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Valuing farm access to irrigation in Nepal: A hedonic pricing model

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ABSTRACT

The objective of this research is to quantify the economic value of access to irrigation for agricultural lands in rural Nepal, while controlling for the effects of social institutions that can either enhance or detract from agricultural production and land values. The analysis employs the hedonic pricing method (HPM) and uses self-assessed land value data from the Nepal Living Standards Survey, 2011. For the econometric modeling, a Box-Cox transformation supports the selection of the double log HPM model. Results show that the value of land with access to irrigation water is approximately 46 percent higher than the value of non-irrigated lands with a marginal implicit price of approximately NRs. 150,840 in 2011, (representing about seven times the median rural annual per capita income). Results also show the importance of built irrigation infrastructure, such as canals and tube wells, as well as access to multiple sources of irrigation water. We find that land-owner membership in community-managed irrigation systems and forestry user groups has positive impacts on land values. In consideration of extensive 2015 earthquake damages across large areas of Nepal, the findings support the critical importance of repairing irrigation access, especially to built irrigation infrastructures, and supporting community-managed irrigation and forestry user groups, which often lack the initial capital to initiate projects, for restoring rural well-being.

1. Introduction

Access to irrigation systems is often a critical determinant of agricultural productivity and sustainability in both developed and developing countries. Attempting to understand and assess the value of access to irrigation where water is generally treated as a non-market good is important because market prices for access to the irrigation systems and facilities are often not readily available, especially in developing countries (Barton and Bergland, 2010). Even in cases when prices are available, they may not match the economic benefit of irrigation access, especially if the prices are administratively set or not derived from a functioning market. Therefore, the economic benefits of these irrigation systems are not explicitly observable.

To address this issue, this analysis applies a non-market valuation approach known as the hedonic pricing method (HPM) (Taylor, 2003; Freeman et al., 2014). The HPM econometrically decomposes the variation in land values to isolate the value of an attribute or characteristic, such as irrigation system access or water volume (e.g., Mukherjee and Schwabe, 2015). Improved economic signals as to the monetary value of irrigation access or system improvements can inform policy actions concerning the management of scarce water resources.

Using HPM modeling, the objective of this analysis is to investigate the economic value of farm access to irrigation and also to different types of irrigation infrastructure in the developing country context of Nepal. Given a significant body of past research (e.g., Bastakoti et al., 2010; Bastakoti and Shivakoti, 2012; Lam and Ostrom, 2010; Ostrom, 2012) illustrating the productivity of community-managed irrigation systems in Nepal, we also control for the effect of farm-owner involvement in social institutions. Community-level common property regimes have been particularly important governance institutions in the development and management of irrigation infrastructure in Nepal, which remain predominately gravity-based distribution systems (Bastakoti et al., 2010). The analysis uses household level data from the 2011 Nepal Living Standards Survey III (NLSS III) in the empirical HPM model. This analysis assumes that landowners are able to identify the various attributes of the agricultural lands while revealing self-assessed values of the lands. That is, the expressed land values taken from the survey are assumed to be a valid reflection of market prices. In such a scenario, the value of access to irrigation, as well as effect of farm participation in alternative community groups (as indicators of alternative institutions that help govern or influence irrigation systems), are embedded within expressed land values.

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Further, it will be examined if different types of irrigation methods such as tube wells, canals, and ponds affect land values differently in Nepal. Moreover, risk distribution behavior would suggest that lands with access to more than one type of irrigation facility should have higher market value than those with access to only one type. Previous research has shown that a diversified water portfolio in terms of a greater variety of irrigation water sources translates into a higher land value (Mukherjee and Schwabe, 2015).

With respect to policy implications, as Nepal recovers from a series of devastating earthquakes that occurred in mid-2015, protecting and restoring access to irrigation systems remains a critical input to economic well-being in rural Nepal (UN News Center, 2015). This is illustrated in econometric results indicating that access to irrigation is one of the most significant attributes of land value. The estimated value of land with access to irrigation water is approximately 46% higher than the value of non-irrigated lands, with a marginal implicit price (MIP) of approximately NRs. 150,840 in 2011. This MIP is approximately seven times the median rural annual per capita income and more than 30% greater than median rural annual household income. Access to built infrastructure such as canals and tube wells is capitalized into the land values more than access to natural sources of irrigation. Lands having access to more than one source of irrigation water also have higher land values. Memberships in water-management associations and community organizations, which proxy for community-managed irrigation systems, as well as membership in forestry user groups have a positive relationship with the land values in Nepal. The unique agroforestry in Nepal, especially in the hilly region, helps make agricultural lands more productive (Oli et al., 2015), which ultimately results in an increase in land values. As expected, distances from the other important infrastructure facilities also have significant impacts on land values. Thus, investments by the government or international non-governmental organizations (NGO's) for the reconstruction of built infrastructure such as canals and tube wells, in addition to markets and roads, etc. can have a significant impact on restoring wealth in rural Nepal. Finally, another place to target reinvestment would be supporting community-based irrigation systems and forestry user groups.

2. Background

2.1. Irrigation systems in Nepal: access and governance

In Nepal, a less developed country with a traditional agrarian-based economy, irrigation systems have been acknowledged as a critical part of the social infrastructure for centuries (Pradhan, 1989). Periodic plans and various other water/irrigation acts of the Nepalese government have emphasized irrigation as the second most important water consumptive sector after the provision of drinking water (MOI-Nepal, 1992). The importance of irrigation in Nepal is also exemplified by the fact that more than 80 percent of households directly rely on the agricultural sector for employment and income generation (Maltsoglou and Taniguchi, 2004). Moreover, the population of Nepal is increasing rapidly at the rate of 1.35% per annum, which leads to increased pressure on the nation's natural resources (CBS-Nepal, 2011). However, the agricultural sector is held back by the lack of sufficient irrigation infrastructure development. This follows from the fact that despite the abundant water resources available in the country, for instance, there are more than 6000 rivers, and numerous glacier regions and wetlands; Nepal is considered as facing a widespread shortage of water for irrigation purposes (Cook et al., 2010).

The topography of Nepal appears favorable for the development of irrigation projects, with an average annual rainfall of 1770 mm and a North-to-South steepness ranging from the highs of Mount Everest (8848 m) to the lows of 60 m above sea level. Yet, Nepal has found it difficult to take advantage of such strategic geographical conditions. As the geographic structure of Nepal is mostly mountainous, the lands above the level of the water source cannot get access to the irrigation water making farmers in Nepal to rely on gravity-based traditional irrigation technologies. This leaves the farmers of such areas solely dependent on precipitation for irrigation (Benjamin et al., 1994). The total arable land in Nepal is 2,641,000 ha and out of this only less than 50 percent of the hectares have access to irrigation water (Bhattarai et al., 2013). The three largest river basins in Nepal are Koshi, Gandaki, and Karnali and there are thousands of other rivers, streams and lakes. But, the country still struggles to take advantage of these resources as shown by the fact that nearly half of the arable land doesn't have access to irrigation water at all, and only one-third of the land has access for the whole year. The potential in agriculture is enormous for Nepal as apart from the high mountains where the usual cropping pattern is mono-crop, the hills and Tarai regions provide the possibility of up to three crops per year provided the availability of water is ensured. Results from a recent analysis (Dillon et al., 2011) of benefit-cost ratios indicate that irrigation is one of the most productive public expenditures in Nepal.

It is also important to note that in Nepal, traditional agriculture and forestry have combined to give rise to an agroforestry system that provides a more productive and sustainable system of land-use, especially in the middle hilly region. Amacher et al. (1999, 1993) describe the complex interdependence between agriculturally-dependent households and nearby forests. This agroforestry system provides benefits in the form of lower soil erosion, higher soil fertility, and greater agricultural productivity while also providing firewood for nearby households and fodder for livestock (Neupane et al., 2002; Oli et al., 2015). The agroforestry system also provides natural protection against landslides and bursting of Himalayan lakes (Pandit et al., 2013). On the whole, agroforestry in Nepal provides a multi-functional working landscape where woody and non-woody parts combine to improve biodiversity and carbon sequestration, increase productivity, diversify livelihoods and enhance ecological protection against topographical changes (Oli et al., 2015). Thus, better irrigation facilities can take advantage of the natural synergy, which exists between the agriculture and forestry sectors, to boost overall security related to food and fuel for the rural population.

Traditional canals in the Kathmandu Valley of Nepal have been in existence since the start of the fifth century. There is even evidence of rules and regulations pertaining to water distribution from that time period (Bastakoti and Shivakoti, 2012). Community-managed irrigation systems have been in place in Nepal for many centuries. These can either be under the control of a community or an individual family. Singh (2010) explains that the construction of these systems was and still is the forte of experts who utilize traditional skills to construct and maintain canal systems. In the hilly region this work is generally carried out by the "Agri" community, while in the Tarai region the "Tharu" community partakes in this exercise. Even the construction of community-managed irrigation systems differs from region to region. In the high mountains, the canals have a mud mortar foundation with slate lining. In the hilly region, the canals are usually open structures. Lastly, in the Tarai region, the canals are similar to the ones in the hilly region but the division structures are made of logs and bushes (Singh, 2010).

The first initial government contribution to the irrigation sector was marked by the construction of a variety of canals, which were part of irrigation schemes carried out during 1922–1950. More significant development in irrigation occurred after the formation of Department of Irrigation in 1952 as a result of the five-year plans introduced in the mid-1950s (Shah and Singh, 2001). The Irrigation Act 1961 and later the Canal, Electricity and Water Resource Act