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Impacts of sparing use of water on farmer income of China

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ABSTRACT

We examine relationships between nationwide sparing use of water and farmer income of China in this article. As increasing implementation of water projects and irrigation system, the cost of water use has increased in many regions. However, as local policy-oriented urban expansion and ecological restoration have carried out during the past decade, water demand has increased. The spatial distributions of water use and farmer income are uneven and their relationships are ambiguous over time, especially it is uncertain that farmers can benefit from those so called water-saving programs when urban expansion grows faster in China. Based on consumption theory, empirical results of Blundell–Bond dynamic panel-data model with generalized method of moments (GMM) estimators indicate saving one percent of water has positive impacts at 0.085–0.35 percent on farmer income in the following statistical year. Population has negative impacts on farmer income. Particularly in Central China, one percent of increase in population will statistically significantly decrease 0.276 percent of contemporaneous farmer income. Particularly, in Eastern China with large population during years 2004 through 2012, the total amount of water use increases one percent, contemporaneous farmer income loses 0.04 percent. Thus, saving water can benefit future farmer income, and it indicates that urban expansion may induce the diversion of resources and agricultural production from rural to urban area. Policy implication of relationships between water allocation and farmer income distribution caused by water-saving programs needs to be further studied at regional scale, in particularly to the regions with large population and urban expansion in China.

1. Introduction

The Word Bank reported that per capita water use is one of key indicators to measure human-wellbeing (Rosegrant et al., 2002). With world-wide increasing demand of economic development with eco-environmental protection (Singh, 1998), water demand of environmental adaptation have been raised up (World Bank Group, 2012) and which is driven by the impacts of both local policy-oriented urban expansion and regional climatic changes (Jiang et al., 2014). China is one of countries severely lack of water (Deng and Zhao, 2014). The per-capita water resource in China is less than 2100 cubic meter, only 28 percent of the world average until 2000s. China, thereby, aims to set an ideal "water-saving society", and have broadly implemented water-saving techniques in both urban and rural area (Deng et al., 2014). There are four categories of synchronous implementation for water-saving techniques in agricultural production, industrial processing, residential living, and municipal construction (*National Agricultural Water-Saving Outlines For* 2012–2020, 2012). However, when facing water shortage at regional scale (Kelly, 2014), heterogeneity may counteract benefits of water-saving implementation at national scale. Particularly, in terms of Wang et al. (2002) studied that agricultural use of water accounts for over 70 percent of the total amount of water in China until 2000s, there are still lack of researches studying how the real farmer income has been influenced by water use changes over time.

According to *National Agricultural Water-Saving Outlines For* 2012–2020 published by The Ministry of Water Resource of the P.R. China in year 2012, water-saving programs efficiently retarded the consumption of water stock. Water use efficiency had increased about 20 percent from year 2000 to 2013. Especially, irrigated water use per ha decreased from 15 cubic meter in year 2000 to 24 cubic meter in year 2013. However, with the increasing demand of water in urban area, water use proportional changes of agricultural sectors and non-agricultural sectors fluctuated under three percent over time, and the growth rate of the total amount of water use was continually increasing about one percent

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per year (see Fig. 1). Therefore, we do not know yet whether farmers will benefit from the national water-saving programs when China's urban expansion grows faster.

Water-saving programs pushed relevant industrial transformation. Through the advanced drought-enduring seeds were fostered and wide sowed, per cubic meter water input on average yield of crops had arisen from 1.33 kg in year 2000 to 1.75 kg in year 2013. The efficiency of fertilizer and pesticide use with respect to yield was improved around 15 percent. Over 2000 firms had invested on research and development of water-saving technique and equipment, which successfully supported annual increase of irrigation facilities covering over 200 million ha per year. Until year 2013, irrigated area were 63.47 million ha, about 43 percent of them covered by irrigation facilities. Moreover, in terms of regulations of regional water quota, implementation of forced water-saving technique, and installation of water-saving equipment for industrial water consumption and retreatment, all of that with some state subsidies had positive impacts on the relevant industries to some extant saving cost of water consumption (Deng et al., 2014).

Impacts of sparing use of water on farmer income of China are rarely researched. Blanke et al. (2007) tended to study household behaviors to irrigated water-saving against drought resistant of cultivation, and discussed water-saving technology development and its acceptance in China. Gilg and Barr (2006) did survey research to find evidence that motivation of household behaviors for water-saving through the purchase investment decision of water-saving facilities and their water use actions. These ideational research designs probe into perception of respondents on water-saving facilities that were practically used in daily living or agricultural production. Wang et al. (2015) analyzed economic welfare of rural and urban residents can benefit from water projects at regional scale that supposed to be achieved by either regional or national government investments to irrigation facilities. However, we do not know yet how much farmer income benefit from sparing use of water at the national level.

In the rest of this article, we review the status of water use in China in the following section, and briefly point out uneven spatial distribution and fuzzy relationships among water use, population, and farmer income of Eastern China, Central China, and Western China. In third section, the empirical models are built up based on a sequential series of hypotheses, and data description are introduced for technical clarification and professional verification. The empirical results and our analysis are given in the fourth section to clarify the fuzzy relationships and verify our hypotheses. The final section presents the conclusions and policy implications.

2. Background

Spatial distribution of the total amount of water use is uneven in China. According to regional division of China in geographical categories, there were three large regions: Eastern China, Central China, and Western China. In year 2012, there were 556 billion ton water used in China. Eastern China consumed 218 billion ton of water, accounts for 40 percent of the total amount of water use in year 2012. In Eastern China, Jiangsu (55 bt), Guangdong (45 bt), and Shandong (22 bt) were the top-three highest provinces in water use, as shown in Table 1. Central China used 196 billion ton of water in year 2012. Heilongjiang (36 bt), Hunan (33 bt), and Hubei (29 bt) were the top-three highest provinces in water use. Western China spent 141 billion ton of water, and Guangxi (30 bt), Sichuan (24 bt), and Inner Mongolia (18 bt) were the top-three highest provinces in water use.

Spatial distribution of per capita water use is uneven in China. The per capita water use is the amount of total water use per person, which is the total amount of water use in year 2012 divided by the total population of each province in China. Population of China was up to 1347.89 million by the end of year 2012. As Table 2 shows, the highest average of per capita water use was in Central China (462 t). That of in Eastern China (390 t) and Western China (388 t) were quite close in year 2012. Per capita water use of Shanxi (203 t), Henan (254 t), and Jilin (472 t) were the three lowest in Central China; Tianjing (164 t), Beijing (173 t), and Shandong (229 t) were the three lowest in Eastern China; and Xinjiang (26 t), Shannxi (235 t), and Chongqing (282 t) were the three lowest in Western China in year 2012.

The relationship between water use and farmer income is ambiguous. According to the statistics of NBSC year 2004–2013,

Table 1
Total amount of water use in each province of China in year 2012.

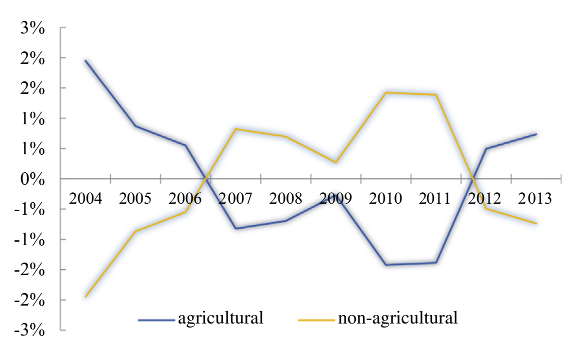
Eastern China		Central China		Western China	
Beijing	3588	Shanxi	7339	Inner Mongolia	18,435
Tianjing	2313	Jilin	12,982	Guangxi	30,301
Hebei	19,531	Heilongjiang	35,890	Chongqing	8294
Liaoning	14,223	Anhui	29,264	Sichuan	24,592
Shanghai	11,598	Jiangxi	24,254	Guizhou	10,082
Jiangsu	55,223	Henan	23,861	Yunnan	15,183
Zhejiang	19,812	Hubei	29,929	Tibet	2981
Fujian	20,008	Hunan	32,880	Shaanxi	8804
Shandong	22,179			Gansu	12,305
Guangdong	45,102			Qinghai	2740
Hainan	4533			Ningxia	6935
				Xinjiang	590
Total	218,110		196,399		141,242

Note: amount of water used is measured in million ton. Data source: NBSC in year 2012.

Table 2
Amount of per capita water use in each province of China in year 2012.

Eastern China		Central China		Western China	
Beijing	173.4	Shanxi	203.2	Inner Mongolia	740.4
Tianjing	163.7	Jilin	472.1	Guangxi	647.2
Hebei	268.0	Heilongjiang	936.1	Chongqing	281.6
Liaoning	324.1	Anhui	488.7	Sichuan	304.5
Shanghai	487.3	Jiangxi	538.5	Guizhou	289.4
Jiangsu	697.3	Henan	253.7	Yunnan	325.9
Zhejiang	361.7	Hubei	517.9	Tibet	967.9
Fujian	533.8	Hunan	495.3	Shaanxi	234.6
Shandong	229.0			Gansu	477.3
Guangdong	425.7			Qinghai	478.2
Hainan	511.1			Ningxia	1071.9
				Xinjiang	26.4
Average	390.5		462.0		387.7

Note: Amount of per capita water use is measured in ton. Data source: NBSC in year 2012.



Data source: National Bureau of Statistics of China (NBSC) in years 2004-2013.

Fig. 1. Water use proportional changes of agricultural sectors and non-agricultural sectors in the years 2004 through 2012.