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The effect of private tubewells on income and income inequality in rural Pakistan

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SUMMARY

Since the introduction of private tubewells in rural Pakistan, farmers have increasingly used groundwater to supplement canal water for irrigation and improve the reliability of the water supply. Farmers obtain groundwater either from their own tubewells or from other well owners. This paper examines the effect of private tubewells on rural income, both in terms of income level and income distribution since it may differ across farmers with different irrigation status (only canal water, canal water and groundwater from own tubewell, and canal water and purchased groundwater). The results show that private tubewells work to enhance rural income and reduce income inequality in rural Pakistan.

1. Introduction

Agriculture is a vital part of Pakistan's economy. It accounts for 21.6% of the nation's GDP in 2009 and employs more than 40% of the labor force (World Bank, 2012). Pakistan's agriculture relies on irrigation much more than most other countries. More than 80% of its cultivated area is irrigated (Kamal, 2009). In rural Pakistan, farmers used to rely solely on the public irrigation system, including a network of canals and public tubewells, for irrigation water. Farmers took turns to use water from the public irrigation system. The turns were fixed based on the locations of plots owned by farmers (Meinzen-Dick, 1996). However, the canal network often failed to supply water with sufficient quantities or at the times needed. Meanwhile, the performance of public tubewells also deteriorated due to a lack of funding for operation and maintenance (Chaudhry and Young, 1990).

In response to the inadequacy and the unpunctuality of the public irrigation system, private tubewells have emerged to supplement the public water supply, especially the canal water supply. Farmers either sink their own tubewells or purchase water from other farmers that own tubewells. The groundwater markets in rural Pakistan are informal since usually there are not any legal sanctions (Meinzen-Dick, 1996). The rise of tubewells could have a positive impact on household income because more reliable water supply is likely to increase crop yields. A relatively large literature exists in India that examines the impact of groundwater market on income (e.g., Kajisa and Sakurai, 2005). However, there is not a large literature that looks at tubewell irrigation in Pakistan. Meinzen-Dick (1996, 1998) found that wheat yields of farmers that had their own tubewells were higher than those of other farmers. However, household income does not always respond positively to the rise of tubewells due to factors such as fluctuating energy costs and declining groundwater levels in the long term. So the effect of tubewells on income becomes an empirical question. For the rest of the paper, tubewells refer to private tubewells unless otherwise noted.

In addition to its effect on the level of income, how the spread of tubewells influences the income inequality is also of concerns to policy makers. Both scholars and policy makers have come to recognize that in addition to income levels, income inequality also matters for poverty reduction (e.g., Atkinson, 1997; Fields, 2002; Sekhri, 2014). Income inequality is usually measured using the Gini coefficient, with the value of 0 indicating perfect equality and 100% indicating perfect inequality. Zaman and Khilji (2013)

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shows that a 1% increase in the Gini coefficient while holding the income level constant increases poverty by more than 1% in Pakistan. This is because although the average income level is the same, a higher inequality level means more income is shared among fewer households and thus more households are left below the poverty line. In addition, rising inequality can negatively affect poverty reduction if it impedes economic growth (Naschold, 2009).

The spread of tubewells has the potential to change the income distribution in rural Pakistan. The costs of tubewell installation and pumping equipment purchase often prevent small and poor farmers from owning a tubewell (Meinzen-Dick, 1996). If only wealthy farmers benefit from tubewell irrigation because they can afford to invest in tubewells and thus expand their irrigated areas, the rise of tubewells is likely to exacerbate income inequality. However, poor farmers could also benefit from the spread of tubewells if they can purchase groundwater through groundwater markets. Thus, whether income inequality will rise or drop depends on the extent to which poor farmers can benefit from tubewell irrigation. If tubewell owners have strong monopoly power and farmers are forced to pay much higher water prices, groundwater markets may reinforce the disparity between tubewell owners and non-owners (Qureshi et al., 2003). Tubewell ownership and groundwater market may also worsen income inequality at the regional level because excessive drawdown in the upstream may lead to less water being available downstream. Since tubewells can influence income inequality through the various channels, it is important to quantify the impact of tubewells on income inequality. This is particular important to policy makers in Pakistan given its high poverty rate, especially in rural areas. In 2008, 60% of Pakistan's population was living below the poverty line defined as $2/day, a rate that is much higher than other countries in the same region such as Sri Lanka (23.9%, World Bank, 2013).

A group of researchers have studied income inequality in Pakistan (e.g., De Kruijk, 1987; Adams, 1994; Adams and He, 1995; Shams, 2012). Most of these studies are descriptive in nature and only decompose income inequality by income components such as off-farm income and crop income. Only a few studies (e.g., Naschold, 2009) examine how the determinants of income such as education and irrigation would affect income inequality. In one of the very few papers that look at the relationship between tubewell irrigation and income inequality, Shaheen and Shiyani (2005) find that income was more equally distributed in the Mehsana district than in the Banaskanth district in North Gujarat. Their explanation is that farmers have more equal access to groundwater in the Mehsana district. However, no quantitative analysis is done to control for the influence of other factors such as off-farm employment.

Outside Pakistan, there is a large literature that examines groundwater market, epically in India, which is now the largest groundwater economy in the world (Shah, 2008). The record on the impacts of groundwater markets is mixed (e.g., Mukherji, 2004; Singh and Singh, 2003). In general, there is a consensus that groundwater markets boost water productivity through channels such as higher crop intensity and higher crop yields (e.g., Shah, 1993). Meanwhile, scholars also debate on whether groundwater market is monopolistic in nature and whether water buyers are being exploited through higher water prices charged by tubewell owners. Fujita and Hossain (1995) argue that the high water charge is reasonable when the high interest rates in the local informal financial market are taken into account and conclude that the development of groundwater markets does not necessarily worsen income disparity. Kajisa and Sakurai (2005) find that the bargaining power of the buyers, not the sellers, is more important in price determination because it is difficult to prevent the entry of new groundwater sellers. Banerji et al. (2012) find that water trades result in a spatially-efficient allocation of water and a social contract exists to determine both water price and water allocation in groundwater markets. Kumar et al. (2011) find that establishing an energy quota at farm level based on sustainability considerations, metering and charging pro rata for power could lead to efficient use of water and energy, and equity in access to groundwater. Although previous studies touch on the issue of equity, most focus on indirect measures such as groundwater prices (e.g., Kajisa and Sakurai, 2005). Our study is among the very few that examine the impact of groundwater markets on the direct measure of income inequality.

The overall goal of this paper is to answer two interrelated questions. First, how do tubewells influence individual farmers in terms of their income? Second, how do tubewells influence the rural community as a whole? Specifically, how does the rise of tubewells affect income inequality in rural Pakistan? We will answer these questions using a data set that contains information on irrigation in the crop seasons during year 2010–2011. To our knowledge, the data set we use is probably the most recent data on tubewell irrigation in Pakistan. The findings from this study will help policy makers determine whether to support the trend of rising private tubewells or to intervene. If tubewells could increase income levels without increasing income inequality, the spread of tubewells should be encouraged by government interventions such as subsidies for tubewell installment and extension efforts to help set up and operate water markets. Otherwise, policy makers ought to balance the positive effect of tubewells on income and their negative effect on income distribution.

The rest of the paper is organized as follows. Section 2 describes the data set that forms the basis of the analysis and characteristics of farmers in the sample area. Section 3 first presents the methods we use to examine the effect of tubewell irrigation on income and then reports the empirical results. Section 4 analyzes the effect of tubewell irrigation on the income inequality in rural Pakistan. The final section concludes.

2. Survey data and descriptive analysis

Data for this study come from a household survey conducted by the International Water Management Institute (IWMI) in 2012 in the most populous province of Pakistan, the Punjab province. There are more tubewells in Punjab than any other regions in Pakistan. In 2002, it was reported that there were 566,446 tubewells in Punjab and almost 90% of wells were equipped with diesel pumps (Qureshi et al., 2003). Although electricity pumps are usually more profitable, diesel pumps are more common in Pakistan, which is probably due to the limited availability of electricity and high replacement cost of electric pumps (Aurangzeb, 2007). The sample area of the survey is the Hakra branch canal of the Bahawalnagar District in Punjab (Fig. 1). Although the focus of the survey is on tubewell irrigation, return flows from canal irrigation need to be taken into account because seepages from unlined canals and irrigated fields have been significant sources of recharge of groundwater in the region (Ahmad et al., 2007). Because of the connection between canal irrigation and groundwater, locations relative to sources of canal water supply are important. The sampling framework of the survey takes this into account. A stratified random sampling strategy was used to select sample distributaries with varying degrees of water scarcity, which was highly correlated with the distance to the head of the Hakra Branch. Three sample distributaries were selected. The Khatan distributary is located at the head reach and has 129 watercourses in total. In most sample villages, the whole village uses water from the same watercourse. The Mamun distributary is in the middle reach and has 129 watercourses. The Sardrewala distributary is in the tail reach and has 106 watercourses. Each distributary was then divided into three sections: the head, the middle and the tail reaches. Around