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Can Peers Improve Agricultural Revenue?

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Summary. — Crop revenues vary greatly among farmers and the source of that variation is not fully understood, even after controlling for factors including input use, technology adoption, and other agro-climatic factors. One hypothesis that may explain the variation in outcomes among farmers is differential access to information through peers. Using a household survey from India containing detailed information about personal relationships, we estimate peer effects on cash crop revenue using a novel spatial econometric technique to control for reflection. Our results show that 60% of farmers' revenue is explained by peers. Peer effects are particularly large in pesticide use and in the cultivation of a new crop. However, peer effects in input expenditures and land allocation cannot fully explain the variation in revenue, implying peers may also associate with management, negotiation, and marketing. We find that peer effects are significant among farmers' self-reported peers, especially among those peers who are farmers' main advisors for agricultural matters. Although caste-based networks (both within the same and in adjacent villages) are important, their effect is smaller than that of self-reported peer networks. We empirically rule out that our effects are driven by other factors such as geographically correlated unobservables, farmers following a lead farmer or economies of scale. Our findings speak to both the potential and the limitations of peers as sources of agricultural information, and highlight the need for future research about how to best integrate peers into agricultural extension.

Key words — peer effects, India, South Asia, crop revenue, spatial econometrics, social networks

1. INTRODUCTION AND MOTIVATION

Economists have long tried to explain the considerable observed variation in economic outcomes across firms and households. In developing countries where market frictions are frequently high, economic outcomes can vary dramatically (Bloom, Eifert, Mahajan, McKenzie, & Roberts, 2013). Agriculture in the developing world provides a special example of this puzzle; farm revenues and profits tend to exhibit wide differences within the same region, even after accounting for inputs, technology use, and agro-climatic factors (Fan, Hazell, & Thorat, 2000; Murgai, Ali, & Byerlee, 2001).

Why do some farmers earn more than others? One possible explanation is that differences in revenues reflect differential farmer access to information about production practices and marketing (Aker, 2010; Birthal, Kumar, Negi, & Roy, 2015; Conley & Udry, 2010; Jensen, 2007). While agricultural extension services offer one mechanism to disseminate new techniques and market opportunities (Roeling, 1984), information flow through such official channels may still be limited, particularly for more complex practices which benefit from demonstration (Anderson & Feder, 2004; Duflo, Kremer, & Robinson, 2011; Waddington, White, & Anderson, 2014). Particularly in contexts characterized by limited formal information, peers have been found to be an important mechanism for disseminating information about new technologies (Foster & Rosenzweig, 1995; Liverpool-Tasie & Winter-Nelson, 2012; Magnan, Spielman, Lybbert, & Gulati, 2015), credit (Okten & Osili, 2004; Wydick, Karp Hayes, & Hilliker Kempf, 2011), labor recruitment (Mano, Yamano, Suzuki, & Matsumoto, 2011), household decision-making (Kandpal & Baylis, 2015), and risk mitigation (Di Falco & Bulte, 2013). These sorts of endogenous social effects are often called *peer effects* in the literature and refer to the relationship between the behavior or outcomes of an individual and the behavior or outcomes of a social group of which the individual is a member (Manski, 1993).

This paper tests how a farmer's agricultural revenues are influenced by the revenues and characteristics of his or her peers. In our setting, one's peers may include family members, relatives, friends, and social and religious ties. Based on this definition of peers, the intensity of interaction in the networks of each individual may vary, which has an important implication for peer effects (Munasib, Roy, & Birol, 2015). We study the revenues of small farmers in Thaltukhod Valley, Himachal Pradesh, India. These small farmers are highly dependent on crop revenues, and even a small increase in crop prices or production can greatly increase their income. Understanding how social connections might influence farmer outcomes can provide critical insights into why some farmers escape poverty and others remain stuck at a low level of productivity.

Our study site is the Thaltukod Valley in the foothills of the Himalayas in Himachal Pradesh, India. Our study analyzes data from a survey of all 522 households in the valley's 17 villages and which exhibit considerable variation in household

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cash crop revenues; up to 100-fold variation across households. We find that peers have a significant effect on farmers' cash crop revenues. Nearly 60% of the variation in farmers' cash crop revenues can be explained by the revenues of their peers. Our results imply that peers act as a critical channel of information for farmers' technology adoption and use. We find that peer effects operate through farmers' input choice, affecting the use of pesticides on all cash crops and through the area under cultivation of peas, a relatively new cash crop in the valley. We find that pesticide use is correlated over self-reported peers and not those who are geographic neighbors—evidence that we observe more than the outcome of a pest outbreak among farmers with nearby fields. Finally, we find that farm input expenditures and land allocation cannot explain the full magnitude of peer effects on farmers' cash crop revenues, suggesting that peer effects likely also operate through non-production channels such as prices or marketing relationships (for example, see Songsermsawas, Baylis, Chhatre, Michelson, & Prasanna (2015)).

Our results make intuitive sense. First, pest infestations are sporadic and vary in type and intensity from year to year. Second, peas are a recent crop, introduced into the area not long before the survey was conducted. Thus both pesticide use and area under pea cultivation are domains in which farmers are still likely to be actively experimenting and learning and plausibly drawing on peers' recent experience for insight and guidance.

Our work builds on studies which have documented the importance of farmer peers in decisions related to input use, land allocation, and sales revenues. For example, Conley and Udry (2010) find evidence that pineapple farmers in Ghana adjust the amount of fertilizer applied on their plots based on peers' positive outcomes. Munshi (2004) finds that land allocation decisions among wheat farmers in India correspond significantly to their peers' experience. Fafchamps and Minten (2002) find that better connected agricultural traders in Madagascar have higher sales volume than their less connected peers. While a large number of studies have found positive peer effects, negative peer effects (Kremer & Miguel, 2007), and no peer effects (Duflo *et al.,* 2011) have also been identified. Results from these studies suggest that the extent to which peers can learn from others is contingent on the type of the technology.

Our paper makes three primary contributions to a growing number of studies linking personal relationships with economic outcomes. First, we are unique in focusing on farm revenues. Previous research on social relationships and economic outcomes for small-scale farmers have mostly focused on input use (Conley & Udry, 2010; Duflo *et al.,* 2011), land allocation (Munshi, 2004), and market information (Aker, 2010; Jensen, 2007). Our study links these three factors—analyzing effects of peers on the total value of farm output, which is closely related to household income, and therefore household welfare (Huffman, 1976; Jacoby, 1991).

A second contribution of our study is the use of spatial econometric methods to account for the problem of peer outcomes being simultaneously determined (Bramoullé, Djebbari, & Fortin, 2009; Manski, 1993). We also test for unobserved characteristics that might be spatially correlated across farmers. Further, we rule out the possibility that the significant peer effects in our estimates are merely the result of peers simply facing similar environments or choosing to belong to the same peer group.

Third, we test our self-identified peer network against other, frequently used definitions of peers. In contrast to previous studies (Helmers & Patnam, 2014; Holloway, Shankar, & Rahman, 2002), we do not find significant peer effects based on geographic proximity, suggesting that geographically related observed attributes do not drive our results, and that physical proximity is not a good proxy for peer networks in our context. We also compare our self-reported networks to networks defined by caste and a "lead-farmer" model in which we allow high-performing farmers in the village to influence other farmers' outcomes. Distinguishing which set of peers best explains the observed distribution of agricultural revenue is important for both future research and policy design. While caste-defined peer networks do generate peer effects, we find the strongest evidence of peer effects on cash crop revenue from self-reported peers, especially among those peers who are farmers' advisors for agricultural matters.

The remainder of this paper is organized as follows. In the next section, we describe the setting in our study and present the descriptive statistics of our survey and data. In Section 3, we use a simple model to derive the hypotheses we test in our estimations. Section 4 describes our estimation strategy to identify peer effects on cash crop revenues. In Section 5, we report the validity of our instruments and main empirical results. In Section 6, we explore possible mechanisms of peer effects and quantify their contributions to cash crop revenues. We also conduct a number of robustness checks to rule out a confounding factors that might drive our results. Section 7 explores alternate specifications of peer networks for our estimations. In Section 8, we relate our results to policy implications for rural development. Section 9 concludes.

2. SETTING AND DATA

(a) *Thaltukhod Valley, India*

Our data come from a household survey of small-scale farmers in Thaltukhod Valley, Himachal Pradesh, India. Figure 1 maps the study area. The survey collected information on all 522 households living in 17 villages in Thaltukhod Valley. However, due to missing data, the total number of observations used in this study is 509. The villages vary in size (between 11 and 66 households) and are located at a range of elevations throughout the Valley.

The majority of the population in Thaltukhod consists of small-scale farmers whose primary sources of household income include cash crop cultivation and livestock rearing. Farmers rely on the forest bordering each village for fuel wood gathering (both for use and for sale), livestock grazing and collection of fodder, timber, and medicinal herbs. Households in each village own between two and seven plots varying in size, elevation, and slope. Some plots are shared among households in the same village. Within each plot, each household owns a specific parcel. These parcels vary in size within and across villages.

In 2008, a survey was administered to all households. Households were asked questions about their livelihood activities for the previous five years (2004–08), and 10 years ago (1998). The survey also collected social network information for every household. Households were asked about crop rotations, land allocation decisions and input expenditures, revenue from sales of cash crops and marketing channels.

Households in the Valley grow three main cash crops: kidney beans, potatoes, and green peas and three main food crops: maize, wheat, and barley. Kidney beans and potatoes are traditional cash crops in Thaltukhod. Green peas, however, were introduced only recently, first appearing five years before the survey was conducted. According to the data from

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