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Role of capitals and capabilities in ensuring economic resilience of land conservation efforts: A case study of the grain for green project in China's Loess Hills

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ABSTRACT

The article describes how economic resilience of farming households can be measured using a composite indicator of revealed adaptive actions, and investigates how capabilities of farm households to recombine human, financial, natural and physical capitals are linked to observed economic resilience to land set-aside interventions. The land set-aside intervention known as the Grain for Green Project (GGP), which has been altering livelihoods of farming households in China's Loess Hills since 1999, is taken as a case study. Household surveys were conducted in three V-shaped valleys and three riparian areas in Yanhe Township in northwestern China in an effort to measure household resilience and explore its' relationship to forms of capital. A composite index of adaptive strategies that can reorganize livelihood activities under land set-aside intervention into a new economic equilibrium is crafted using an objective weighting scheme based on principal component analysis. Subsequently, a multiple regression model was utilized to examine the relationship between the composite resilience index and various indicators related to human, social, financial, natural and physical capitals. The results reveal the latent structure and internal correlations of adaptive strategies, and present quantitative evidence about the relationship between livelihood capitals and household economic resilience. The analysis shows that household resilience deteriorates when the ratio of GGP land to cultivated farmland goes above a threshold level, and revealed that interventions targeting various forms of capitals can enhance the economic resilience for households to conservation efforts.

1. Introduction

In China's Loess Plateau, most of its cultivated areas (up to 70%) transitioned to degraded lands as a result of centuries of unsustainable cultivation and grazing practices in an extremely hilly landscape with a continental monsoon climate (Liu et al., 2013). In order to tackle the rampant land degradation, the Grain for Green Project (GGP) initiated (since 1999) in the Loess Plateau by the Chinese government, prioritized the actions to tackle massive soil erosion. The project aimed to set aside 14.63 million ha of sloping farmland (slope exceeding 25°) and revegetate 17.33 million ha of sparsely vegetated land by 2010 (Yin and Yin, 2010). More than 80% of the set-aside land has been converted to forests where cropping, grazing and timber logging are generally prohibited (Xu et al., 2006). Though set-aside land provides only limited direct economic benefit for farmers, the government provides an annual compensation of RMB 1350 per ha (Lu et al., 2004).

As one of the major environmental protection projects in the world, the GGP did indeed change rural land use patterns and reduced soil erosion by increasing the proportion of forest and grassland in the region (Liu and Wu, 2010; Putz et al., 2003; Fu et al., 2006; Cao et al., 2007). Nevertheless, the resulted reduction in the cropped land generated a sharp increase in surplus labour (Peng et al., 2007; Bullock and King, 2011) and a significant decrease in grain production (9–14%: Feng et al., 2005). Additionally, grazing constraints imposed by the set-aside programme affected animal husbandry in the region (Zhang et al., 2005; Yao et al., 2010; Yin and Yin, 2010). The reduction in crop and grazing land as well as surplus labour generated as a result forced farmers to reorganize their farming systems. Though the compensation provided by the state was higher than the net profits gained from sloping cropland cultivation (Liu and Wu, 2010), the net effect of the intervention depended on how farmers reorganized their activities after the policy shock. The available studies show that GGP increased rural livelihood diversification (especially income diversification), but it also increased

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rural income disparities (Liu and Lan, 2015; Liu and Wu, 2010). In this scenario, this study attempts to develop deeper understanding on farmer's behaviour in response to policy shocks such as land set-aside programmes.

Despite the studies that investigated the effects of GGP on the environment and on poverty, the relevance of farm household's capability to reorganize the farming systems (Bebbington, 1999) and its relationship to various forms of capital (human, social, financial, natural and physical) is under explored. The current study attempts to bridge this void by investigating farmer's capability to transform the farm to ensure the long-term economic and social sustainability through the lens of resilience thinking. Though the concept of resilience is gaining ever increasing acceptance among developmental agencies, its definition and measurement are challenging due to complexity and multi-dimensionality (USAID, 2013; Cumming et al., 2005; Jones and Tanner, 2015). Although resilience has a wide variety of meanings and definitions (Walker et al., 1969; Odum, 1985; Alexander, 2013; Holling, 1973:14; Carpenter et al., 2001, 2005; Folke et al., 2002; Eakin et al., 2012; Tanner et al., 2015), we define resilience as "system's capacity to reorganize under change to reach a new equilibrium" (Robinson and Carson, 2015). In the current research work, farm households' ability to reorganize after the shock (i.e. reduction in cultivated and grazing lands, surplus farm labour) is understood as their capability for economic resilience. Though direct (subjective) and indirect (objective) approaches measuring resilience at household level (Constas and Barrett, 2013 Twigg, 2009; Elasha et al., 2005; Jones and Tanner, 2015) are available, livelihood resilience at the household level is measured here through revealed (objective) adaptive strategies (i.e. the way of combining and transforming resource use in response to changes). Previous studies have measured resilience by constructing a composite index of the adaptive strategies viz. extensification, intensification, diversification, alteration and migration (Paavola, 2008; Mutabazi et al., 2015). These strategies are defined as the ways to combine and transform the capital assets so to achieve new livelihood equilibrium (Bebbington, 1999; Darnhofer et al., 2010), which provides clarity in how to apply resilience thinking in practical terms and how to measure "revealed" resilience. The current study tries to measure economic resilience in response to policy shocks such as set-aside programme, taking the case of GGP in China's Loess Plateau.

The question here is: how to track and measure the ability of a farm facing an abrupt change in conditions (loss in cropped and grazing area, surplus farm labour) to navigate to a new economic equilibrium (Darnhofer et al., 2010)? To answer the question, it is important to identify which strategies (adaptive) of combining and transforming resources are successful, and understand what this means for conservation and the economic development debate in the region. Therefore, our study attempts to answer the following questions: (1) What kind of adaptive strategies do farmers adopt to reorganize the farming system? (2) How different are the farm households in the capability to reorganize the farming systems (resilience) in response to the set-aside programme (policy shock)? (3) What are the major determinants of farm household's capability to take resilience-building actions? (4) What is the relationship of various forms of capital and resources to the observed resilience?

2. Methodology

2.1. Study area

This study was carried out in Yanhe Township in Ansai County, in order to represent the geographic and economic conditions of the Loess Hills. It lies in the middle part of the Loess Plateau in Shaanxi Province in the north of China, 16 km south of the county headquarters and 25 km northwest of Yanan City. The town occupies 210.7 square kilometres (0.1%) of China's Loess Hills. The typical topography of Yanhe Township is representative of the Loess Hills. Hills, gullies and plains are interlaced, with an average gully density of 4.7 km/km^2 (Xu et al., 2009). The soils contain 60%–70% silt, around 15% clay and 30% sand, a high content of $CaCO_3$ (approximately 9%–14%) and pH value above 8.0 (Lu et al., 2003). The area has a semi-arid climate where annual precipitation ranges from 296.6 mm to 645.0 mm (mean 505.3 mm) and annual temperature varies from −23.6 °C to 36.8 °C (with a mean level of 8.8 °C) (Lu et al., 2003; Lu et al., 2004). The rainy season is from July to September, accounting for nearly 74% of total annual rainfall.

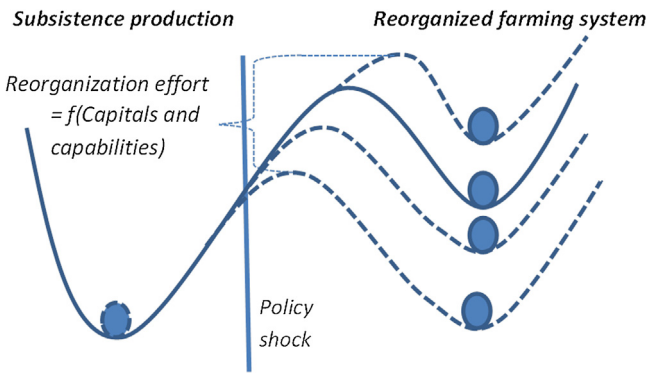

Fig. 1. Linkage of capital and capacities to economic resilience at farm level.
Note: The circle depicts the alternative equilibrium states. The higher or lower equilibrium state is a result of the reorganization effort (mix of reorganization actions) which is function of capitals and capabilities.
Adapted from Dile et al., 2013.

Farming is the primary economic activity for 64.4% of the population (Ansai Statistical Bureau, 2013). Smallholders practice farming with low external inputs and irrigation. The average arable land per capita is close to China's average at around 0.1 ha (Lichtenberg and Ding, 2009). Agricultural output of the region is worth RMB 8339 per capita, 40% below the national average. This is mainly generated from cropping (88%) and livestock (7.5%) (Ansai Statistical Bureau, 2013; National Bureau of Statistics of China, 2014). In terms of cropping, orchard crops (mainly apples) account for 30% of the total arable land, open-field crops covers 44.3% (e.g. potato, soybean, millet, corn, oilseed rape and sorghum), horticulture crops account for 4.1% (e.g. chili, cabbage, cucumber, eggplant and carrot), and melons cover 0.6% (e.g. watermelon and honey melon). In the case of livestock products, pork and lamb account for 61.2% and 14.4% of the total slaughtered, respectively.

2.2. The conceptual and analytical framework of economic resilience

Our current study focuses on how the farming households reorganize and reach new equilibrium in terms of aggregate farm income (economic resilience) after the policy shock i.e. conservation (land set-aside) programme (GGP). Fig. 1 explains how the concept of economic resilience operates under the current context. As the final equilibrium state is dependent on actions of the adaptive strategies during reorganization phase (Berkes et al., 2003) termed as "reorganization actions" throughout the text, we use them as proxies of economic resilience (revealed) and explore the role of various capitals in a combined indicator of resilience-building actions (explained in the next sections).

To measure the revealed economic resilience to policy shocks, we first identify resilience-building actions (e.g. adaptive strategies hereafter) undertaken by the farming households. Relevant indicators are then assigned for each adaptive strategy, based on a range