterprises now account for 60% of assets and generate 75% of profits in the industry sector. Rates of return earned by private enterprises have on average been almost double that of the SOEs, pointing to a much better performance by the private sector.[11]

28. The private sector nonetheless struggled to develop in areas of the economy where it faced a dominating presence from SOEs, notably in the finance sector. The private sector remained excluded from certain areas of the economy—notably electricity transmission and distribution, petroleum and petrochemicals, telecommunications, coal, civil aviation, and waterway transport—which were reserved for SOEs. It was generally difficult for the private sector to gain strong presence in infrastructure given widespread preference of local governments to issue projects to their own SOEs. Tollways and electricity generation, and subsequently the water sector (excluding water pipelines, which remained reserved for the state sector), were notable exceptions within infrastructure.

29. The private sector had taken its first, tentative steps in the delivery of infrastructure even before the 1990s' reorientation to a socialist market economy. A small number of the modern form of PPPs were seen in the PRC in the 1980s. Their use gathered pace in the early 1990s with the release of policy statements and regulations in support of PPPs. The range of these releases widened over the 1990s, and they continued into the 2000s.

30. Key regulations issued by central government agencies included the: Circular on Several Issues Concerning the Examination, Approval, and Administration of Experimental Foreign-Invested Concession Projects (1995); Provisional Measures on the Overseas Financing of Projects (1995); Opinions on Accelerating the Market Liberalization of Public Utilities (2002); Rules on Management of Urban Utilities Concessions Operation (2003); Measures on Public Utilities Concession Management (2004); Sample Document for the Concession Operation of the Urban Water Supply; Gas Supply and Waste Disposal (2004); and the Opinions on Strengthening Regulation of Public Utilities (2005).

31. Many local governments also issued PPP regulatory instruments. Examples included the Rules for the Operation of Urban Utilities Concessions (2003) issued by the Shenzhen Municipal Government, the Rules for the Operation of Urban Basic Utilities Concessions (2003) and Regulations for Concession Operation of Basic Urban Facilities (2006) approved by the Beijing Municipal Government, and the Procedures on the Administration of Urban Infrastructure Concession (2010) issued by the Shanghai Municipality. Other examples were found in Hebei, Hefei, Henan, Hunan, Guizhou, Ji'nan, Jiangsu, Liaoning, Qinghai, Shandong, Sichuan, Shanxi, Shanxi, Tianjin, Wuhan, Xinjiang, Xuzhou, and Yunnan.[12]

32. Sample PPP contracts were also issued by the Ministry of Construction in the mid-2000s for urban water and sewage, heating, and solid waste management, which greatly facilitated their uptake by local governments. The reforms progressively opened up urban infrastructure market, creating market competition as a replacement of local monopolies.

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[11] The data exclude small enterprises, and define the private sector as all enterprises excluding SOEs and state-held industrial enterprises (National Bureau of Statistics of [the People's Republic of] China. 2014. [The People's Republic of] *China Statistical Yearbook*. http://www.stats.gov.cn/tjsj/ndsj/2014/indexeh.htm).

[12] Fu, Change and Zhong (2008); Cheng and Wang (2009); and Wang, Ke, and Xie (2012).

33. The broader role of the private sector in public service delivery, not just economic infrastructure, had been clarified in 2005 by a prominent, overarching policy statement, the "Several Opinions of the State Council on Encouraging, Supporting and Guiding the Development of Individual and Private Economy and Other Non-Public Sectors of the Economy." Known as the "36 Clauses," the statement clarified that private sector investment was welcome in all sectors of the economy, except specific sectors identified as of strategic national interest, and pledged to promote private sector development.

34. In 2010, the State Council issued "Several Opinions on Encouraging and Guiding Healthy Development of Private Investment," known as the "new 36 Clauses." The new 36 Clauses were notable for encouraging and guiding the entry of private capital into a broad range of industries, along with the use of a wider range of investment vehicles. Support for the approved participation of the private sector in communication, power, and transport was to continue. The private sector was also encouraged to invest in the construction of roads, waterways, seaports, civil airports, common aviation facilities, railways, and clean energy. The new 36 Clauses encouraged a further deepening of the reform of the municipal utility system, including through the transfer or equity or management rights to the private sector. This included the fields of municipal water supply, gas supply, heat supply, sewage and waste disposal, public transport, and urban landscaping. Special note was made of the need for a favorable institutional environment that would encourage and guide the entry of private capital in municipal areas.

35. The Twelfth Five-Year Plan for National Economic and Social Development (2011–2015) of the PRC provided further impetus to the engagement of the private sector in public service delivery. The plan called for an expansion in infrastructure and other public services at the municipal level to meet the needs of rising urban populations.[13] An aim of ensuring equal access to basic public services was set.

36. Hundreds of infrastructure PPPs were put in place by the private sector over the 1990s and 2000s, many of which were led by foreign investors. According to World Bank data, PPPs that partnered with the private sector reached a peak in 1997 of the equivalent of 1.4% of gross domestic product or 10.5% of government expenditure (Figure 6). Many more PPPs were also issued in which SOEs provided the "private partner." Data on these additional PPPs is, however, lacking and the full extent of such PPPs has not been quantified.

37. The public sector dominated the delivery of infrastructure and other public services. Private firms found it difficult to obtain scale-economies that would allow them to compete on equal terms with SOEs in sectors such as power generation and telecommunications. In some instances, private businesses were unable to obtain bank financing for projects in previously restricted sectors because of a lack operating experience. Banks dominated the financial sector and still favored SOEs over private enterprises. Governments tended to turn the private sector for infrastructure when they lacked financial resources—and except for the water sector—they did so less over the 2000s as fiscal constraints on local governments were relaxed.

[13] Government of the PRC (2010).

Figure 6: A Snapshot of the PRC's Private PPPs in Infrastructure

PPP = public–private partnership.

Notes: The data only show PPPs that involve a private partner, where state-owned enterprises or their subsidiaries that remain majority owned by government entities are not considered a private partner. The data show the number of PPP projects and the value of the investment committed to by the project. Data for 1989 are estimated as the average of 1990 and 1991. Constant prices estimates use the gross domestic product deflator.

Source: ADB estimates based on World Bank (2014) and the International Monetary Fund (2014).

38. The imperative to work with the private sector was weakened even further by the economic stimulus package provided in response to the global economic and financial crisis. Even though infrastructure investment remained high following the global crisis, private investment in infrastructure via PPPs declined. World Bank data reported investment by PPPs that partnered with the private sector as the equivalent of 5% of government expenditure in 2013, with 73 infrastructure PPPs finalized.

39. The Third Plenary Session of the 18th Central Committee of the Communist Party of [the People's Republic of] China held in November 2013 then initiated a ramp up in PPP activity. In what are known as "the Decisions," a commitment was made to further restructure the economy and foster inclusive growth by allowing the market to play a decisive role in the PRC's development.[14] Among other initiatives, the decisions committed to allow social capital (which include the private sector and SOEs) to participate in urban infrastructure investment and operation through concessions. Concessions, or PPPs, are to be a vehicle for broadening urbanization financing channels, accelerating the transformation of government functions, and improving fiscal investment and management.[15]

40. Wide-ranging policy announcements and regulatory releases from the central government subsequently set out a new operational framework for PPPs. Many good international practices have been introduced, and PPPs are now being promoted across urban economic and social infrastructure. One of the features of this latest wave of PPP activity is a formalization of the interpretation of PPPs as "government and social capital cooperation." SOEs as well as the private sector are to fill the role of the "private partner." This formalized what had become common practice by the late 2000s.

D. Private Participation in the Water Sector

41. Under the PRC's centrally planned economy, a city's water services, including water investment were managed solely by its government. As well as providing additional finance for much needed investment, the introduction of private ownership was expected to launch management reforms that would improve operational efficiency and service quality.[16] Private participation was limited initially to a small number of leading international water equipment manufacturing enterprises.

42. Private investors began to acquire ownership stakes in the PRC's water supply utilities in 1992. As of 1986, 5% of state-run municipal enterprises were incurring losses. This ratio had risen above 40% by 1997.[17] The first case was provided by the French Suez Group's investment in the water utility of Zhongshan City of Guangdong Province. This form of PPP, in which the entry of private capital reduced the share of capital in the utility held by the government, or state capital, proved very popular. Private investors, both foreign and domestic, actively engaged in dozens of urban water utilities through capital share transfer arrangements. A government survey concluded that by 2005, joint ventures and joint-stock arrangements accounted for 71% of an estimated 152 water supply projects with private sector involvement, and 17% of an estimated 200 wastewater projects with private sector

[14] Government of the Peoples' Republic of China, Chinese Communist Party Central Committee. 2013. Decisions on Important Issues Concerning Comprehensive and Far-reaching Reform: Third Plenum of the 18th Central Committee of the Communist Party of [the People's Republic of] China. Beijing. http://www.chinadaily.com.cn/china/2013cpctps/2013-11/16/content_17109648.htm

[15] PPP and related public finance reforms are discussed in ADB. 2014. *Money Matters: Local Government Finance Reform in the People's Republic of China*. Manila.

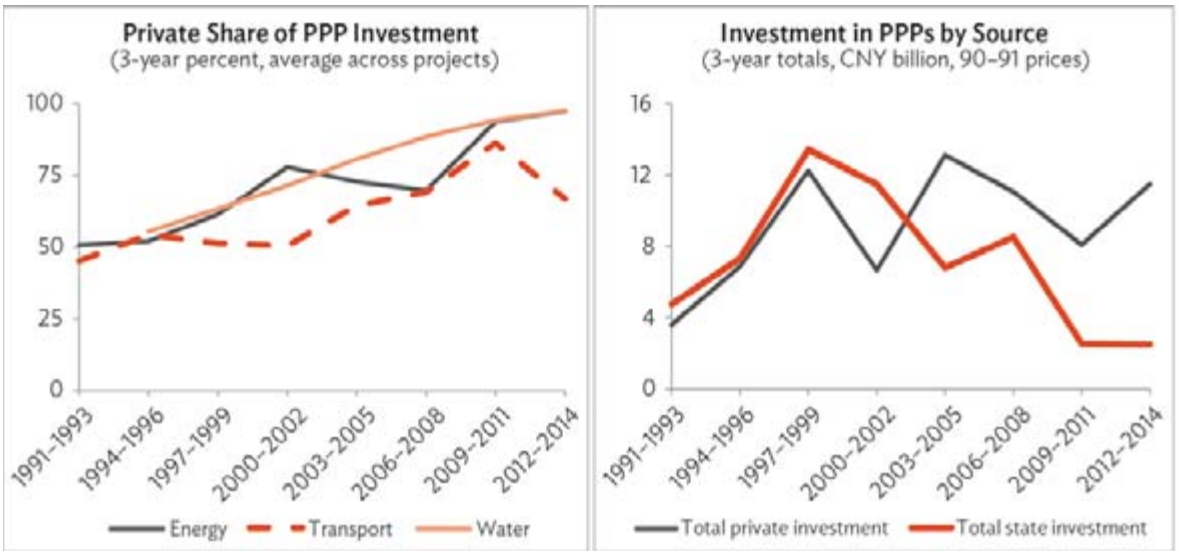
[16] For more background of the reform of the PRC's water sector, see Fu, Chang, and Zong (2008); Jiang and Zheng (2010); and Wei (2014).

[17] Song (2000).

involvement.[18] Jiang and Zheng (2014) report that by 2007, more than 30% of large and medium urban water utilities had attracted private sector participation. Of these, two-thirds had nonstate shareholders in the majority.

43. The state engagement in the early PPPs is shown in World Bank data. But private investors always contributed of the majority of investment in water PPPs (Figure 7). The ratio rose over time and by 2012, private investors were contributing most of the investment in water sector PPPs.[19]

Figure 7: Private versus State Capital



PPP = public–private partnership.

Notes: The data only show PPPs that involve a private partner, where state-owned enterprises or their subsidiaries that remain majority owned by government entities are not considered a private partner. The data show the number of PPP projects and the value of the investment committed to by the project.

Source: ADB estimates based on Public-Private Infrastructure Advisory Facility (2014) and the International Fund (2014).

44. Foreign investment in the water sector was primarily from multinational water groups. They typically had matured investment, operations, technology, and brands. With a complete set of water-related technologies, mature modes of operation, and strong financial and technical support, they had a strong competitive advantage in the PRC market. The international investors made an important contribution. They introduced commercial practices and built momentum for reform, provided needed financing and management expertise, and introduced strong competition. Their presence also accelerated the restructuring of water sector governance arrangements by removing state monopolies and replacing them with PPPs.

45. Many of the initial PPPs provided guaranteed rates of return in the water sector as well in other sectors. While the guarantees contributed to the PRC's early surge in PPP activity, they had a downside of sharing risks unevenly, with too much protection provided to the private partner. The 2002 circular, *Issues Relevant to the Proper Handling of Current Projects with Guaranteed Fixed Returns for Foreign Investors* called for the modification of contract terms, the repurchase of foreign investors' shares, the

[18] Fu, Chang, and Zhong (2008) p.38, 47.

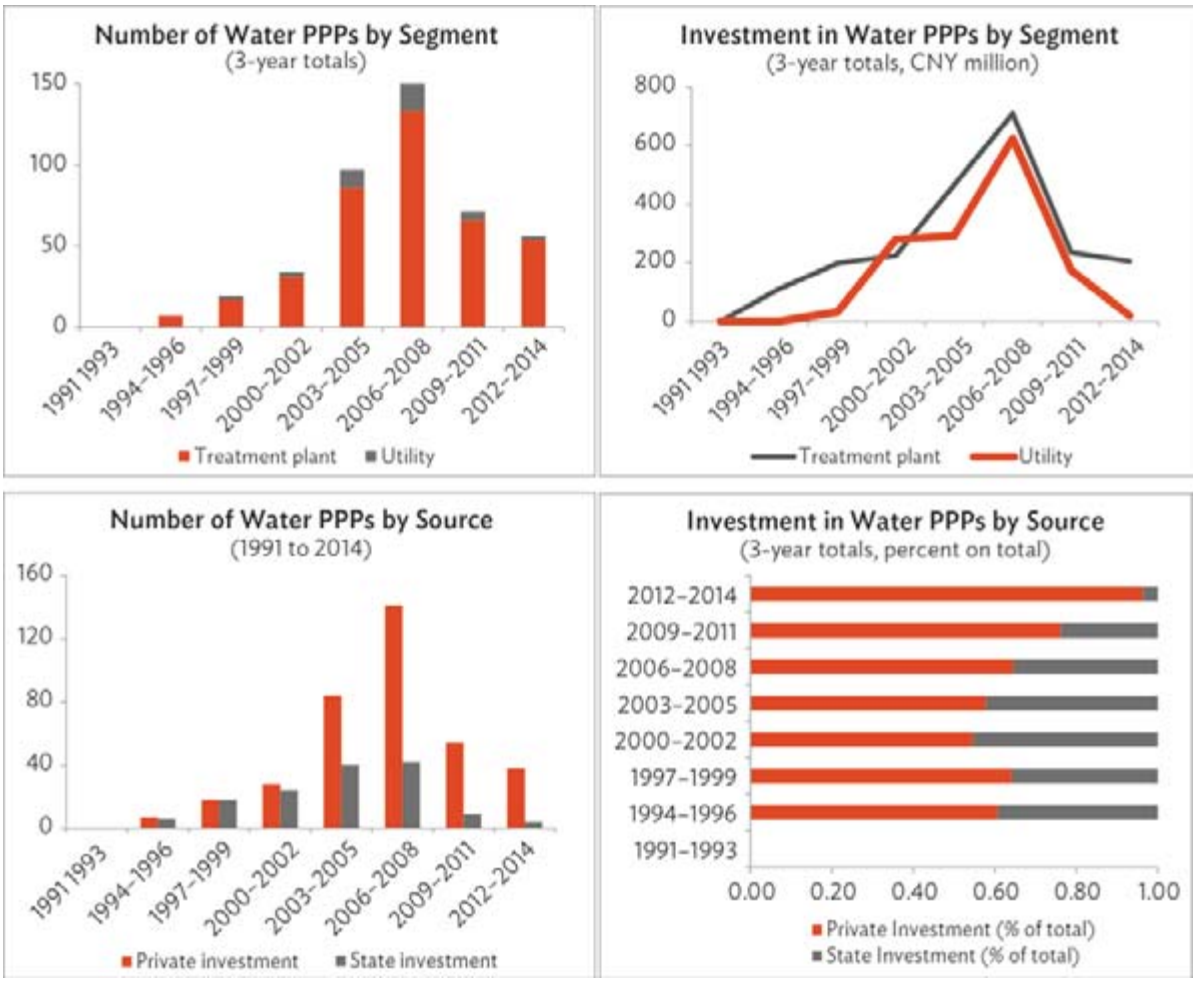
[19] This data excludes those PPPs where SOEs provide the "private partner." Such PPPs are numerous, but data are lacking on their number and value.

translation of foreign equity into foreign loans, and for contract termination. This change in policy saw the exit of some foreign operators and hastened the emergence of local providers.

46. Locally owned, private water companies were able to expand as their financial and technical capacity improved. Some started as state-affiliated entities, and were restructured under mixed private ownership (e.g., via a public listing) later. Others started as water technology and engineering companies, and then branched out into build–operate–transfers (BOTs) and other forms of PPPs as their capacity developed. They grew into one-stop, diversified water businesses that provide investment, design, construction, equipment, and management.

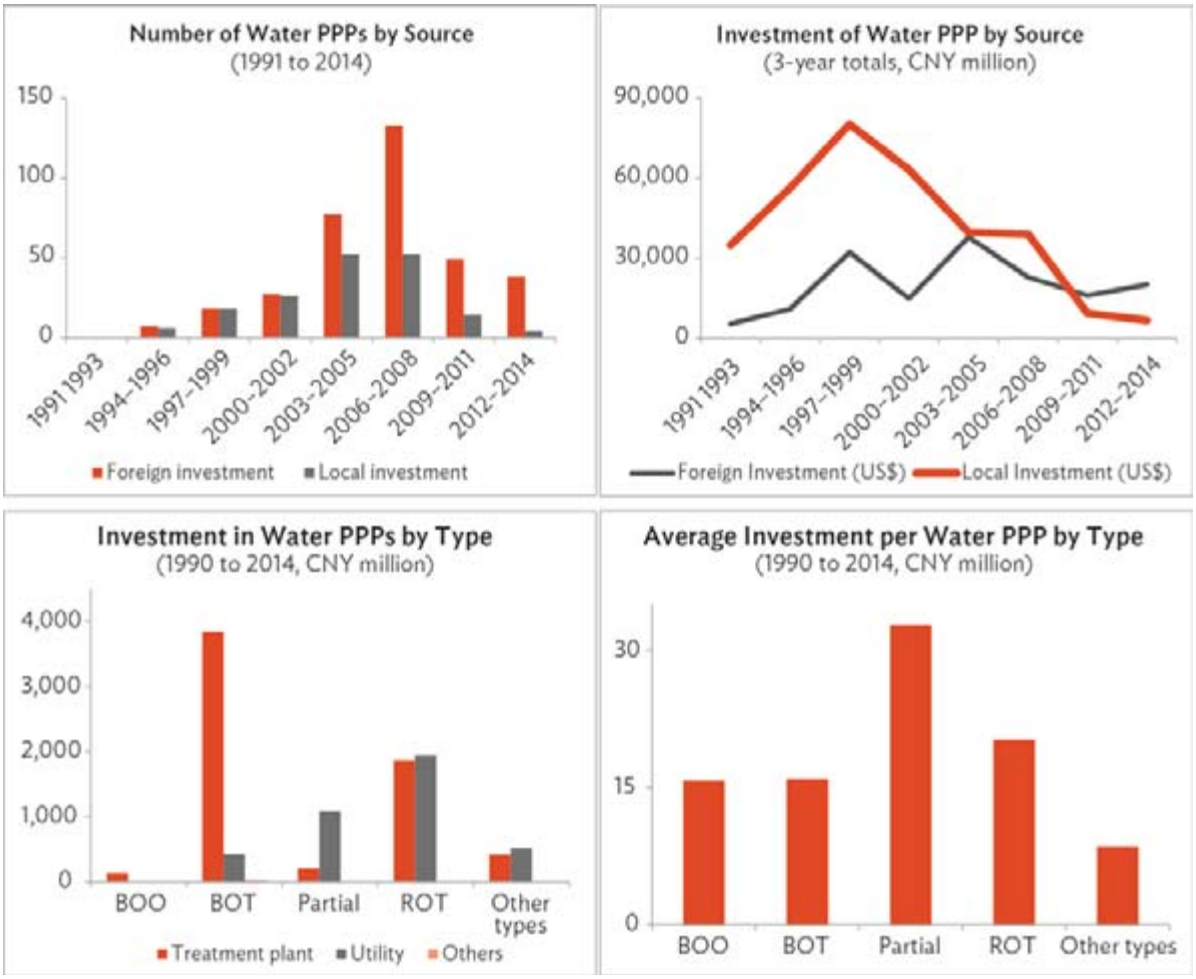
47. While the presence of locally owned entities has risen substantially, foreign investments have remained prominent (Figure 8). Of the 12 water sector PPPs finalized in 2014 with a private partner, only 3 were wholly locally owned (Table 1).[20] These locally owned PPPs accounted for CNY757.40 million of the approximately CNY2.5 billion in PPP investment commitments during 2014. A total of 17 water PPP projects in 2014 are 100% owned by foreign investors and only 3 water projects have mixed ownership.

Figure 8: Features of the PRC's Private Water PPPs



[20] Public-Private Infrastructure Advisory Facility (2014).

Figure 8: Features of the PRC's Private Water PPPs (continued)



BOO = build-own-operate; BOT = build-operate-transfer; e= estimate; partial = the government transfers part of the equity in the state-owned company to private entities (operator, institutional investors, and the like). The private stake may or may not imply private management of the facility; PPP = public-private partnership; PRC = People's Republic of China; ROT = rehabilitate-operate-transfer.

Notes: The data only show PPPs that involve a private partner, where state-owned enterprises or their subsidiaries that remain majority owned by government entities are not considered a private partner. The data show the number of PPP projects and the value of the investment committed to by the project. Constant prices estimates use the gross domestic product deflator.

Source: ADB estimates based on World Bank (2014) and the International Monetary Fund (2014).

48. SOEs and other state-affiliated entities remain major players in the water sector, both as social capital partners to PPPs and as holders of local monopoly. Many have built up strong technical teams, some having been active since the early development of the water sector.

49. The local water corporations also remain active. They tend to have a background as an entity within a local government agency, with the government guarantee (either explicit or implicit) provided by their local government ownership ensuring strong fund raising capacity. While local water corporations remain focused on their home city, they often form a strategic cooperation within a region to carry out a series of water projects elsewhere.

IV. EMPIRICAL ANALYSIS

E. Introduction

50. A key argument in favor of a PPP is that the private investor will reform the utility to make it more efficient and effective, and thereby ensuring adequate return on investment. But profit-maximizing behavior can also have adverse effects, if inadequately managed by government. While well-prepared privatization has an unambiguously positive effect on efficiency for small firms in markets with effective competition, this is not necessarily the case for large firms in monopolistic or oligopolistic situations.[21] One of the areas is the infrastructure market with economies of scale or barriers to entry that preclude the presence of many operators, like the water sector. Private operators in such noncompetitive markets may abuse their market power. A laizze-faire market will reduce welfare and requires careful regulation.

51. But information asymmetries can make it difficult for regulators of such markets to guard against the abuse of market power and to ensure better market outcomes.[22] For example, private operators may succeed in securing tariff increases that do little more than improve the utility's financial returns. There are many other reasons why private water utilities may lead to worse outcomes than public water utilities, such as a heightened potential for governance problems. While public utilities can also abuse their position in such markets, such abuses may be curtailed by community obligations and through transparency of financial records.

52. Private participation in water utilities has proved controversial at times in the PRC, as it has in many other countries. Notably, water tariff adjustments required to enhance commercial sustainability often triggered furious debate. Some residents, mainly existing users, were strongly against water tariff increases, and attributed the increment in water tariffs to the involvement of private investors in water utilities. Some people argued that PPP water utilities only became better performers because they had a better tariff regime. Such perceptions were reinforced when water utilities applied for price adjustments, commonly in the form of price increases, shortly after the introduction of a PPP. Concern was often expressed that the better financial performance, due a higher tariff, may not translate into higher efficiency. This concern underpinned some skepticism in the introduction of PPPs into the PRC's water utilities. But to some extent the debate was misplaced. Even cities with only state-owned water utilities raised their water tariffs. This reflected government policy to raise tariffs to moderate excess demand and improve the financial sustainability of the water sector.

53. Whether the private or public water utility is superior cannot be resolved solely at a theoretical level. The answer is ultimately an empirical matter. A lack of data on water utilities has, however, made it difficult to objectively assess the overall performance and contribution of PPPs in the PRC's water utilities. In the absence of objective empirical analysis, much of debate was often driven by ideology and preconceived notions.

F. Views from Earlier Empirical Studies

54. Privatization of state-owned enterprises in the PRC as long been a research interest in development economics (Zhang, Zhang et al.; 2001, Bai, Lu et al. 2009). Bai, Lu et al. (2009) present one of the more recent empirical studies on this topic. However, Bai, Lu et al. (2009) focused their

[21] See for example the discussion in Vining and Boardman (1992).
[22] See for example the discussion in Averch and Leland (1962) and Shleifer (1985).

analysis on the manufacturing and mining industries, leaving out the public utilities from the data. This is understandable since manufacturing and mining sectors are considered as competitive sectors while public utility sectors like water supply are not.

55. For the water sector, Wang et al. (2011) used panel data for 35 major PRC cities from 1998 to 2008 to examine the performance of private water utilities. They concluded that the introduction of private sector participation was significantly correlated with improvements to the integrated production capacity and water coverage rate, but was not correlated with investment in fixed assets. Jiang and Zheng (2014) analyzed a dataset of 208 urban water utilities servicing more than 300 million urban residents from 1998 to 2007. They found that a utility's profitability and liability level and host city's road infrastructure in the prior year play important roles in driving private investors to both enter and withdraw from the sector. It is further found that privately run utilities, and mainly those with majority nonstate shareholders, substantially saved on costs by downsizing employment and cutting managerial expenses, which lead to remarkable profit increases. Other estimates, though statistically insignificant, showed that private sector participation increased a utility's investment and efficiency, and cities with private sector participation have lower total and domestic water supply but more domestic water users.

56. While the international economic literature generally supports private ownership in markets with effective competition, the debate on the effects of privatization in monopolistic markets is far from settled.[23] For the water sector, considerable research has found that private water utilities are more efficient than public water utilities (e.g., Morgan 1977; Crain and Zardkoohi 1978; Raffiee, Narayanan et al. 1993). But quite a few papers have supported the finding that state-owned water utilities are more efficient than private utilities (e.g., Mann and Mikesell 1976; Bruggink 1982; Lambert, Dichev et al. 1993; Bhattacharyya, Parker et al. 1994). Some studies concluded that there is no significant difference in efficiency between public and private water utilities (e.g., Feigenbaum and Teeples 1983; Byrnes 1986; Teeples and Glyer 1987). Fox and Hofler (1986) showed that private firms are more inefficient in allocating resources. Bhattacharyya et al. (1995) revealed that private water utilities are more efficient for small utilities, while state-owned utilities are more efficient when the scale is large.

57. The mixed findings on the effect of private ownership in the water sector call into question the conditions under which a PPP will be more effective in improving performances of water utilities. After investigating the New England and Wales water utilities privatization, Saal and Parker (2000) concluded that privatization did not improve cost efficiency, but good regulation did. Saal et al. (2007) also found that productivity improved after regulatory reform that had imposed strict financial regime but not on privatization. Aubert and Reynaud (2005) point out that efficiency of water utilities is influenced by regulatory structure.

58. Studies focused on developing economies have relied mostly on cross-country data. Estache and Rossi (2002) analyzed the survey data collected by the Asian Development Bank in 1995 on 50 water enterprises (22 involving private sector participation in some form) from 29 countries in the Asia and Pacific region.[24] Adopting the stochastic cost frontier technique, applying error components and technical efficiency effects models, the authors found no significant efficiency difference between the private and state water enterprises. Estache and Kouassi (2002) used an unbalanced panel of

[23] See for example the overview in Shirley and Walsh (2000).

[24] ADB. 2010. *Economics Working Paper Series: Private Sector Participation and Performance of Urban Water Utilities in the People's Republic of China*. Manila.

21 water utilities in Africa during 1995–1997 to estimate a production function and apply 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 are far more important than the ownership variable in explaining efficiency variation among firms.

59. Earlier studies tended to be limited by small sample size. More recent studies were able to employ larger samples as more data became available. Kirkpatrick, et al. (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 of state-owned utilities was better, though statistically insignificant. More recently, Gassner et al. (2009) examined 977 water utilities in 48 countries from 1980 to 2005 using difference-in-differences combined with matching method. The results showed that private sector participation in water services led to increases in residential connections, connections per workers, water sold per worker, and a decline in employment but the authors found no evidence of an increase in investment or retail tariffs.

60. Many scholars have looked beyond efficiency to investigate the impact of water utility privatization on other aspects, such as health, water coverage, or water access. For example, Galiani et al. (2005) evaluated the impact of water services privatization on child mortality in Argentina with a large, within-country sample. The study 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 possible pathways was that privatization expanded access to water services, which was supported by case studies of Buenos Aires (Crampes and Estache [1996]) and Bolivia (Estache et al. [2000]).

61. Hirvi (2012) investigated the relationship between globalization, privatization, and social citizenship, and found that water privatization left people's social citizenship in Accra relatively unchanged. Hirvi (2012) suggested that water provision as a social right has to be conceived in connection to political and civil rights, and the possibilities to exercise democratic control over public services. De Oliveira (2011) assessed the impact of private participation water supply on access (coverage), and suggested that private sector participation in Brazil has delivered higher access to water services and provided evidence that it has benefited poor households. Lee (2011) found that privatization does not seem to have improved access to treated water in Malaysia. Clarke et al. (2009) explored the effects of private sector participation on coverage in a cross-section study of Argentina, Bolivia, and Brazil, and they identify an increase in the share of households connected to piped water and sewerage.

62. Though the international literature on water supply sector performance has been an active one, there are few rigorous studies of the impact of PPPs on the performance of the PRC's water sector using large sample, utility-level panel data. This paper now turns to such research. Building on Jiang and Zheng (2014), the research expands the data set to include all prefecture-level cities in the PRC, examines a broader range of performance indicators that look at both efficiency and effectiveness, and controls for the effect of water price adjustments.

G. Overview of Variables and Data

63. The research looks at the PRC's prefecture cities. For this research, a PPP is defined as a utility that is at least partly owned by a corporate entity. This termed the variable, PPP. In most cases, this corporate entity is privately owned. In some cases the entity's owner may be an SOE. The potential effect of SOE ownership of some utilities is examined as a robustness check.

64. An additional binary PPP variable was also prepared for the variable city-ID. If a city has a PPP water utility, then the PPP variable for the city is 1, otherwise it is 0. This additional variable is termed PPP3. Water supply is usually a monopoly, and for most cities, there is only one water utility in a city. But the megacities of Beijing, Chongqing, Shanghai, and Tianjin have more than one utility. These megacities are called Zhixia cities. They are administrated directly by the central government at the same level of a province. Zhixia cities have more than one water utility, which operate in different districts of the city. The values of city-ID of Zhixia cities at district level were recoded to ensure there is only one utility matched to one unique city-ID and vice versa. Zhixia cities were excluded from some regressions as a robustness check.

65. Figure 7 and Figure 8 show the numbers of PPPs in the dataset. They increased from 24 in 2000 to 92 by 2007 in the PRC's prefecture-level cities (Figure 9). Over the same time period, the number of state-owned water utilities decreased from 310 to 232. In 2000, only 8% of water utilities in prefecture-level cities involved private participation. This ratio had risen to almost 40% by 2007. The share of these PPPs in total capital, assets, and sales rose from about 10% in 2000 to nearly 40% in 2007, and the employment share increased from 8% to 28% (Figure 10).

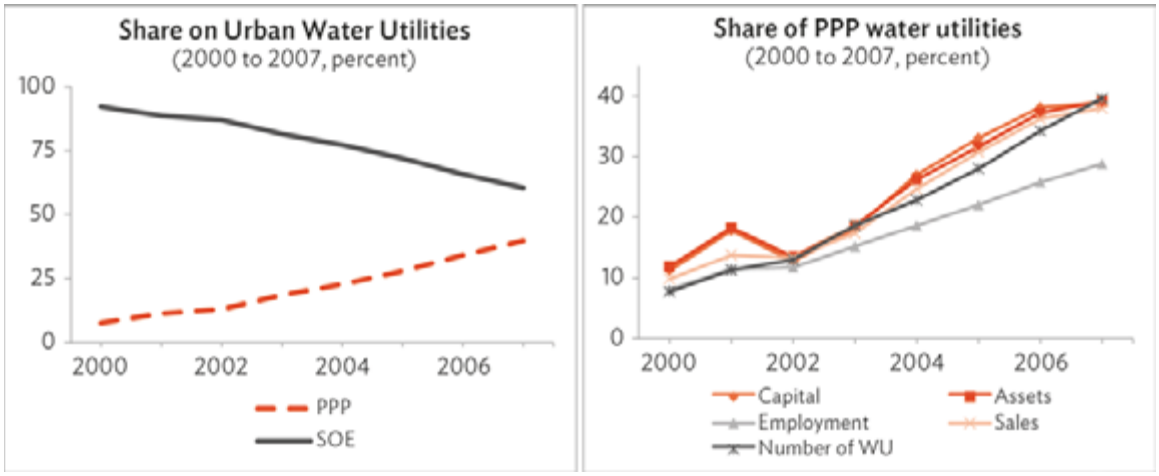
66. The average values of capital and assets of the PPPs are much higher than those of state-owned utilities, while the average numbers of employed are quite close. Average sales revenue per employee of PPPs are higher than those of state-owned utilities. The management cost shares are a little lower in PPP utilities. The average numbers of subsidy of the PPPs are lower. The average numbers of value added per employee of PPPs are higher, except for 2002 and 2003. The PPPs have a positive TFP on average, while on average TFPs are negative for the state-owned utilities (Figure 10).

67. Water supply data from the City Water Supply Statistical Yearbooks (2001–2008) and the [People's Republic of] China City Statistical Yearbooks (2001–2008) were also used to assemble a panel data set on water supply indicators in cities for 2000 to 2007. These allow the effectiveness of water utilities to be examined.

68. The average levels of water supply indicators for cities with PPP and non-PPP water utilities are presented in Figure 11. For cities with PPP water utilities, on average, the supply areas of piped water (area), total pipe lengths (Pipe_total), pipe lengths of pipes with a diameter exceeding 75mm (Pipe75), total number of water meters (meter_total) and total number of meters for residential users (meter_res) are larger in PPP cities than in non-PPP cities. The leakage rates(leakage rate) are smaller in PPP cities though the average amount of leakaged water (leakage) are smaller in non-PPP cities in several years. The average low pressure areas, populations of PPP cities, and total power consumption levels are larger than or smaller but very close to non-PPP cities.

69. Data and variables are presented in the Appendix.

Figure 9: Comparisons of PPP and Non-PPP Water Utilities



PPP = public-private partnership; SOE = state-owned enterprise; WU = water utility.
Source: Annual [People's Republic of] China Industrial Firm Surveys (2000–2007).

Figure 10: Average Levels of Scale and Performance of PPP and Non-PPP Water Utilities

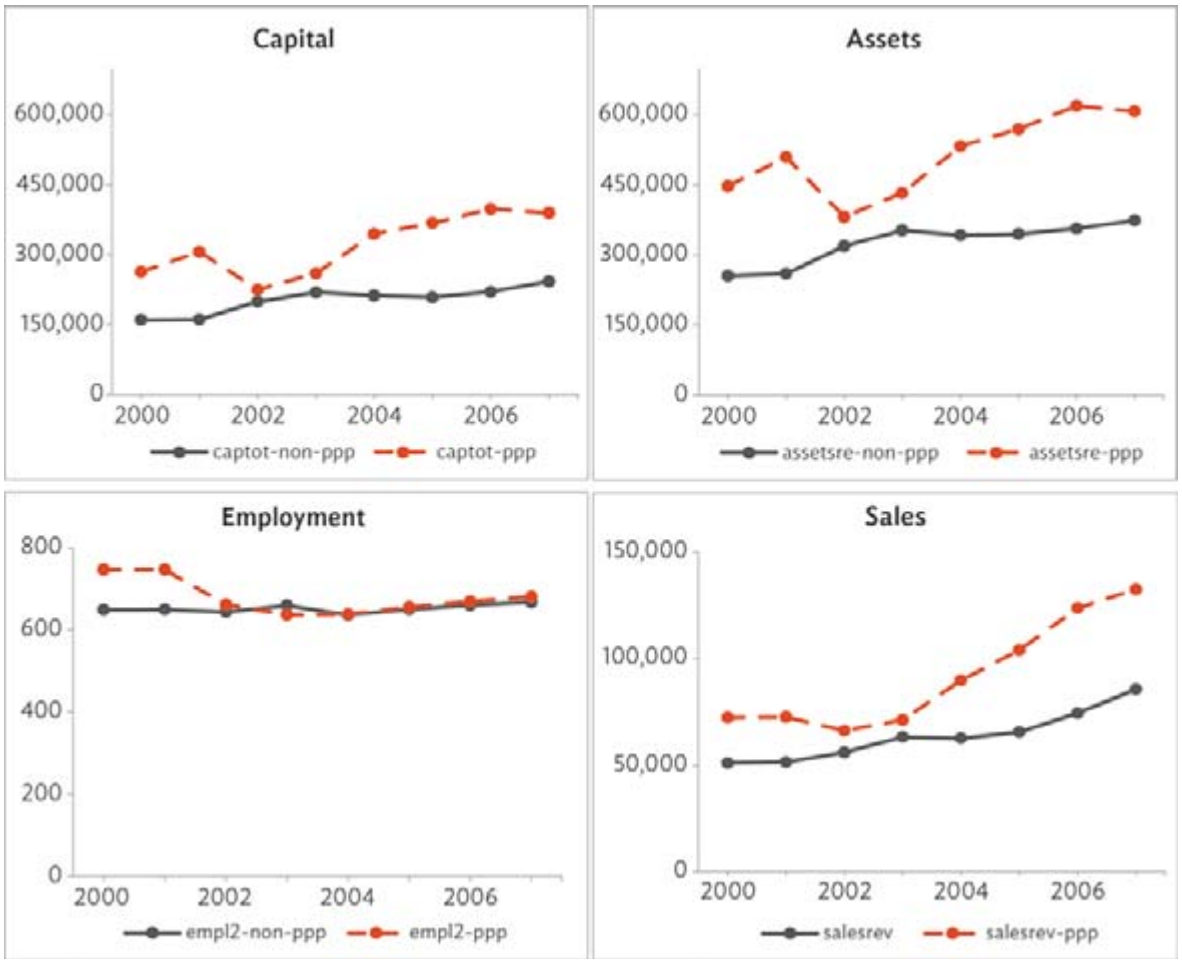
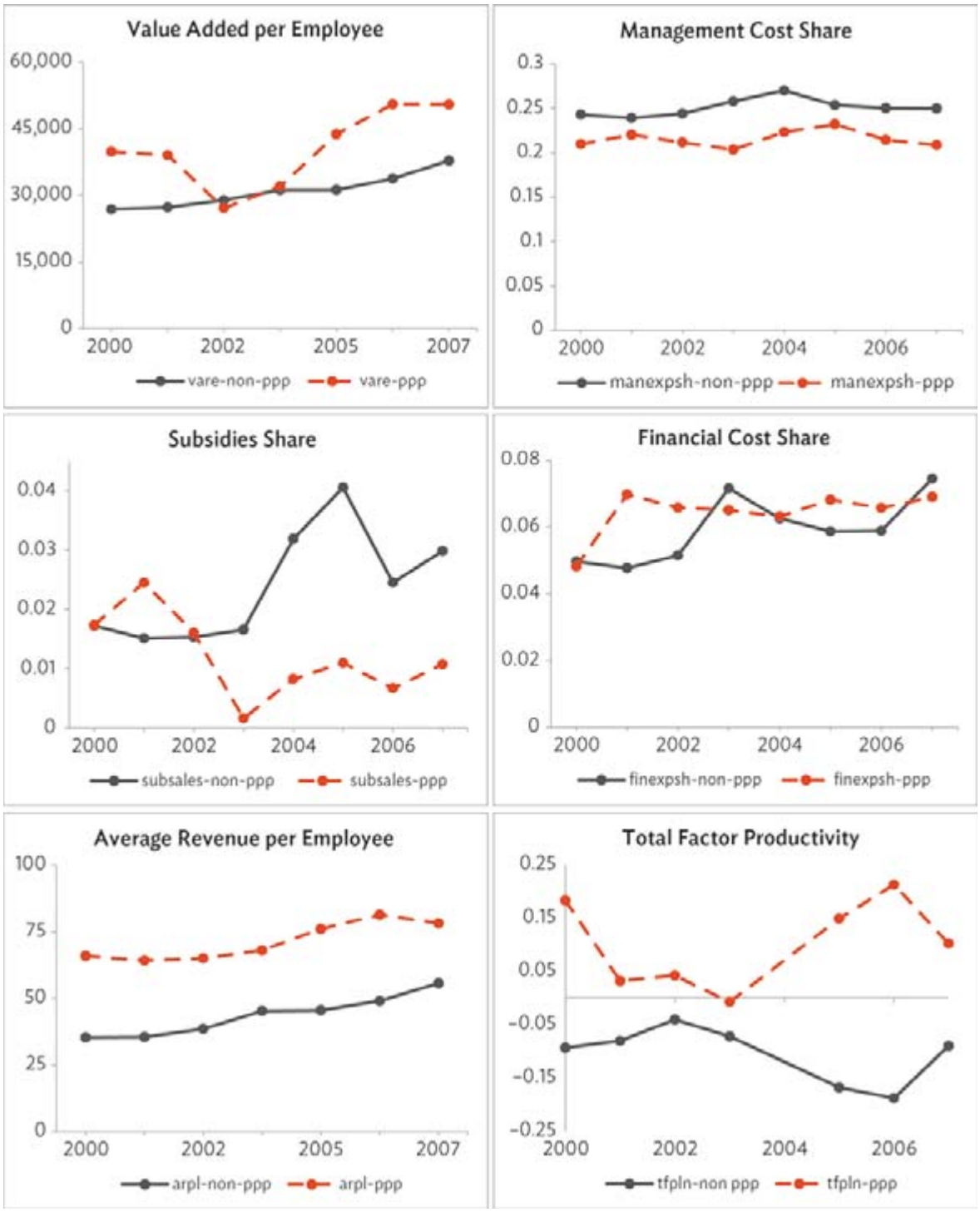


Figure 10: Average Levels of Scale and Performance of PPP and Non-PPP Water Utilities (continued)



PPP = public-private partnership.

Notes: The orange dashed lines are the average levels of all the indicators of PPP water utilities and the gray straight ones are that of non-PPP water utilities.

Source: Annual [People's Republic of] China Industrial Firm Surveys (2000–2007).

Figure 11: Average Level of Water Supply Indicators for Cities with PPP and Non-PPP Water Utilities

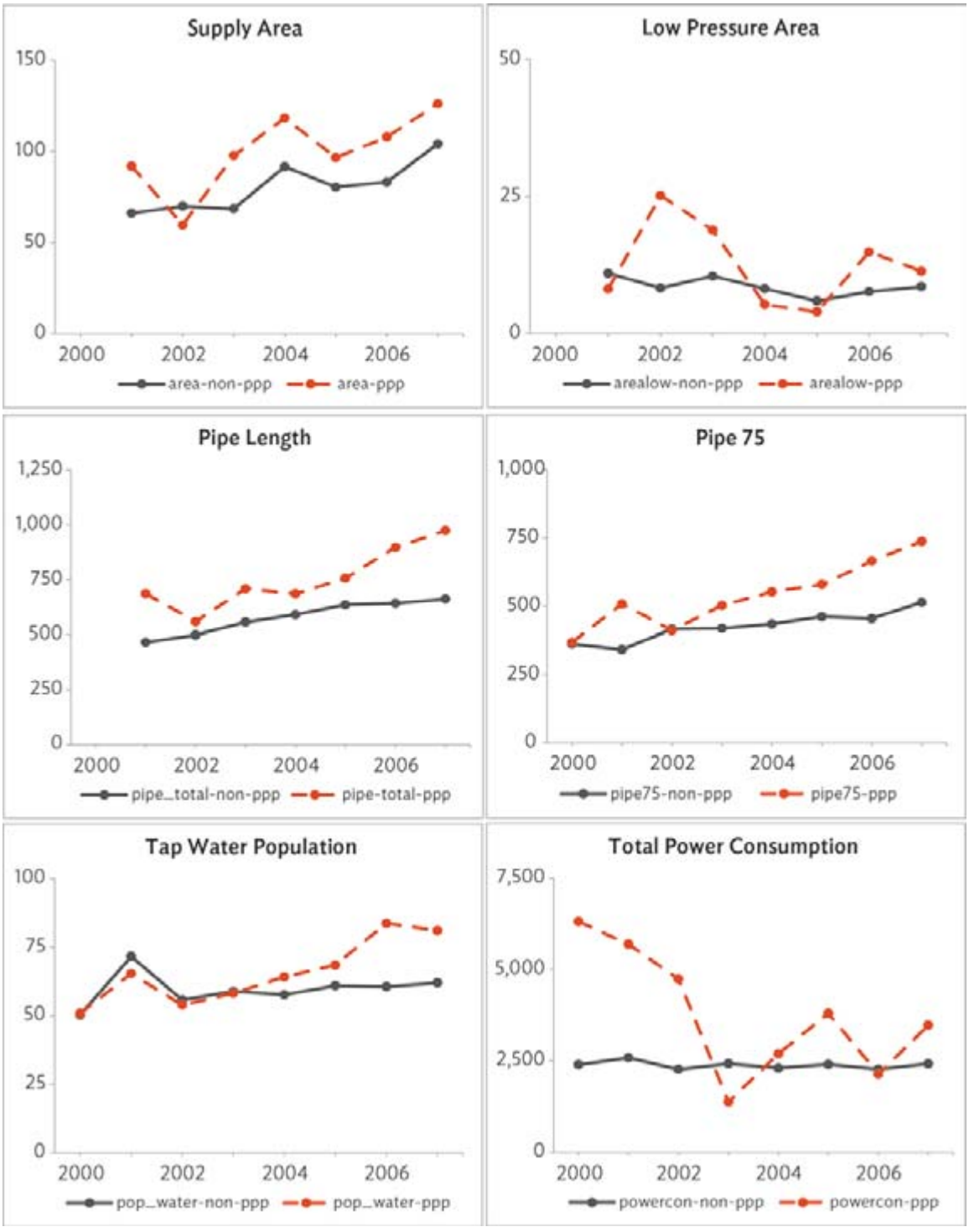
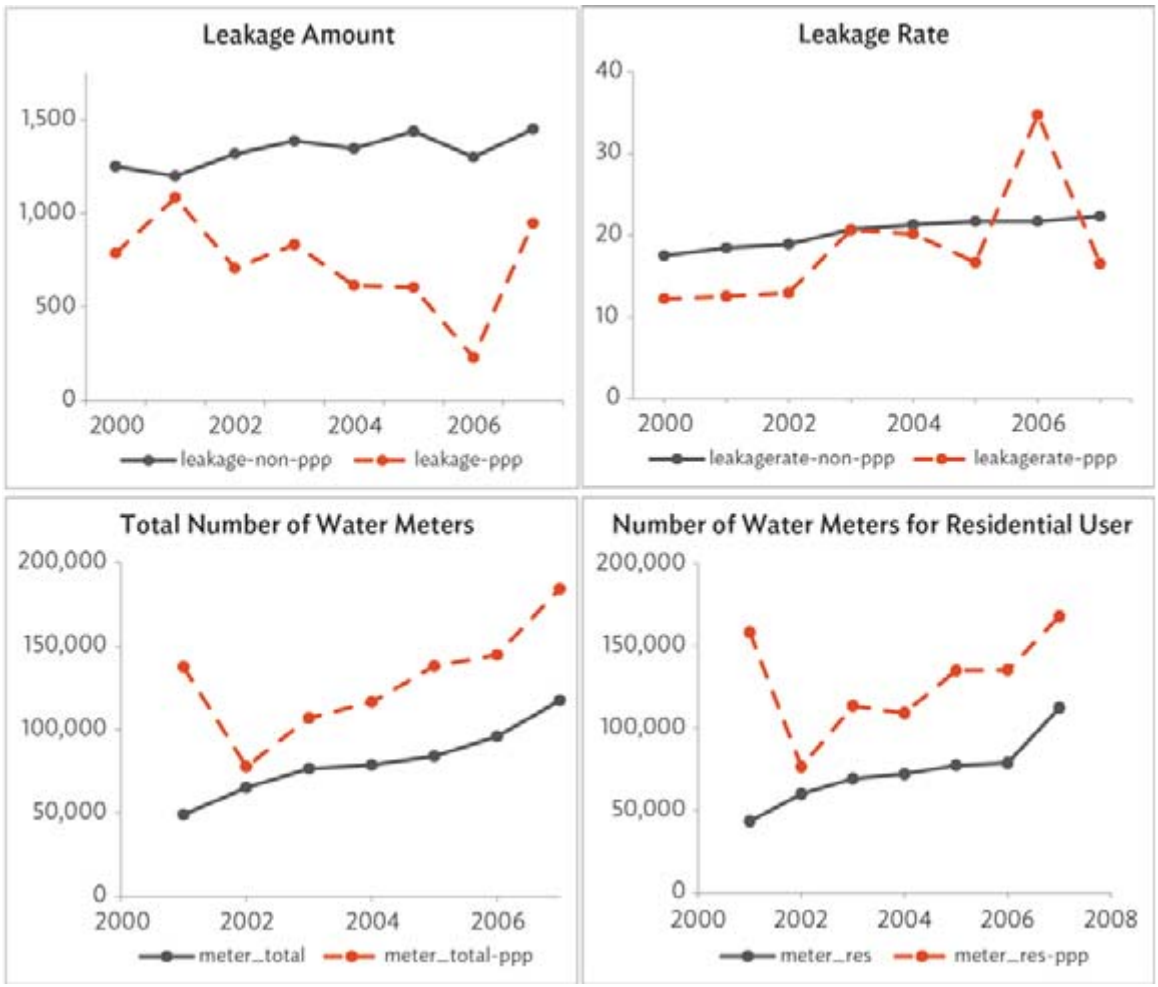


Figure 11: The Average Level of Water Supply Indicators for Cities with PPP and Non-PPP Water Utilities (continued)



PPP = public-private partnership.

Notes:

Extreme and abnormal observations are cleaned or recoded by some rules described in section I.

The orange dashed lines are the average levels of all the indicators of PPP water utilities and the gray straight ones are that of non-PPP water utilities.

Source: Author's estimates from City Water Supply Statistical Yearbooks (2000–2007).

H. Findings on Utility Efficiency

1. Main Findings

70. PPP is found to reduce a utility's employment and subsidy, and to increase profitability even when the price effect is controlled. Most importantly, PPP is found to improve TFP.

71. Impacts are identified using the temporal and geographical variations in PPP while controlling for utility and year fixed effect and lags of utility and city variables. A two-way fixed-effects panel model is estimated:

$$y_{it} = \beta_0 + \beta_1 PPP_{it} + \gamma Price_{it} + \sum_k \phi_k x_{it-1k} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

Where:

- y_{it} is a performance indicator of utility in year *t*;
- PPP_{it} is a binary variable that takes on the value one if water utility *i* involves non-state capital investment in year *t* and zero otherwise;
- $Price_{it}$ is the residential water tariff of city i in year *t*;
- x_{it-1} is a vector of lagged utility and/or city variables to capture time-variant factors.

72. Previous analysis (Jiang and Zheng, 2010) found that one-year lags of utility profit-sales ratio, liability ratio, and urban road area per capita are important in explaining in the probability of a utility being a PPP. Therefore, including them in the model can control for selection caused by these time-variant factors. The full specification also includes utility sales and assets to capture scale-effects and the city-level characteristics that are associated with water demand or supply and may affect utility performance; and μ_i and λ_t are fixed effects for utility *i* and year *t*, respectively.

73. The parameter β_1 measures the average causal impact of PPP on utility performance. The parameter β_1 will be consistently estimated if it is conditional on the control variables as well as utility and year fixed effects, and *PPP* is not further correlated with any time-variant unobservable variables that simultaneously affect utility performance.

74. Where the lags of the dependent variables are used, such as sales, liability ratios, and profit-sales ratios, the dynamic panel model is estimated:

$$y_{it} = \beta_0 + \beta_1 PPP_{it} + \gamma Price_{it} + \delta y_{it-1} + \sum_k \phi_k x_{it-1k} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

75. This model is estimated using the Arrelano-Bond approach. Specifically, the regressions with dependent variables liaratio, salesreln and profsales were estimated by the Arrelano-Bond approach, otherwise estimated by the ordinary least squares (OLS). Clustered errors within utilities are estimated for the OLS estimates. Robust errors were estimated for the Arrelano-Bond estimates.

76. Table 2 reports the estimated effect of PPP on each of the 12 water utility performance indicators. These regressions use a corrected form of PPP. A few utilities were found to switch between state-owned and PPP states in 3 consecutive years. It is difficult to gain a clear understanding of such cases, and they may simply be errors in coding capital sources. A recode of utility into PPP if it was PPP, non-PPP, and PPP in a row of 3 consecutive years and vice versa was also conducted. The recoding results in 29 changes in PPP.

77. In Table 2 "With-price" means the regression includes logarithm of deflated residential water price as a control variable; "Lag controls" means these regressions include lags of assetsreln, salesreln, and profsales as control variables; and city controls means these regressions not only include lags of assetsreln, salesreln, and profsales, but also city characteristic controls, as control variables.[25] In general, the signs of coefficients were not changed when more controls were included.

[25] "Assetsreln" means total assets in CNY1,000, in 1998 constant prices; "salesreln" is defined as logarithm of sales revenues in CNY1,000 in 1998 constant price; and "profsales" is ratio of profits to sales revenues.

Table 2: PPP Impact on Urban Water Supply Utilities' Performance

Item	Basic With-Price	Basic No-Price	Lag Controls With-Price	Lag Controls No-Price	City Controls With-Price	City Controls No-Price
investre	(14,583)	(14,376)	(13,120)	(13,137)	(10,972)	(10,702)
	(24,265)	(23,418)	(24,789)	(23,856)	(26,074)	(26,049)
empln	(0.0765)**	(0.0780)**	(0.0569)*	(0.0617)**	(0.0620)*	(0.0620)*
	(0.0326)	(0.0326)	(0.0311)	(0.0309)	(0.0342)	(0.0342)
salesreln	(0.000557)	(0.0186)	(0.00179)	(0.0240)	(0.000403)	(0.00375)
	(0.0313)	(0.0517)	(0.0304)	(0.0313)	(0.0376)	(0.0383)
vareln	0.0627	0.0821	0.0157	0.0380	(0.00300)	0.00577
	(0.0531)	(0.0534)	(0.0449)	(0.0463)	(0.0483)	(0.0492)
liaratio	0.0125	0.0138	0.0117	0.0125	0.0101	0.0140
	(0.0297)	(0.0350)	(0.0260)	(0.0251)	(0.0304)	(0.0303)
manexpsh	(0.0179)	(0.0173)	(0.0144)	(0.0165)	(0.0237)	(0.0240)
	(0.0125)	(0.0125)	(0.0151)	(0.0148)	(0.0168)	(0.0167)
finexpsh	(0.0111)	(0.0139)	(0.00766)	(0.0110)	(0.00207)	(0.00155)
	(0.00882)	(0.00910)	(0.00756)	(0.00803)	(0.00661)	(0.00662)
profsales	(0.00136)	(0.0188)	0.0145	(0.00101)	0.0272	0.0260
	(0.0281)	(0.0278)	(0.0259)	(0.0262)	(0.0258)	(0.0258)
taxsales	1.84e-05	(0.000205)	0.000123	(0.000128)	(0.00151)	(0.00152)
	(0.00363)	(0.00363)	(0.00362)	(0.00362)	(0.00296)	(0.00296)
subsales	(0.0106)**	(0.0130)**	(0.00862)**	(0.0130)**	(0.00867)*	(0.00896)*
	(0.00525)	(0.00588)	(0.00434)	(0.00643)	(0.00506)	(0.00507)
arpl	8.475*	8.668*	3.812	4.269	3.628	4.085
	(4.683)	(4.583)	(4.587)	(4.573)	(4.745)	(4.787)
tfpln	0.157**	0.184***	0.136**	0.169***	0.133*	0.142*
	(0.0662)	(0.0668)	(0.0623)	(0.0641)	(0.0712)	(0.0721)

arpl = labor productivity, empln = number of employment, investre = lower investment, finexpsh = financial expenses relative to sales, liaratio = liabilities as a percentage of total assets, manexpsh = ratio of managerial expenses to sales revenues, profsales = ratio of profits to sales revenues, salesreln = sales revenue, subsales = subsidy-sales ratio, taxsales = ratio of tax paid to sales revenues, tfpln = total factor productivity, value added = vareln.

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Source: Annual [People's Republic of] China Industrial Firm Surveys (2000–2007).

78. PPP has positive and negative effects on the input and output indicators. PPP is associated with lower investment (investre), number of employment (empln), and sales revenue (salesreln), and increases the value-added (vareln). For the financial performance and profitability indicators, PPP is associated with lower managerial expenses relative to sales (manexpsh), financial expenses relative to sales (finexpsh), and a subsidy-sales ratio (subsales), but higher liabilities as a percentage of total assets (liaratio). The relationship between PPP and profit relative to sales and taxes paid relative to sales are ambiguous. In some regressions, this association is positive, while it is negative but insignificant in others. Finally, PPP is associated with higher labor productivity (arpl) and total factor productivity (tfpln).

79. The comparison of no-price and with-prices columns indicated that the estimated results were highly consistent and stable with or without water price controls. The results were also stable when the lagged controls and city controls were included in the regressions.

80. Three indicators: employment and subsidy ratio and TFP showed statistically significant impacts of PPP. PPP reduced employment by about 6% to 7% and lowers the subsidy ratio by 1 percentage point. PPP also improves TFP by about 13% to 16%.

81. The negative signs of PPP on investment and sales revenue were unexpected, but were not statistically significant.

2. Collective Capital

82. Robustness checks were carried out. The first check treated collective capital as state capital. Collective capital is a kind of capital from a group of private individuals, such as a village or residential district. Though collective capital is not from state, it can share characteristics of public capital. While the authors believe that collective capital is more private in nature rather than state, columns 1–3 in Table 3 present the results of counting collective capital as state capital rather than private capital. The signs were quite similar and the coefficients were quite close when compared to the standard results, except for employment reduction, which is no longer significant.

Table 3: Treat Collective Capital or Legal Entity Capital as State Capital

.	First Robustness Check			Second Robustness Check		
Item	Basic With Price	Lag Controls With Price	City Controls With Price	Basic With Price	Lag Controls With Price	City Controls With Price
investre	(11,650)	(11,476)	(11,965)	(44,368)	(45,025)	(43,181)
	(23,377)	(23,386)	(25,636)	(37,078)	(38,735)	(36,856)
empln	(0.0724)**	(0.0495)	(0.0525)	(0.113)**	(0.0975)**	(0.113)***
	(0.0332)	(0.0317)	(0.0345)	(0.0482)	(0.0380)	(0.0407)
salesreln	0.0168	0.0167	0.0162	(0.00816)	(0.00495)	0.00530
	(0.0890)	(0.0301)	(0.0374)	(0.0406)	(0.0388)	(0.0477)
vareln	0.0860	0.0466	0.0149	0.121	0.0192	0.0301
	(0.0530)	(0.0448)	(0.0492)	(0.0744)	(0.0642)	(0.0691)
liaratio	0.0186	0.0219	0.0138	0.033586	0.0247	0.0313
	(0.0260)	(0.0258)	(0.0312)	0.051807	(0.0315)	(0.0302)
manexpsh	(0.0161)	(0.0142)	(0.0230)	(0.0273)**	(0.0162)	(0.0247)**
	(0.0132)	(0.0156)	(0.0172)	(0.0120)	(0.0109)	(0.0121)
finexpsh	(0.0116)	(0.00853)	(0.00142)	(0.0228)*	(0.0138)	(0.0107)
	(0.00908)	(0.00779)	(0.00678)	(0.0137)	(0.0104)	(0.00957)
profsales	0.0168	0.0116	0.0280	0.0573**	0.0562**	0.0827***
	(0.0890)	(0.0280)	(0.0273)	(0.0264)	(0.0260)	(0.0308)
taxsales	0.000572	0.000452	(0.00142)	(0.000900)	(2.94e-05)	(0.00342)
	(0.00340)	(0.00346)	(0.00295)	(0.00678)	(0.00651)	(0.00324)
subsales	(0.0111)**	(0.00924)**	(0.00911)*	(0.0134)**	(0.00930)**	(0.0112)**
	(0.00543)	(0.00455)	(0.00513)	(0.00559)	(0.00438)	(0.00517)
tfpln	0.175**	0.163**	0.144*	0.236**	0.140	0.175
	(0.0678)	(0.0650)	(0.0734)	(0.0941)	(0.0888)	(0.108)
arpl	9.264**	4.865	4.534	9.886	4.812	5.525
	(4.353)	(4.191)	(4.232)	(7.261)	(7.056)	(7.612)

arpl = labor productivity, empln = number of employment, investre = lower investment, finexpsh = financial expenses relative to sales, liaratio = liabilities as a percentage of total assets, manexpsh = ratio of managerial expenses to sales revenues, profsales = ratio of profits to sales revenues, salesreln = sales revenue, subsales = subsidy-sales ratio, taxsales = ratio of tax paid to sales revenues, tfpln = total factor productivity, value added = vareln.

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Source: Annual [People's Republic of] China Industrial Firm Surveys (2000–2007).

3. Removing SOE-Controlled Entities

84. One potential concern is that a legal entity identified as private may secure its capital from an SOE. In which case, the entity may be most correctly treated as state capital, even though the entity has a corporate structure. One argument against this alternative treatment is that if a legal entity has a corporate structure, it is more profit-driven and acts like a private enterpriser rather than the traditional state-owned entity.

85. In the second robustness check, utilities were excluded from PPP if nonstate capital is absent. This led to 227 observations dropping from the regressions. Estimated results are shown in Table 4 with different controls. The results are found to be robust. PPP reduced employment by about 10% to 11% and still lowers the subsidy ratio by 1 percentage point. PPP also improves TFP by around 5% to 10%, and the profit-sales ratio was found to increase by 6% to 8%. All coefficients on these indicators are statistically significant.

Table 4: Treat Collective Capital or Legal Entity Capital as State Capital

	First Robustness Check			Second Robustness Check		
	Basic	Lag Controls	City Controls	Basic	Lag Controls	City Controls
Item	PPP-major	PPP-major	PPP-major	PPP-minor	PPP-minor	PPP-minor
investre	(11,066)	(11,569)	(11,389)	(20,803)	(15,488)	(10,108)
	(20,982)	(23,745)	(24,007)	(42,861)	(40,329)	(37,794)
empln	(0.123)***	(0.0915)***	(0.0975)***	0.0138	0.00976	0.0129
	(0.0306)	(0.0255)	(0.0267)	(0.0505)	(0.0551)	(0.0622)
salesreln	(0.0386)	(0.0452)	(0.0396)	0.0566	0.0589	0.0707
	(0.0364)	(0.0376)	(0.0404)	(0.0625)	(0.0597)	(0.0740)
vareln	0.0425	(0.0107)	(0.0301)	0.109	0.0729	0.0580
	(0.0644)	(0.0567)	(0.0600)	(0.0669)	(0.0584)	(0.0649)
liaratio	0.00706	0.00387	0.00147	0.0206	0.0241	0.0288
	(0.0353)	(0.0327)	(0.0351)	(0.0276)	(0.0243)	(0.0323)
manexpsh	(0.0190)**	(0.0130)	(0.0196)*	(0.0160)	(0.0171)	(0.0324)
	(0.00892)	(0.00976)	(0.0115)	(0.0241)	(0.0306)	(0.0331)
finexpsh	(0.00400)	(0.00414)	0.000278	(0.0242)*	(0.0140)	(0.00671)
	(0.00890)	(0.00847)	(0.00749)	(0.0140)	(0.00872)	(0.00724)
taxsales	(0.000766)	(0.000993)	(0.00218)	0.00165	0.00242	0.000234
	(0.00367)	(0.00360)	(0.00338)	(0.00549)	(0.00546)	(0.00356)
subsales	(0.0112)*	(0.00811)	(0.00784)	(0.00993)	(0.0101)*	(0.0109)*
	(0.00626)	(0.00514)	(0.00589)	(0.00718)	(0.00553)	(0.00611)
profsales	0.0370	0.0374	0.0479**	(0.0588)	(0.0298)	(0.0132)
	(0.0238)	(0.0240)	(0.0226)	(0.0478)	(0.0424)	(0.0430)
tfpln	0.157**	0.119	0.119	0.161*	0.175**	0.168*
	(0.0764)	(0.0726)	(0.0794)	(0.0820)	(0.0816)	(0.0935)
arpl	7.821	2.137	2.533	9.850	7.112	6.171
	(5.330)	(5.272)	(4.996)	(6.251)	(6.008)	(6.951)

arpl = labor productivity, empln = number of employment, investre = lower investment, finexpsh = financial expenses relative to sales, liaratio = liabilities as a percentage of total assets, manexpsh = ratio of managerial expenses to sales revenues, profsales = ratio of profits to sales revenues, salesreln = sales revenue, subsales = subsidy-sales ratio, taxsales = ratio of tax paid to sales revenues, tfpln = total factor productivity, value added = vareln.

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Source: Annual [People's Republic of] China Industrial Firm Surveys (2000–2007).

4. Majority Versus Minority Private Ownership

86. In the third robustness check, the effect of the ownership share is examined in more detail. PPP is separated into PPP-major if a private partner holds more 50%, and PPP-minor if the private partner holds less than 50%. The distinction may be important as private participation without control right may limit the private owners' capability to improve performance of the water utility.

87. Table 4 reports the estimates of equation (2') with PPP replaced by PPP-major and PPP-minor. The first three columns represent the coefficients of PPP-major with different controls, and the last three columns represent the coefficients of PPP-minor with different controls. The third and sixth columns are the regressions with lag controls and city controls, and are the results to be analyzed. The results showed that PPP-major significantly reduced employment while PPP-minor did not. PPP-majors have 10% fewer employees. PPP-majors also had a management expenditure to sales ratio that is 2 percentage points lower. PPP-major utilities had significantly higher profitability, about 5 percentage points higher, while PPP-minor utilities have lower profitability but the relationship is insignificant. However, large positive effects on TFP are reported for PPP-minor of 16.8%, while the coefficient of PPP-major is positive but not significant.

88. It is concluded that control rights are critical in improving efficiency and productivity. A private partner without control may help reduce management expenditures, and/or improve productivity. However, without control right, a private partner cannot easily decide to downsize employment, and profitability cannot be enhanced. There are many more PPP-majority than PPP-minority in the data after 2002. The better impacts of PPP-majority over PPP-minority may help explain why PPP-majority became more popular.

I. Findings on Utility Effectiveness

89. This subsection reports the impacts of PPP on utility effectiveness, as captured within a range of water supply indicators. Indicators of water supply were categorized into four subcategories: bill collection, accessibility or coverage, service quality, and energy consumption. The main finding is that utility effectiveness is not significantly influenced by PPP.

90. A two way fixed-effect panel model was estimated:

$$y_{it} = \beta_0 + \beta_1 PPP_{it} + \gamma Price_{it} + \sum_k \phi_k x_{itk} + \mu_i + \lambda_t + \varepsilon_{it} \quad (3)$$

Where

- y_{it} is a water supply indicator of a city in year *t*;
- PPP_{it} is a binary variable that takes on the value one if water utility of city *i* involves non-state capital investment in year t and zero otherwise;
- $Price_{it}$ is the residential water tariff of city *i* in year *t*;
- x_{it} is a vector of residential water price and city variables to capture time-variant factors; and μ_i and λ_t are fixed effects for utility i and year *t*, respectively.

91. Some abnormal values were identified in the original data set. Some values of observations were 0, such as tap water population, total pipe length, and other variables, even though this is impossible.These values were recoded to missing values rather than 0. Some values are extremely large

or small. Some rules were applied to exclude very large or small values relative to consecutive years. Observations that are less than 1/10 or larger than 10 times the median of a variable of certain city are recoded to missing values.

92. The impact of PPP on the water supply indicators are reported in Table 4. The first four columns of results include all prefecture cities, while the last four columns exclude the observations of districts of Zhixia cities. The regressions of columns 2, 4, 6, and 8 control for the city characteristics. The fourth and eighth columns were the basic results for this section. The results are found to be very similar for PPP and PPP3. That is, recoding has very little effect. Recoding does not change the positive or negative signs.

93. Most coefficients were statistically insignificant or marginally significant except the meter_total and meter_res. The impacts of PPP on bill collection indicators, such as notsoldwater, leakagerate, were all insignificant when city characteristics are controlled for. However, pipe75 and pipe_ductile were marginally significantly positive if Zhixia cities were included and city characteristics were controlled for. The apparent interpretation is that PPP improves bill collections through the installation of more water meters, and PPP improved the quality of pipe network marginally.

94. The coefficients on water accessibility indicators were generally insignificant, except for the coefficient on pipe75 and pipe_ductile. PPP increases piped water population (pop_water), increases the total pipe length (pipe_total), the pipe length of diameter exceeding 75mm (pipe75), pipe length-Ductile iron pipe (pipe_ductile), and decreases pipe density (density). But all coefficients are insignificant when Zhixia cities are exclude.

95. Water pressure is not improved by PPP. PPP decreases the pass rate of pressure tests (prate_pressure), average pressure (pressure), and reduces low pressure area percentage (areapro), but coefficients are all insignificant.

96. The total power consumption (powercon) and power consumption per cubic meter water in production (powerconave) is increased but is not significantly affected by PPP. Power consumption per cubic meter water in water distribution (powerconave2) is reduced by PPP at the 10% significance level when the city controls are added to the regressions. This result is consistent with the negative coefficients of the prate-pressure and pressure. The power for water distribution is mainly used to exert more pressure on water supply. Increasing average service pressure can lead to more burst pipes and water losses. Utilities have an incentive to reduce power consumption in water distribution by reducing water pressure, giving rise to a positive relationship between the indicators. These coefficients are, however, not significant or only marginally significant.

97. The results are found to be unaffected by the exclusion of more less possible outliers.

98. PPP is expected a priori to reduce costs by minimizing leakages and the gap between water produced and water sold, but it does not. The coefficients of pop_water and density are both negative and insignificant. In terms of accessibility and the coverage of piped water, there is little difference between PPP and state utilities.

99. One possible reason is that effectiveness improvement by reducing leakages and expanding coverage need investment in new pipes and meters that costs more than the extra revenue that will be earned. The low tariffs seen in many cities that fall short of full cost recovery, combined with a reluctance or fiscal incapacity of city governments to make capital contributions, may make new

investment unviable. Managers may instead prefer to achieve financial targets by reducing inefficiency in the utility, such as by reducing labor and therefore wage costs.

100. Another possible explanation is that PPP agreements are weak in terms of obliging private operators to improve effectiveness. PPP agreements create contractual obligations on the partner to deliver the outputs required by the public partner. If private utilities did not deliver better outputs, it may simply be they have not been required to. It is also because water supply data contains too many missing observations.

J. Interpreting the Findings

101. Private participation in the water sector remains a sensitive matter in the PRC, especially when the water and/or sewage tariff is being adjusted. One concern is that improvements in utility financial performance arise solely because of tariff increases. Previous research into the impact of private participation on the performance of water utilities had not settled this criticism.

102. This paper explores the effect of private participation on the efficiency and effectiveness of utilities. After controlling for price effects and extending the sample to all prefecture cities in the PRC, private participation is found to significantly improve the efficiency of water utilities. Subsidies and employment is reduced, and TFP is improved. These findings are found to be robust to different treatments of collective capital and removing "private" utility owners that may actually be financed by SOEs. Improvements in performance are found to be superior when a utility is majority owned by the private investor.

103. The main finding is that private participation improves utility performance. That is, the same output is produced with less resources. This provides a strong argument for extending the use of the PPP mode in the water sector. Or in other words, it is important to avoid simply issuing locally owned monopolies the rights to develop water treatment plants, wastewater treatment plants, etc. Transferring existing operations from public to private partners can be expected to improve sector performance.

104. However, most indicators of effectiveness, or the quality of the water supply service, are not affected significantly by private participation. Fifteen indicators of water supply were chosen and categorized into four categories: bill collection, water accessibility, service quality, and power consumption. The results show that PPP does not improve accessibility or service quality. Bill collection and power consumption only marginally improved.

105. These findings also point to a need to better understand why utilities with private participation, although confirmed as more efficient, have not also generated dividends in the coverage of clean water supply and other aspects of effectiveness. One plausible explanation is that local governments focused their reforms on improving efficiency and reducing financial losses and government subsidies. Private operators may not have the right incentives to lift effectiveness, or have simply not been required to improve quality. It may now be timely to extend the scope of reforms by paying more attention to the output specifications included in PPP agreements. Specifically, PPPs may need clearer obligations to improve the effectiveness of urban water supply networks.

Table 5: The Impact of PPP on Water Supply

Item	PPP	PPP	PPP3	PPP3	PPP	PPP	PPP3	PPP3
notsoldwater	175.5	193.2	157.7	174.2	55.57	63.12	26.03	30.75
	(119.1)	(133.1)	(122.6)	(137.2)	(100.6)	(114.7)	(100.6)	(115.1)
leakagerate	0.945	1.096	1.207	1.341	0.556	0.687	0.804	0.915
	(0.745)	(0.793)	(0.773)	(0.820)	(0.743)	(0.797)	(0.770)	(0.823)
meter_total	23,432***	23,139**	23,386**	25,194**	19,667**	18,886**	19,173**	20,622**
	(8,794)	(9,243)	(9,780)	(10,215)	(8,245)	(8,630)	(9,194)	(9,550)
meter_res	19,320**	19,396**	18,999**	21,021**	16,876*	16,546*	16,140*	17,881*
	(8,511)	(8,989)	(9,454)	(9,900)	(8,665)	(9,180)	(9,699)	(10,195)
pop_water	1.549	2.012	2.091	2.784	1.299	1.647	1.860	2.470
	(2.537)	(2.756)	(2.755)	(2.993)	(1.838)	(1.947)	(2.014)	(2.132)
pipe_total	30.15	45.41	32.28	51.37	7.651	22.51	7.286	25.77
	(31.69)	(31.36)	(34.80)	(34.74)	(28.72)	(28.48)	(31.70)	(31.69)
pipe75	54.17*	56.96*	53.55	57.09*	29.03	29.73	26.41	27.52
	(31.06)	(31.90)	(32.64)	(33.73)	(22.56)	(23.21)	(22.76)	(23.36)
pipe_ductile	28.97	26.55	33.05*	32.45*	12.65	9.581	15.24	13.30
	(18.18)	(17.84)	(19.66)	(19.56)	(14.19)	(13.51)	(15.30)	(14.79)
Density	(0.385)	(0.263)	(0.662)	(0.445)	(0.493)	(0.413)	(0.820)	(0.644)
	(0.622)	(0.578)	(0.697)	(0.643)	(0.665)	(0.620)	(0.757)	(0.700)
prate_pressure	(0.133)	(0.256)	(0.0871)	(0.202)	(0.0757)	(0.188)	(0.0224)	(0.125)
	(0.456)	(0.485)	(0.486)	(0.517)	(0.484)	(0.517)	(0.519)	(0.555)
Pressure	0.000355	(0.000562)	(0.00258)	(0.00383)	0.000603	(0.000565)	(0.00240)	(0.00408)
	(0.00545)	(0.00517)	(0.00593)	(0.00559)	(0.00560)	(0.00532)	(0.00613)	(0.00576)
Areapro	(2.084)	(1.472)	(2.879)	(2.287)	(1.665)	(0.936)	(2.446)	(1.730)
	(2.206)	(2.567)	(2.263)	(2.677)	(2.251)	(2.629)	(2.316)	(2.758)
Powercon	109.1	3.617	112.6	(6.018)	(127.6)	(211.5)	(143.4)	(244.4)
	(248.8)	(250.6)	(266.5)	(271.0)	(145.6)	(199.5)	(158.3)	(215.9)
powerconave	15.70	12.92	15.56	13.50	13.86	13.20	13.60	13.97
	(10.44)	(11.33)	(11.24)	(12.21)	(10.90)	(11.91)	(11.85)	(12.96)
Powerconave2	(13.98)	(22.54)	(22.55)	(30.65)*	(15.10)	(24.94)	(24.67)	(34.23)*
	(15.65)	(14.94)	(17.72)	(15.75)	(17.41)	(16.26)	(20.09)	(17.48)
Control Variable		City controls		City controls		City controls		City controls
		Zhixia Cities included				Zhixia Cities excluded		

PPP = public–private partnership, PPP3 = 1 when a city has a PPP (and 0 when it does not).

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Note: In all regressions, logarithm of deflated residential water tariff is included as a covariate.

Source: City Water Supply Statistical Yearbooks (2000–2007).

V. CONCLUSION

106. PPPs are being pursued in the PRC because they are expected to improve the delivery of public services. A past emphasis on the use of PPPs as financing vehicles has been replaced by an emphasis on their role in public sector reform. The State Council, for example, has explained that the "PPP mode is an important innovation of the public services supply mechanism. PPP mode can give full play to the market mechanism to improve the quality and efficiency of the supply of public services, and maximize public interests."[26]

107. This paper provides empirical evidence that PPPs can indeed provide the improvements hoped for in the PRC. While the evidence is from within a single sector, it is in line with the widespread perception in the PRC that the private sector is outperforming the SOEs, and the international experience of the benefits of well-managed private participation in infrastructure. While some PPPs will fail and poorly prepared PPPs should always be avoided, the paper provides confidence that in the PRC, PPPs will generally outperform state-run infrastructure monopolies.

108. Water industry revenue reforms will be central to efforts to expand private participation in the water sector. Better revenue flows, in terms of both higher tariffs and more reliable payment, are needed to make investment affordable to government or to ensure that investments are commercially viable for private operators. Tariffs for both treated water and wastewater generally remain below cost recovery, despite many years of tariff reform. Most recently, the "Opinions on Promoting the Government and the social capital of cooperation in the field of water pollution prevention and control" issued by the Ministry of Finance and Ministry of Environment Protection in April 2015 noted that low water tariffs and delayed payment from government often cause the water supply companies to operate at loss. The opinions argued that reasonable tariffs must be charged to provide projects an adequate cash flow. While revenue reforms will benefit both local monopoly service providers and PPPs, the PPPs are more sensitive to such improvements.

109. Revisions of water tariffs could be usefully joined to efforts to improve the effectiveness of water utilities. Matching these efforts will help address reservations from the community in higher tariffs, as they would see the benefits of paying more for water supply.

[26] 'State Council's Guidance': Notice of the General Office of the State Council on Forwarding the Guiding Opinions of the Ministry of Finance, the National Development and Reform Commission and the People's Bank of [the People's Republic of] China on Promoting the Public-Private Partnership Mode in Public Service Field, Guo Ban Fa [2015] No. 42 05/19/2015 (国务院办公厅转发财政部、发展改革委、人民银行关于在公共服务领域推广政府和社会资本合作模式指导意见的通知), 国办发[2015]42 号, 05/19/2015)

APPENDIX

Data and Variables

1. The paper draws on several data sets. The first data set is the panel data of utilities in more than 300 cities obtained from Annual [People's Republic of] China Industrial Firm Surveys (2000–2007). The surveys covered all registered industrial firms that have annual sales above CNY5 million. It included 39 two-digit industries and over 600 four-digit industries in three broad categories—mining, manufacturing, and public utilities. There are 3 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 paper focuses on water production and supply firms with an industry code equal to 4610.[1]

2. Water utilities servicing dense urban populations are the primary interest of the research (as private participation is concentrated in larger urban areas), and accordingly the data sets are restricted to water utilities in all prefecture-level cities. Water utilities in small counties and towns are excluded. Some big cities, such as Beijing and Shanghai, have more than one water utility.

3. Some utilities may not report to the survey in some years. As a result, the number of water utilities varies over time, as shown in Table A2.

4. The second data set is the city panel data of water supply indicators from the City Water Supply Statistical Yearbooks (2000–2007). This data set includes important variables to measure the water supply performance of water utilities in the first data set, such as the water supply capability, the coverage of the population, pipe length, leakage, water pressure and price (2000-2007). However, the panel is quite unbanlanced.

5. A water tariff variable is compiled through combining the residential water prices data in City Water Supply Statistical Yearbooks (2000–2007) with information from the official water tariff adjustment government documents as released on the web.

6. The third data set used is the city panel data assembled from the [People's Republic of] China City Statistical Yearbooks (2000–2008). This contains many control variables of cities' characteristics, such as population, density, gross domestic capital (GDP) per capita, and other economic indicators. The first two data sets were merged separately with the third one to control for the city characteristics.

7. In this paper, 12 indicators were used to assess utility efficiency. Indicators were prepared for key aggregates, namely investment, total employment (empln), sales revenues (salesreln), and value added (vareln). Indicators were also prepared of financial performance, namely the ratio of liability to assets (liaratio), managerial expenses to sales (manexpsh), financial expenses to sales (finexpsh), profits to sales (profsales), taxes paid to sales (taxsales), and subsidies to sales (subsales). Summmary indicators of utility efficiency were also prepared, namely average revenue product of labor (arpl), and total factor productivity (tfpln).

8. To compare total factor productivity in a consistent manner across firms within the same industry, the methodology of Caves, Christensen, and Diewert (1982) was used. This calculates the logarithm of total factor productivity of water utility i in year t, as follows:

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

$\ln TFP_{it} = (\ln VA_{it} - \overline{\ln VA_t}) - s^*_{it}(\ln L_{it} - \overline{\ln L_t}) - (1 - s^*_{it})(\ln K_{it} - \overline{\ln K_t})$, where TFP, VA, L and K stand for total factor productivity, 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 $s^*_{it} = (s_{it} + \overline{s_t})/2$ with s_{it} being share of wage bill in value added of individual utility and $\overline{s_t}$ being industry average of wage bill shares.

9. This specification is flexible enough to allow heterogeneity in technology across utilities and time.

10. Several indicators on water supply were compiled. They were grouped into four categories: bill collection, water accessibility, service quality, and energy consumption.

11. Bill collection indicators show the degree of effort that a utility is exerting to reduce leakage and increase revenue, through more precise measurement and reduced wastewater. Bill collection indicators include the gap between water produced and sold (notsoldwater), leakage rate (leakagerate), number of installed water meters (meter_total), and number of installed water meters for residential users (meter_res).

12. Accessibility was examined by preparing indicators of piped water users and the scope of the pipe network. To provide water to more consumers, a water utility company needs to lay more pipes. This can require heavy investment, particularly for better and more durable pipe. Whether the user numbers and pipe density move in the same direction is the main concern, not just the pipe length itself. If the user numbers increase, and pipe density also increases, it is probable that the utility is gaining customers in existing service areas that only need to branch more pipes from an existing pipe network. If the piped water population is rising while the pipe density drops, then the utility is probably providing piped water to new areas that have a few users at the beginning.

13. Making more pipe water available is critical to improving public health conditions. It requires capital investment and that can see a utility incur losses until capital costs rerecovered. Utilities probably prefer to expand users in existing service areas, as this minimizes the required investment. Whether utilities are making large investments can be monitored by the diameter of pipes installed, specifically if pipes with a diameter exceeding 75 millimeters are being installed.

14. Therefore, in this paper, accessibility is measured by piped water population (pop_water), pipe length (pipe_total), pipe length of those diameter exceeding 75mm (pipe75), pipe length of Ductile iron pipe (pipe_ductile), pipe density (density).

15. Key indicators of water supply service quality are the pressure pass rate (prate_pressure), average pressure (pressure), and low pressure area percentage (areapro).

16. Finally, indicators of energy consumption were prepared in terms of total power consumption (powercon), power consumption for water production (powerconave), power consumption for water distribution (powerconave2).

17. Table A.1 provides the definition of the main variables used in this paper. Province-year specific deflators are applied to all relevant variables to obtain values in 1998 constant terms.

Table A1: Variable Definitions

Variable	Definition
Water Utilities	
PPP	Dummy variable =1 if state capital share in total capital is less than 1
Captot	Capital
assetsre	Total assets in CNY1,000, in 1998 constant price
Investment	Difference between assets in the end of current year and assets in the end of previous year, both in 1998 constant price
empln	Logarithm of number of employees
salesreln	Logarithm of sales revenues in CNY1,000, in 1998 constant price
vareln	Logarithm of value added in CNY1,000, in 1998 constant price
liaratio	Ratio of liability to total assets
manexpsh	Ratio of managerial expenses to sales revenues
finexpsh	Ratio of financial expenses to sales revenues
profsales	Ratio of profits to sales revenues
taxsales	Ratio of tax paid to sales revenues
subsales	Ratio of subsidy to sales revenues
arpl	Value added in 1998 constant price divided by total employment
tfpln	Logarithm of total factor productivity as calculated by equation (*)
City Variables	
popln	Logarithm of total population of the city
popden	Population per square kilometers
gdppcre	Per capita gross regional product in CNY, in 1998 constant price
gdpindsh	Percentage of industry in total gross domestic product (GDP)
gdpsersh	Percentage of services in total GDP
invfixsh	Ratio of fixed assets investment to GDP
urbanroadpc	Total urban road areas divided by population (square meters per person)
govdefsqr	Difference between public expenditure and revenues divided by public revenues
Water Supply	
notsoldwater	Water produced minus water sold (10,000 cubic metres)
leakagerate	Leakage rate
meter_total	Number of installed water meters
meter_res	Number of installed water meters-resident
pop_water	Piped water population (10,000 persons)
pipe_total	Pipe length (kilometer [km])
pipe75	Pipe length-diameter exceed 75 millimeters (km)
pipe_ductile	Pipe length-Ductile iron pipe (km)
density	Pipe density (km/sq km)
prate_pressure	Pressure pass rate of ressure tests(%)
pressure	Average pressure (Mpa)
areapro	Low pressure area percentage(%)
powercon	Total power consumption (10,000 kilowatts [KW])
powerconave	Power consumption for water production (10,000 KW)
powerconave2	Power consumption for water distribution (10,000 KW)

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

Table A2: Share of PPP Water Utilities in Capital, Assets, Employment, and Sales

Item	2000	2001	2002	2003	2004	2005	2006	2007
A. All Water Utilities								
Capital	559.974	585.425	683.205	763.711	803.444	822.790	885.599	921.736
Assets	897.896	950.637	1,103.247	1235.425	1,280.687	1,331.379	1,411.918	1,426.405
Employment	219,251	219,769	218,532	221,855	215,957	220,227	220,872	217,714
Sales	175.897	178.784	193.568	218.026	229.755	250.320	290.001	320.631
B. PPP Water Utilities								
Capital	63.209	104.044	87.684	137.877	216.961	272.278	338.301	358.569
Assets	107.419	173.262	148.849	229.403	335.809	421.278	526.545	559.110
Employment	17,930	25,397	25,812	33,771	40,234	48,526	56,904	62,694
Sales	17.382	24.703	25.858	37.809	56.647	77.016	105.224	121.961
C. PPPshare (%)								
Capital	11.29	17.77	12.83	18.05	27.00	33.09	38.20	38.90
Assets	11.96	18.23	13.49	18.57	26.22	31.64	37.29	39.20
Employment	8.18	11.56	11.81	15.22	18.63	22.03	25.76	28.80
Sales	9.88	13.82	13.36	17.34	24.66	30.77	36.28	38.04
Number of WU	7.74	11.37	13.04	18.60	22.83	28.03	34.27	39.66

Note: The units of capital (Captot), assets (Assetsre), and sales (Salesrev) are all billion yuans. The unit of employment (empl2) is person.
Source: Annual [People's Republic of] China Industrial Firm Surveys (2000–2007).

REFERENCES

ASEM Water Resources Research and Development Center. Available at: http://www.asemwater.org/

Aubert, C. and A. Reynaud. 2005. The Impact of Regulation on Cost Efficiency: An Empirical Analysis of Wisconsin Water Utilities. *Journal of Productivity Analysis* 23(3): 383–409.

Averch, H. and L. J. Leland. 1962. Behavior of the Firm Under Regulatory Constraint. *The American Economic Review* 52(5): 1052–1069.

Bai, C.-E., J. Lu, and Z. Tao. 2009. How does privatization work in [the People's Republic of] China? *Journal of Comparative Economics* 37(3): 453–470.

Bhattacharyya, A., T. R. Harris, R. Narayanan and K. Raffiee. 1995. Specification and estimation of the effect of ownership on the economic efficiency of the water utilities. *Regional Science and Urban Economics* 25(6): 759–784.

Bhattacharyya, A., E. Parker, and K. Raffiee. 1994. An examination of the effect of ownership on the relative efficiency of public and private water. *Land Economics* 70(2): 197.

Bruggink, T. H. 1982. Public versus regulated private enterprise in the municipal water industry: A comparison of operating costs. *Quarterly Review of Economics and Business* 22(1): 111–125.

Byrnes, P., Shawna Grosskopf, and Kathy Hayes. 1986. Efficiency and ownership: Further evidence. *Review of Economics and Statistic* 68(2): 337–341.

Carmody, L. 2010. *Water in* [the People's Republic of] *China.* Responsible Research. p. 24. Feb.

Chan, E. and S. Griffiths. 2010. The implication of water on public health: The Case of [the People's Republic of] China. *Perspectives in Public Health* 130(5): 209–210.

Clarke, G. R. G., K. Kosec, and S. Wallsten. 2009. Has private participation in water and sewerage improved coverage? Empirical evidence from Latin America. *Journal of International Development* 21(3): 327–361.

Crain, W. M. and A. Zardkoohi 1978. A Test of the Property-Rights Theory of the Firm: Water Utilities in the United States. *Journal of Law and Economics* 21(2): 395–408.

Crampes, C., Antonio. 1996. Regulating Water Concessions. Viewpoint. *Word Bank Group. Note* No.91.Washington, DC: World Bank.

de Oliveira, A. R. 2011. Impact of Private Sector Participation in the Provision of Water Services in Brazil: Empirical Analysis and Policy Recommendations. *Journal of Business Inquiry: Research, Education & Application* 10(1): 95–119.

Ebenstein, A. 2010. The Consequences of Industrialization: Evidence from Water Pollution and Digestive Cancers in [the People's Republic of] China. *Review of Economics and Statistics* 94(1): 186–201.

Estache, A., A. Gomez-Lobo, and D. Leipziger. 2000. Utility privatization and the needs of the poor in Latin America - Have we learned enough to get it right? *World Bank Policy Research Working Paper* 2407. Washington, DC: World Bank.

Estache, A. and E. Kouassi. 2002. Sector Organization, Governance, and the Inefficiency of African Water Utilities. *World Bank Policy Research Working Papers* No.2890: 26. Washington, DC: World Bank.

Estache, A. and M. A. Rossi. 2002. How different is the efficiency of public and private water companies in Asia? *The World Bank Economic Review* 16(1): 139. Washington, DC.

Feigenbaum, S. and R. Teeples. 1983. Public versus private water delivery: A hedonic cost approach. *Review of Economics and Statistics* 65(4): 672–678.

Fox, W. F. and R. A. Hofler. 1986. Using Homothetic Composed Error Frontiers to Measure Water Utility Efficiency. *Southern Economic Journal* 53(2): 461–477.

Galiani, S., P. Gertler, and E. Schargrodsky. 2005. Water for Life: The Impact of the Privatization of Water Services on Child Mortality. *The Journal of Political Economy* 113(1): 83–120.

Gassner, K., A. A. Popov, and N. Pushak. 2009. Does private sector participation improve performance in electricity and water distribution? *World Bank Publications Trends and Policy Options* No. 6. Washington, DC: World Bank.

Government of the People's Republic of China. 2010. *Twelfth Five-Year Plan for National Economic and Social Development of the People's Republic of China, 2011–2015*. Beijing.

Henry, Erin. 2004. *Water Scarcity in the North* [the People's Republic of] *China Plain: Water Saving Irrigation and Its Implications for Water Conservation.* 8 July. Michigan State University.

Hirvi, M. 2012. Water Privatization and Social Citizenship: The Case of Urban Water Sector in Ghana. *Journal of Civil Society* 8(4): 351–368.

International Institute for Applied System Analysis. 1999. International Institute for Applied System Analysis databases.

Jiang, Y. and X. Zheng. 2010. Private Sector Participation and Performance of Urban Water Utilities in the People's Republic of China. *Asian Development Bank Working Paper* No. 237. Manila: ADB.

———. 2014. Private Sector Participation and Performance of Urban Water Utilities in [the People's Republic of] China. *Economic Development and Cultural Change* 63 (1): 155–189.

Kirkpatrick, C., D. Parker, and Y.-F. Zhang. 2006. An Empirical Analysis of State and Private-Sector Provision of Water Services in Africa. *The World Bank Economic Review* 20(1): 143–163. Washington, DC.

Lambert, D. K., D. Dichev, and K. Raffie. 1993. Ownership and sources of inefficiency in the provision of the water services. *Water Resources Research* 29(6): 1573–1578.

Lee, C. 2011. Privatization, water access and affordability: Evidence from Malaysian household expenditure data. *Economic Modelling* 28(5): 2121–2128.

Luo, J., and Y. Wang. 2013. *Time for PRC's environmental protection enterprises to go overseas Chamber of Commerce*. The National Federation of Environmental Services.

Lyu Fu-sheng and Zhing Deng-hua. 2013. *Chinese water industry development status and trends*. Three Gorges Corporation Strategic Development Department. http://en.cnki.com.cn/Article_en/CJFDTOTAL-GSPS201310003.htm

Mann, P. C. and J. L. Mikesell. 1976. Ownership and Water System Operation. *Water Resources Bulletin* 12(5): 995–1004.

Ministry of Water Resources. 2011. People's Republic of China. Scientifically Exploiting Hydropower Resource to Promote the Sustainable Utilization of Water Resources and the Sustainable Development of Economy and Society. Speech by the Vice Minister Suo Lisheng of Ministry of Water Resources. PRC. http://www.un.org/esa/sustdev/sdissues/energy/op/hydro_suolisheng.pdf

Morgan, D. 1977. I*nvestor Owned vs. Publicly Owned Water Agencies: An Evaluation of the Property Rights Theory of the Firm.* Water Resources Bulletin 13: 775–781.

National Bureau of Statistics (NBS) People's Republic of China. 2014. [The People's Republic of] *China Statistical Yearbook (2014) (Zhongguo Tongji Nianjian-2014)*. Beijing: [The People's Republic of] China Statistics Press. http://www.stats.gov.cn/tjsj/ndsj/2014/indexeh.htm

———. 2013 *Statistical Communiqué of the People's Republic of China.* National Economic and Social Development. National Bureau of Statistics of [the People's Republic of] China. 22 February. http://www.stats.gov.cn/english/PressRelease/201302/t20130222_72261.html

———. 2010 *Statistical Communiqué of the People's Republic of China.* National Economic and Social Development. National Bureau of Statistics of [the People's Republic of] China. 25 February. http://www.stats.gov.cn/english/NewsEvents/201002/t20100226_26295.html

Organization for Economic Cooperation and Development (OECD). 2015. *Fostering Investment in Infrastructure Lessons learned from OECD Investment Policy Reviews*. January. http://www.oecd.org/daf/inv/investment-policy/Fostering-Investment-in-Infrastructure.pdf

PRC's Industrial Wastewater Market Analysis Report (2013 edition) Available at www.h2o-PRC.com /www.solidwaste.com.cn

Raffiee, K., R. Narayanan, T. Harris, D. Lambert and J. Collins. 1993. Cost analysis of water utilities: A goodness-of-fit approach. *Atlantic Economic Journal* 21(3): 18–29.

Saal, D., D. Parker, and T. Weyman-Jones. 2007. Determining the contribution of technical change, efficiency change and scale change to productivity growth in the privatized English and Welsh water and sewerage industry: 1985–2000. *Journal of Productivity Analysis* 28(1-2): 127–139.

Saal, D. S. and D. Parker. 2000. The impact of privatization and regulation on the water and sewerage industry in England and Wales: a translog cost function model. *Managerial and Decision Economics* 21(6): 253–268.

Shirley, M. and P. M. Walsh. 2000. Public versus private ownership: the current state of the debate. *World Bank Policy Research Working Papers* No. 2420. Washington, DC: World Bank.

Shleifer, A. 1985. A Theory of Yardstick Competition. *The RAND Journal of Economics* 16(3): 319–327.

Shleifer, A. 1998. State versus Private Ownership. *The Journal of Economic Perspectives* 12(4): 133–150.

Song X.T. 2000. Characteristics and Countermeasures of [the People's Republic of] China's Urban Water and Sewer Development. [The People's Republic of] *China Water and Wastewater.* 16:21–25.

State Council of the People's Republic of China. 2014. *State Council Organizational Chart.* Available at http://english.gov.cn/state_council/2014/09/03/content_281474985533579.htm

———. 2012. *The Master Plan for National Urban Wastewater Treatment and Recycling Facilities Under the 12th Five-Year Plan.* Beijing . 19 April.

Tao, F., 2012. *Environmental Industry 2012 Review and Outlook*. Beijing: Water Policy Research Center, Qinghua University.

Teeples, R. and D. Glyer. 1987. Cost of water delivery systems: Specifications and ownership effects. *Review of Economics and Statistics* 69(3): 399–408.

United Nations Commission on Sustainable Development. 2011. *Fresh Water 2004.* http://www.un.org/esa/agenda21/natlinfo/countr/china/Waterf.pdf

Vining, A. R. and A. E. Boardman. 1992. Ownership versus Competition: Efficiency in Public Enterprise. *Public Choice* 73(2): 205–239.

Wang, H., W. Wu, and S. Zheng. 2011. An econometric analysis of private sector participation in [the People's Republic of] China's urban water supply. *Utilities Policy* 19(3): 134–141.

Wei, Y. 2014. *Regulating Municipal Water Concessions: Accountability in Transitional* [the People's Republic of] *China.* Shanghai: Shanghai University.

World Bank. 2014. *Private Participation in Infrastructure in Infrastructure Projects Database.* Washington, DC: World Bank Group. http://ppi.worldbank.org/

Xiao, Q., Xiaomu Huang and Meishuang Zhang. 2013. *Chinese water market research report.* www.h2o-PRC.com

Zhang, A., Y. Zhang, and R. Zhao. 2001. Impact of Ownership and Competition on the Productivity of Chinese Enterprises. *Journal of Comparative Economics* 29(2): 327–346.

Zheng, X. *The Impacts of Public-Private Partnership on the Performance of Urban Water Supply Utilities in PRC.* Guangzhou: Institute of Industrial Economics, Jinan University.

Zhong, Z. *Chinese local government water management functions and its reorganization.* Changchun: Northeast Normal University.

People's Republic of China: Do Private Water Utilities Outperform State-Run Utilities?

This analysis of the water utilities in the People's Republic of China has confirmed the potential benefits of public-private partnerships (PPPs) in infrastructure. A study of water utilities in 300 prefecture-level cities, over a period in which the share run as PPPs rose from 8% to almost 40%, found that PPPs improved performance. Urban water utilities run as PPPs were more efficient than conventionally-run water utilities. PPPs were more productive, required less subsidies (and this was not a result of higher charges), and had lower labor costs. Many of the PPPs in the People's Republic of China's water sector have mixed private-state ownership. PPPs with majority private ownership had better impacts than those with minority private ownership.

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