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The asymmetric response of farmers to an expected change in the price of rubber: The roles of sunk costs and path dependency

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ABSTRACT

This study examines the impacts of sunk costs and path dependency of rubber farming on farmers' production responses to expected changes in the price of rubber based on a simple choice experiment implemented in the upper Mekong region in March, 2013. The results show that nearly 73% of farmers choose to adjust their production behaviors when the price of rubber is hypothesized to increase by 50%, while only approximately 55% choose to adjust their behaviors when the price of rubber is hypothesized to decrease by 50%. The responses of farmers to these two hypothetical changes in the price of rubber are significantly asymmetric. The estimation results of empirical models consistently indicate that higher sunk costs and a longer path dependency of rubber farming significantly hinder the probability that smallholders will adjust their production behaviors in response to the two hypothetical changes in the price of rubber. The significant difference in the impacts of sunk costs and path dependency on the choice of response behaviors under the two hypothetical situations may, to some extent, help explain the observed asymmetric responses. Additionally, the impacts of sunk costs and path dependency on the specific adjustments to production behaviors are heterogeneous. The findings provide essential empirical evidences for the roles of sunk costs and path dependency in farmers' production behaviors in the context of the price volatility of agricultural products.

1. Introduction

The responses of farmers to the price volatility of agricultural products is an important research issue related to farmers' welfare and the supply of agricultural products. Modern economic theories normally assume that a rational farmer will adjust his/her agricultural production behaviors to maximize profits according to the previous market price (Ezekiel, 1938; Waugh, 1964), the adaptive expectation of price (Nerlove, 1956, 1958), or the rational expectation of price (Muth, 1961; Lucas and Rapping, 1969; Lucas and Prescott, 1971). However, in the mid-1980's, the rationality assumption was directly challenged by the prospect theory and loss aversion (Kahneman and Tversky, 1979; Tversky and Kahneman, 1981, 1986; Kahneman, 2003) as well as their inducing endowment effects (Thaler, 1980; Saqib et al., 2010).

The rationality assumption regarding farmers' price response behaviors may also be challenged in the case of agricultural products with long production periods, such as trees, perennial crops, and animals. While the long production period of such agricultural products makes their future price difficult to predict, the likely resulting path dependence may affect farmers' decision making (Arthur, 1989; David, 1994). Accordingly, decision making in response to the price change is no longer rational. Moreover, the relatively high initial investment cost of such agricultural products may also lead to irrational economic behaviors by farmers, which is often referred to as the sunk cost effect (Arkes and Blumer, 1985). These results mean that a farmer's price response behaviors may be determined not only by the extent of a price change but also by the farmer's prior investments, including the duration and extent. However, the possible impact of path dependency on the response of farmers to a change in the price of an agricultural product is still unknown. While sunk costs could cause firms' strategies to be irreversible (Arkes and Blumer, 1985; Dixit and Pindyck, 1994), the impact of sunk costs on farmers' price response behaviors has not been identified.

As the economic theory of the producer is generally based on a rational maximizing model, this theory will make systematic errors in predicting behavior due to the potential challenge of the rationality assumption. Responses to increases and decreases in price might not always be mirror images of each other (Kahneman et al., 1991), while responses to changes in economic variables should distinguish the cases of favorable and unfavorable changes, whether based on prospect theory, loss aversion effects or endowment effects. By introducing such distinctions, previous studies have evidenced asymmetric responses to

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increases and decreases in the prices of specified goods (e.g., Thaler, 1980; Tversky and Kahneman, 1981; Kahneman et al., 1990; Weber et al., 2000; Reb and Connolly, 2007; Morewedge et al., 2009), which is inconsistent with the results derived by irrational assumption.

While the price responses of agricultural products (Houck and Gallagher, 1976; Willett et al., 1997; Haile et al., 2015) and the possible causes of asymmetric price adjustments have been widely discussed in previous studies (Chavas and Mehta, 2004; Meyer and Cramon, 2004), few studies have focused on the response of rubber farmers to a change in the price of rubber (latex).[1] Generally, in the presence of adjustment costs, firms may not respond to small or transitory price changes until the benefits of changing strategies outweigh the costs (Chavas and Mehta, 2004). Price response behavior is significantly influenced by non-proportional variable transaction costs and labor heterogeneity (Henning and Henningsen, 2007). In early studies (Dowling, 1979; Hartley et al., 1987), the supply response to the volatility of the price of rubber was well explored using time series data. However, from the perspective of the micro household level, farmers' responses to volatility in the price of rubber remain unclear. A possible reason is due to the lack of micro-level data with long-term price information.

This study attempts to empirically investigate the responses of farmers to fluctuations in the prices of rubber and examine the existence of the effects of sunk costs and path dependency. To achieve this goal, we conducted a simple choice experiment with smallholder rubber farmers in early 2013 in Xishuangbanna, Southwest China, which is in the upper Mekong region. Natural rubber is a tropical agroforestry product with a long production period of approximately 35 years, and it normally grows for approximately 6–8 years before being harvested (Min et al., 2017a). Thereby, this product provides a unique opportunity for this study. A choice experiment was implemented to collect the responses of farmers to expected changes in the price of rubber. We focus on exploring farmers' response behaviors under two hypothesized cases of expected changes in the price of rubber: compared to the constant market price in 2012, the price of rubber is expected to (i) decrease by 50% and (ii) increase by 50%. The assumption of these two relatively large changes allows the variances in farmers' response behaviors to be observed.

A good understanding of farmers' response behaviors to changes in the price of rubber has important practical and theoretical implications. On the one hand, this topic not only is closely related to rubber farmers' welfare, including income and consumption, but also is important for the supply security of natural rubber, which is a strategic resource in China. On the other hand, detecting the roles of sunk costs and path dependency in the price responses of rubber farmers contributes to the existing literature on the price response behaviors of farmers with regard to perennial crops, trees, animals and other similar products with relatively long production periods (Chavas et al., 1985; Price and Wetzstein, 1999; Foltz, 2004). This study also complements the literature on the price responses of producers and the roles of sunk costs and path dependency in farmers' agricultural production behaviors (Chavas, 1994; Cowan and Gunby, 1996).

The remainder of this paper is organized as follows: in Section 2, a conceptual model for the impacts of sunk costs and path dependency on smallholder rubber farmers' decision making is developed. Section 3 briefly presents the study area, the data collection methods, and the descriptive statistics. Section 4 describes the empirical models that are developed to assess the likelihood that smallholders adjust their production behaviors to respond to changes in the price of rubber. In Section 5, we report and discuss the results of our models. The last section provides a summary and the conclusions.

2. Data

2.1. Data source

The data used in this study were obtained from a comprehensive socioeconomic survey of 612 smallholder rubber farmers in Xishuangbanna Dai, an autonomous prefecture in the southern Yunnan Province of China, that was conducted in early 2013. Xishuangbanna is located in the upper Mekong region, is one of the most important natural rubber planting regions in China and contributes nearly half of the nation's rubber production (Min et al., 2017a). The introduction of natural rubber has also contributed to the local economy by improving farmers' incomes and reducing poverty (Min et al., 2017b). However, in the context of recent volatility in the price of natural rubber, poverty and vulnerability to poverty are potentially severe threats for many smallholders (Min et al., 2017a).

For the survey, we used a comprehensive household questionnaire that included detailed information on the socioeconomic characteristics of all the family members, the household, and the farm as well as the other economic activities of the household. Furthermore, we conducted a simple choice experiment to investigate how smallholder farmers adjust their production behaviors in response to a hypothetical change in the price of rubber. We used the following two main survey questions: (i) If, in the next 10 years, the price of natural rubber decreases by 50%, how will you respond? (1. No response/do nothing; 2. Rent out the land used for rubber crops; 3. Plant other crops instead of rubber; 4. Reduce the variable costs of inputs; or 5. Other, please specify) and (ii) If, in the next 10 years, the price of natural rubber increases by 50%, how will you respond? (1. No response/do nothing; 2. Rent land to increase the area for rubber crops; 3. Plant more rubber instead of other crops; 4. Increase the variable costs of inputs; or 5. Other, please specify). In this study, we primarily focus on exploring whether farmers will respond to changes in the price of rubber and then focus on the different adjustment behaviors.

The reference price was the market price of natural rubber in the surveyed year, approximately 21 Yuan/kg, which was a relatively high price for natural rubber and could result in a net revenue of approximately 1200–1800 Yuan/mu[2] (Min et al., 2017b). Even though the price of rubber would decrease by 50% in the next 10 years, most farmers could still obtain a positive net revenue from rubber farming, as the breakeven price was only approximately 8.5 Yuan/kg locally in the surveyed year (Min et al., 2017a). However, at this time, the net revenue of rubber farming per mu would be relatively small. Hence, these two hypothesized changes in the price of rubber (decrease by 50% and increase by 50%) assure the variances in farmers' response behaviors to be observed.

Natural rubber generally can be harvested after growing for 6–8 years. Hence, there exists a certain sunk cost for rubber farming. As a rubber tree on average can be harvested for 30 years, the long-term context of rubber farming also results in a certain path dependency for rubber farmers. Referring to the definitions of sunk cost and path dependency used in previous studies (Arkes and Blumer, 1985; Arthur, 1989; David, 1994; Martin and Sunley, 2006), sunk costs are closely associated with a proportion of fixed costs (Baumol et al., 1983) that increase with farm size (Adelaja, 1991), while path dependency could be formed by historical experience depending on the natural resource. For the sake of simplicity, in this study, the sunk costs and path dependency of rubber farming are assumed to be proxied by the rubber planting area and the experience in rubber farming, respectively. It is worth noting that sunk costs also include opportunity costs and other directly and indirectly unrecoverable costs; however, these costs are generally difficult to measure in empirical studies. While the use of rubber planting area as a proxy variable for sunk costs may

[1] For simplicity, the price of rubber represents the price of latex in the remainder of the study.

[2] In 2012, US$ 1 = 6.31 Yuan; 1 Hectare = 15 mu.