China Economic Review 27 (2013) 104–120

Contents lists available at ScienceDirect

China Economic Review

Social learning and parameter uncertainty in irreversible investments: Evidence from greenhouse adoption in northern China

Honglin WANG [a,*], Fan YU [b], Thomas REARDON [c], Jikun HUANG [d], Scott ROZELLE [e]

[a] Hong Kong Institute for Monetary Research, Hong Kong
[b] Claremont McKenna College, United States
[c] Michigan State University, United States
[d] Chinese Academy of Sciences, China
[e] Stanford University, United States

ARTICLE INFO

Article history:
Received 17 September 2012
Received in revised form 12 September 2013
Accepted 14 September 2013
Available online 26 September 2013

JEL classification:
D83
O12
Q16

Keywords:
Social learning
Technology adoption
Irreversible investment
Greenhouse
China

ABSTRACT

This paper aims at an important gap in the literature, which has not modeled the effect of social learning in a real option context and examined uncertainty-reduction measures through social learning. This paper addresses the gap by modeling social learning as a way of reducing parameter uncertainty, thus facilitating technology adoption and shortening the waiting time in irreversible investments. We use household-level data on intermediate-technology greenhouse adoption in northern China to test the predictions in both a linear probability model and a duration analysis. Our empirical findings support the hypothesis. We also find that market volatility and insecure land property rights discourage adoption.

1. Introduction

Profitability long reigned as the central explanation of adoption and diffusion of new agricultural technologies (Griliches, 1957; Hayami & Ruttan, 1971).[1] Lags and shortfalls in diffusion in the Green Revolution era led agricultural economists to emphasize the role of risk and uncertainty in adoption and diffusion (e.g., Feder, 1980; Roumasset, 1976). They were included in studies of Green Revolution technology adoption to explain lagged or partial adoption or even disadoption. This can be seen as part of a broader literature on the economics of risk and uncertainty and their constraining effects on investment (Newbery & Stiglitz, 1981).

* Corresponding author.

[1] The dominance of profitability (reflected in relative factor prices and output price) in explaining diffusion of agricultural technology was challenged by Olmstead and Rhode (1993) in the case of the US; they noted that factors such as farmer–seed supplier interactions, crop composition, and regional settlement patterns were important in explaining long term trends in US agricultural technology. They examined, however, evolving technologies and inter-regional differences, so these considerations fall outside of our study's scope as our empirical case is that of adoption of a fixed technology and a single region.

1043-951X/$ – see front matter
http://dx.doi.org/10.1016/j.chieco.2013.09.003

Information reduces farmers' uncertainty about the payoffs to adopting a new technology. The literature has examined the methods by which farmers receive information in order to evaluate new technologies and operate them well. These methods include receiving information from extension agents, from other farmers ("learning from neighbors"), and from their own experience ("learning by doing") (Besley & Case, 1994; Foster & Rosenzweig, 1995).

The role of "learning from neighbors" has been further refined in recent work on "social learning". Four recent papers exemplify this work. Conley and Udry (2001, 2010) model Ghana farmers' adoption of fertilizer in pineapple production, conditioned by their incomplete information and communication networks with neighbors. Bandiera and Rasul (2006) model Mozambique farmers' adoption of sunflowers conditioned by their social network (neighbors and friends who have adopted). Munshi (2004) models Indian farmers' adoption of HYV seeds of rice and wheat conditioned by neighbors' experiences. These papers demonstrate the effects of social learning on technology adoption. In most cases social learning's effect is interpreted as increasing the capacity of the farmer to adopt as well as reducing the farmer's uncertainty and perception of risk in adoption.

The studies of the impacts of social learning on adoption have, up to now, focused on reversible technologies, such as the examples of those on new crops and new seeds above. But the adoption literature has not yet addressed the issue of how social learning, through its role in reducing risk and uncertainty, conditions adoption of irreversible investments in capital-embodying technology, such as tube wells and greenhouses. Irreversible investments such as building a greenhouse are characterized by the salvage value of the asset being negligible or the asset not being able to be transferred or sold. Because of incomplete information with respect to the performance, reliability, and appropriateness of agricultural equipment, irreversibility entails substantial risk for the investor (Dixit & Pindyck, 1994; Sunding & Zilberman, 2001).

The ability to delay an irreversible investment can be considered as a real option; a higher level of uncertainty regarding future benefits raises the option value and causes the investment decision to deviate from the classical NPV rule.[2] Specifically, investors may rationally delay investment to gain additional information, reduce the level of uncertainty, and increase discounted expected payoffs. While investment delay in the face of uncertainty has been studied in the economics literature (Dixit & Pindyck, 1994; Hassett & Metcalf, 1995; McDonald & Siegel, 1986; Nelson & Amegbeto, 1998; Zilberman, Sunding, Howitt, Dinar, & MacDougall, 1994), this literature has tended to assume that all parameters of the dynamic process are known to agents, and the only uncertainty in the model comes from the future value of the dynamic process.

In contrast, we present a new model wherein, following McDonald and Siegel (1986), we assume that a farmer is considering an investment project, the value of which follows a geometric Brownian motion. Departing from the standard framework, we assume that the true drift of the Brownian motion is unobservable to the farmer (we call this "parameter uncertainty"). In essence, the farmer is imperfectly informed as to the expected rate of return of the farmer's investment. He/she must make an inference about the true expected return based on their information and, at the same time, determine the optimal timing for investing in the project. The farmer can learn about the unknown parameter in two ways: by extracting information on the true drift from a continuous observation of past realized returns on the project value; and by obtaining discrete noisy signals of the true drift. This latter channel represents the process of social learning from early adopters in the farmer's social network.

Furthermore, we empirically model greenhouse investments with primary data collected by the authors in the Shandong province of China. We test both whether social learning induces adoption, and whether social learning shortens the waiting time until adoption, using a duration analysis. The data are multi-year, observing the characteristics, including their social network of prior adopters, of the adopters the year before their adoption. Thus, new to this literature, we capture causality of social learning and adoption.

Previously, investment under parameter uncertainty has been examined in the finance literature. Gennotte (1986) studies portfolio choice under incomplete information about the stock return process. The study uses tools of nonlinear filtering to derive the optimal drift estimator as agents continuously observe the returns. Brennan (1998) and Xia (2001) construct similar models to examine how learning about unknown parameters and unknown predictability affects portfolio choice. Huang and Liu (2007) model learning from discrete noisy signals about the true drift in their study of periodic news on portfolio selection.

The finance literature modeling investment under parameter uncertainty is primarily theoretical, with few empirical applications and none in the domain of investment in agricultural capital as an embodiment of agricultural technology adoption. The present paper addresses this gap in the literature. We analyze irreversible investment under parameter uncertainty, modeling the effect of social learning. The contribution to filling the gap in the literature is both theoretical and empirical.

The rest of the paper is organized as follows. First, we present the theoretical model. Second, we provide background information about greenhouse technology in northern China. Third, we discuss our sample selection and summarize the data. Fourth, we explain our empirical methodology. Fifth, we present the empirical findings from linear probability models and a duration analysis. Finally, we conclude with a summary and policy implications.

[2] The NPV rule could be misleading under irreversible investment because it ignores the fact that the delaying of adoption has its own value, which has to be included as a part of the cost of the investment.