Renewable Agriculture and Food Systems

cambridge.org/raf

Heir presence? The impact of offspring gender composition on long-term agricultural investment behavior

Pengyu Chen[1], Lu Zhang[1] and Jorge Ruiz-Menjivar[2]

[1]College of Economics and Management, Huazhong Agricultural University, Wuhan, China and [2]Department of Family, Youth, and Community Sciences/Social Dimensions of Food & Agriculture Lab, University of Florida, Gainesville, FL, USA

Research Paper

Cite this article: Chen P, Zhang L, Ruiz-Menjivar J (2025). Heir presence? The impact of offspring gender composition on long-term agricultural investment behavior. *Renewable Agriculture and Food Systems* **40**, e5, 1–12. https://doi.org/10.1017/S1742170524000358

Received: 17 September 2024
Revised: 5 December 2024
Accepted: 20 December 2024

Keywords:
long-term agricultural investment behavior; offspring gender composition; organic fertilizer; social capital; time preferences

Corresponding author:
Lu Zhang;
Email: luzhang@mail.hzau.edu.cn

Abstract

In rural China, male offspring are traditionally regarded as the primary heirs of household assets, particularly land. This study examines the impact of offspring gender composition on long-term agricultural investment behavior, using commercial organic fertilizer application as an example of a strategic long-term investment in farmland. Based on cross-sectional data from 4090 rice farming households across 10 cities (counties) in Hubei province, collected between 2021 and 2023, this analysis identifies three key findings. First, the absence of male offspring significantly reduces long-term agricultural investments, a result that remains robust even when addressing potential endogeneity biases using instrumental variable techniques. Second, households without male heirs exhibit stronger present-oriented preferences and diminished social capital, which further hinder long-term agricultural investments. Third, the negative impact of not having male offspring is more pronounced when the current agricultural decision-maker is male and when land marketization is underdeveloped. These findings underscore the complex interplay between gender norms and agricultural behavior, revealing significant socioeconomic implications of inheritance practices. The study provides insights into addressing these challenges by emphasizing the importance of promoting gender equality and advancing land marketization to enhance equitable land use and support long-term agricultural investment.

Introduction

The impact of household human capital on agricultural production decisions has drawn considerable scholarly attention. Existing research predominantly focuses on current agricultural labor endowments, such as age, education, health, farming experience, and their effects on long-term investment behaviors (Foster and Rosenzweig, 2010; Abdulai and Huffman, 2014; Zhang et al., 2022; Li et al., 2024). While this perspective offers valuable insights, it overlooks the dual dimensions of investment decisions: current resource availability and forward-looking expectations (Huffman, 1985). For example, stable land tenure expectations drive land investments by enhancing security, collateral, and liquidity effects (Cao, Bai and Zhang, 2020; Senda et al., 2022), underscoring the importance of long-term resource accessibility in decision-making (Zhou, Lu and Zou, 2023). However, a comparable focus on labor remains limited. Future labor availability, mainly reflected by offspring gender composition, holds potential implications for long-term agricultural strategies but remains underexplored.

Throughout China's extensive history of agrarian production, families served as both kinship networks and economic units, embedding enduring family-centered ideologies (Hansen, Jensen and Skovsgaard, 2015; Fredriksson and Gupta, 2023). Male offspring, valued for their physical advantages, emerged as central figures in agricultural labor, enabling households to expand arable land and enhance bargaining power within village communities (Sheridan et al., 2023). These roles facilitated access to external resources and bolstered the household's economic status (Boserup, Tan and Toulmin, 2007). Consequently, this gender-based division of labor reinforced cultural norms that positioned women within the domestic sphere while men engaged in external economic roles (Becker, 1985; Alesina, Giuliano and Nunn, 2013). Furthermore, ideologies emphasized the imperatives of 'continuing the family line' ('Continuing the family line' refers to the perpetuation of a family's lineage, traditionally through the birth of sons who can carry on the family name and heritage across generations.) and 'raising sons for old age' ('Raising sons for old age' signifies the traditional belief that raising sons ensures support and care in one's old age. It encompasses raising children to provide security and support during later years.), underscoring the sociocultural importance of male offspring, entrenched male offspring as primary inheritors of family assets, particularly land and property (Alesina and Giuliano, 2010; Breitenbach and Foguesatto, 2023; Edafe et al., 2023; Bavorová et al., 2024). In contrast, female offspring, perceived as a labor loss due to

marital relocation—encapsulated by the saying 'a married daughter is like spilt water' (The saying 'a married daughter is like spilt water' signifies that once a daughter is married, she is no longer considered part of her natal family. This idiom compares a married daughter to water spilt onto the ground, which spreads and seeps into the soil, becoming irretrievable. This metaphor highlights the traditional belief in the severance of ties between a daughter and her birth family after marriage, underscoring the notion that she no longer has any connection to her natal family.)—were often excluded from substantial inheritance (Fei, Hamilton and Zheng, 1992). This entrenched framework of gendered resource allocation highlights household expectations for male and female offspring, raising critical questions about its implications for long-term agricultural investment.

The role of offspring gender composition in shaping household agricultural investment decisions

When households have male offspring, they gain heirs to inherit family assets and continue the family lineage (Glauben et al., 2009; Alesina, Giuliano and Nunn, 2013). This reduces decision-makers' preference for immediate returns, encouraging them to prioritize long-term strategies, such as organic fertilizer application, that support intergenerational survival (Arends-kuenning et al., 2021; Breitenbach and Foguesatto, 2023). Meanwhile, male heirs are pivotal in building household social capital through active participation in village collective affairs and labor-sharing activities during peak agricultural seasons (Alesina, Giuliano and Nunn, 2013). Stronger social capital enables households to mitigate the labor, credit, and information constraints that often hinder long-term agricultural investments (Shiferaw, Okello and Reddy, 2009; Magnan et al., 2015; Gao et al., 2019). By contrast, households with only female offspring face constraints in long-term labor availability, which weaken their intergenerational planning and reinforce their preference for immediate returns (Wheeler et al., 2012). These constraints exacerbate challenges, coupled with insufficient social capital, further limiting their ability to pursue long-term agricultural investments (Shiferaw, Okello and Reddy, 2009; Gao et al., 2019; Xie et al., 2024).

The current study

The purpose of this study is to examine whether and how offspring gender composition influences household long-term agricultural investment behavior, focusing on commercial organic fertilizer adoption (Gao, Sun and Huang, 2017; Zhou, Cheng and Zhang, 2022). Analyzing cross-sectional data from 4090 rice-growing households across 10 counties in Hubei province, China (2021–2023), ordinary least-squares (OLS) regressions reveal a significant negative relationship between the absence of male offspring and long-term investments. Instrumental variable (IV) techniques are employed to address potential endogeneity. We examine two key pathways through which offspring gender composition affects investment decisions: psychological and decision-making tendencies, reflected in time preferences, and external resource acquisition, mediated by social capital. The analysis also highlights heterogeneity, distinguishing between internal factors, such as the gender of the agricultural decision-maker, and external conditions, including the level of land marketization.

The contributions of this paper are twofold. First, it extends the existing literature by shifting the focus from the short-term availability of human capital to forward-looking expectations, as reflected in the offspring gender composition. This perspective highlights how differences in the long-term availability of offspring labor influence household long-term agricultural investments. Second, the paper identifies both the mechanisms through which offspring gender composition impacts investment behavior and the heterogeneity of these effects, offering valuable guidance for policymakers.

Theoretical framework and research hypothesis

Offspring gender composition and long-term investment behavior in rural households

China's principles of 'no increase in land with population growth, no decrease with population decline' ('Increase in population without an increase in land, decrease in population without a decrease in land' is a significant institutional arrangement in rural China. Under this system, rural households are regarded as the primary entities holding the contractual management rights to land. As a result, the death or migration of one or more family members does not affect the household's entitlement to possess, use, and benefit from the contracted land. If members listed on a household registration migrate out of the household but remain within the village collective, they may negotiate with the original household head to claim a portion of the land rights; however, they are not eligible to obtain additional land. When all the natal family's hukou members pass away, the village collective recovers the contracted land.) aim to clarify land management rights and stabilize farmers' expectations. This policy strengthens farmland's property attributes, providing greater security and predictability (Zhou, Lu and Zou, 2023). Despite these efforts, land redistribution within farming households remains challenging, particularly during 'family division' when offspring marry. ('Family division' refers to the process in which relatives who previously cohabited divide their shared family assets, establishing separate households and living independently. Upon marriage and forming a new household, a male offspring relocating from the original household registration while remaining within the same village collective can negotiate with the original household head to claim a share of the family's contracted land. However, additional land cannot be obtained. He retains inheritance rights to the family's contracted land if he stays registered with the original household.) This process often exposes gender-based disparities, with male offspring typically inheriting family assets (Breitenbach and Foguesatto, 2023; Edafe et al., 2023; Bavorová et al., 2024). The preference for male heirs is driven by three primary factors.

First, male offspring are seen as the bearers of the family lineage. They inherit the Y chromosome from their ancestors, and the father's chromosomes determine the sex of the offspring. Passing on the Y chromosome results in a male child, while passing on the X chromosome results in a female child (Jobling and Tyler-Smith 2003). Furthermore, male offspring increase the family population through marriage, integrating their wives into the family and having children (Fei, Hamilton and Zheng, 1992). Thus, male offspring are considered capable of 'continuing the family line' and ensuring the 'prosperity of the family'. Historically, China has followed the tradition of 'women are not included in genealogy', meaning only males are listed in family records as they are believed to continue the family bloodline.

Second, male offspring are traditionally viewed as the guardians of family property. In rural families, this concept extends beyond financial assets to include land. Rooted in the concept

https://doi.org/10.1017/S1742170524000358 Published online by Cambridge University Press

of 'obedience to the husband after marriage' ('Obedience to the husband after marriage' is a principle rooted in the *Three Obediences and Four Virtues*, constituting a foundational set of moral principles for women in Confucianism. These doctrines dictate that a virtuous woman must adhere to the authority of the male figures in her life: obeying her father before marriage, her husband during marriage, and her son if widowed.), marriage customs typically require female offspring to relocate to their husband's household (Zhang, 2019; Du, Xiao and Zhao 2021). This practice reduces the natal family's labor force and increases the risk of the property being transferred to the husband's family, potentially leading to a net outflow of assets (Fei, Hamilton and Zheng, 1992). Furthermore, marriage typically creates a separation between women and the land, compounded by cultural perceptions of women as less capable of managing agriculture, thereby weakening their ability to safeguard the natal family's contracted land (Edafe et al., 2023; Bavorová et al., 2024). (A more severe scenario arises when female offspring transfer their household registration (hukou) to their husband's village or region upon marriage, losing the collective membership necessary to inherit their natal family's contracted land. As a result, when all original household members pass away, the land reverts to collective ownership.) In contrast, when male offspring marry, their spouses' integration and children's birth enhance the family's labor force and property retention capacity.

Third, male offspring are viewed as the primary bearers of filial responsibility. This perception arises from both physiological and socioeconomic considerations. Specifically, males traditionally serve as the primary labor force in agricultural societies, a role often attributed to their physical strength advantages (Alesina, Giuliano and Nunn, 2013; Sheridan et al., 2023). This physiological distinction, reinforced by cultural norms surrounding gendered labor division, underpins the broader economic and social roles assigned to males, whereas females are typically tasked with domestic responsibilities and childcare (Becker, 1985). Thus, rural families prioritize educational and economic investments in male offspring, viewing their labor capacity and income potential as essential for safeguarding family property and ensuring reliable old-age support (Zhang, 2019). (However, in households without male offspring, traditional intergenerational support is limited, and government subsidies provide essential support for such families to sustain their livelihoods and address old-age security needs. Individuals aged 50 or older with agricultural household registration and one or two surviving daughters receive annual subsidies: 600 yuan for ages 50–54, 1200 yuan for single-daughter households aged 55 and above, and 960 yuan for dual-daughter households in the same age range.)

Although daughters possess legal inheritance rights, rural customs and practical constraints often impede transferring family land contracting rights to female offspring (Breitenbach and Foguesatto, 2023; Bavorová et al., 2024). Therefore, when farming households lack male offspring, they face challenges in succession, asset retention, and economic capacity, which weaken intergenerational demands (Wheeler et al., 2012). Long-term agricultural investments require substantial financial input and extended return cycles (Kansanga et al., 2021). Organic fertilizer exemplifies this, as it decomposes gradually, releasing nutrients gradually and necessitating continuous application across multiple planting cycles to enhance soil fertility and crop yields (Adekiya et al., 2020; Zheng et al., 2024). Families without male offspring often question the viability of long-term investments, fearing these efforts may not be inherited or effectively utilized. This concern is amplified by the limited timeframe for aging laborers, whose physical decline diminishes the returns on such investments. (Although families without male heirs may theoretically have a longer decision-making period, the agricultural labor structure and the late emphasis on sustainable agricultural practices limit long-term investment incentives. First, the rural workforce is increasingly dominated by older laborers as younger workers migrate to higher-paying off-farm jobs. Those returning to farming are often near retirement, leaving little time for long-term agricultural investments. Second, sustainable agriculture has only recently become a policy priority in China. Early agricultural policies emphasized production, with little regard for sustainability. Not until 2016, with the Central Government's No. 1 Document, did resource conservation and ecological restoration emerge as core objectives.) Consequently, these families prioritize basic subsistence and shift resources away from long-term investments toward immediate economic needs (Breitenbach and Foguesatto, 2023). In contrast, families with male offspring, driven by the need to preserve land for generational transfer, exhibit greater confidence in the continuity of their investments. This assurance drives them to prioritize enhancing the land's value as an inheritable asset and securing its long-term productivity to meet intergenerational demands (Foguesatto et al., 2020). Based on this, the following hypothesis is proposed:

H1: The absence of male offspring inhibits long-term agricultural investment behavior.

Pathways through which offspring gender composition affects long-term investment behavior in rural households

Offspring gender composition influences long-term investment behavior in rural households through two main pathways: changes in internal family psychology and decision-making tendencies, specifically time preference, and variations in external resource acquisition and capabilities, namely social capital.

Offspring gender composition, time preference, and long-term investment behavior

The absence of male offspring influences household time preferences, shaping long-term agricultural investment behavior. These investments, such as organic fertilizer application, require immediate costs with benefits accruing over time, making them classic intertemporal decisions (Zhou, Cheng and Zhang, 2022; Zheng et al., 2024). Psychological mechanisms, particularly time preference and discount rates, govern these decisions. Time preference refers to the inclination to prioritize immediate utility over delayed utility (Frederick, Loewenstein and O'Donoghue, 2002): a higher time preference indicates a stronger preference for immediate satisfaction, whereas a lower time preference reflects a greater willingness to defer gratification for future rewards (Thaler, 1981; Harris and Laibson, 2013; Kennedy, 2020). According to time preference theory, these evaluations of future returns influence households' decisions on long-term investments (Shiferaw, Okello and Reddy, 2009; Thaler, 2016).

As previously discussed, the gender composition of offspring profoundly shapes household expectations regarding long-term labor availability, influencing intergenerational inheritance strategies, particularly regarding land (Breitenbach and Foguesatto, 2023; Bavorová et al., 2024). Households without male offspring, constrained by the post-marriage relocation of female offspring,

https://doi.org/10.1017/S1742170524000358 Published online by Cambridge University Press

often face reduced intergenerational inheritance needs (Zhang, 2019; Du, Xiao and Zhao 2021). Without reliable mechanisms to transfer land across generations, these households emphasize immediate financial returns, prioritizing short-term utility over long-term productivity (Wheeler et al., 2012). This inclination reflects a higher time preference, favoring immediate gains over investments with delayed returns (Kennedy, 2020). In contrast, households with male offspring anticipate a stable future labor supply. Male offspring's marriages typically expand household size by integrating spouses and children, ensuring continuity in family (Fei, Hamilton and Zheng, 1992). This expectation strengthens their commitment to preserving arable land as a durable family asset, prioritizing its long-term generational value over immediate returns. As a result, these households exhibit a lower time preference, aligning their investment strategies with intergenerational continuity (Thaler, 1981).

Time preferences further shape farmers' long-term investment decisions (Thaler, 2016). Farmers with low time preference are more likely to undertake long-term investments characterized by extended return cycles and substantial potential for future appreciation, thereby maximizing intergenerational benefits (Thaler, 1981; O'Donoghue and Rabin, 1999). As such, they are more inclined to invest in high-cost, long-term ventures like organic fertilizers and biopesticides, which contribute to long-term agricultural productivity and sustainability (Mao et al., 2021). In contrast, farmers with high time preferences tend to focus on immediate gains and short-term satisfaction (Thaler, 1981). They prefer agricultural inputs with quick paybacks, such as chemical fertilizers and pesticides, and typically avoid long-term investments with delayed returns, even if such investments could improve production efficiency and support sustainable land use in the long run. Based on this, the following hypothesis is proposed:

H2: The absence of male offspring increases time preference, inhibiting long-term agricultural investment behavior in farming households.

Offspring gender composition, social capital, and long-term investment behavior

Offspring gender composition significantly shapes long-term agricultural investment behavior by influencing household social capital. Rural areas in China are often described as 'relational societies', where social capital serves as a vital supplement to formal institutions (Gao et al., 2019). Social capital, defined as resources obtained through social interactions such as networks, trust, and reciprocity (Coleman, 1988; Putnam, 1993), underpins many aspects of rural life. Within this context, offspring gender composition directly impacts the construction and accumulation of household social capital (Boserup, Tan and Toulmin, 2007).

Families with male offspring typically hold a stronger voice in village collective affairs. These families frequently contribute more labor to communal projects, such as repairing canals and roads (Alesina, Giuliano and Nunn, 2013), traditionally assigned to men due to gender-based labor division (Becker, 1985). By contributing labor, the family enhances its social influence within the village, accumulating social capital (Putnam, 2000). Moreover, the seasonal nature of agricultural work further underscores the importance of male offspring. During peak agricultural periods, families with male offspring are better equipped to participate in labor-sharing activities (Krishna, 2001). These arrangements reinforce reciprocal ties and broaden social networks by fostering cooperative household relationships. Over time, such interactions enable these families to accumulate higher levels of social capital (Fredriksson and Gupta, 2023). In contrast, families without male offspring limit their engagement in collective affairs and communal interactions. Consequently, they tend to form weaker social networks, gain less access to shared resources, and build relatively lower levels of social capital.

Long-term investments are often hindered by deficiencies in labor, credit, and information markets (Shiferaw, Okello and Reddy, 2009). Social capital, as an informal institution, mitigates these issues by coordinating labor, facilitating access to financial resources, and promoting information flow (Gao et al., 2019). However, its erosion weakens this capacity. First, the decline in social capital worsens labor shortages by disrupting labor-sharing arrangements that enable farmers to share workforce resources during peak agricultural seasons (Krishna, 2001). Second, diminished social capital restricts access to informal financial networks, heightening liquidity constraints for cash-strapped households (Wossen, Berger and Di Falco, 2015). This limitation restricts farmers' ability to adopt long-term agricultural investments, which require high upfront costs and offer returns only over extended periods (Gao, Sun and Huang, 2017). Third, reduced social capital disrupts information dissemination, widening information asymmetries and increasing the transaction costs of adopting new technologies (Rogers, Singhal and Quinlan, 2008; Xie et al., 2024). Farmers without access to solid peer networks struggle to acquire reliable knowledge about the benefits and proper usage of investments (Kassie et al., 2013). Empirical evidence indicates that farmers consistently regard peers as their most trusted and reliable sources of information (Magnan et al., 2015). When these networks weaken, uncertainties regarding new technologies grow, and trial-and-error costs rise, further discouraging investment (Conley and Udry, 2010). Based on this, the following hypothesis is proposed:

H3: The absence of male offspring reduces household social capital, inhibiting long-term agricultural investment behavior.

In summary, this paper constructs a theoretical framework illustrating how the offspring gender composition affects long-term agricultural investment behavior (Fig. 1).

Materials and methods

Data collection

The data for this study were collected in a cross-sectional household survey in 2021, 2022, and 2023 in Hubei province's primary rice-producing regions. Hubei province is a central grain-producing region in China with high agricultural production levels. Selecting Hubei reflects central China's agricultural production and management patterns. Additionally, its central location offers a unique context for examining family cultural characteristics and gender roles. Rice occupies the largest planting area in Hubei, approximately 28.02% (source of data: Hubei Provincial Bureau of Statistics), followed by wheat and corn. Thus, focusing on rice farmers allows this study to gain deeper insights into agricultural investment behavior and decision-making mechanisms.

All respondents in this study provided informed consent by signing a consent form that outlined the risks and benefits of participation, confidentiality clauses, and the incentives offered. Each

https://doi.org/10.1017/S1742170524000358 Published online by Cambridge University Press

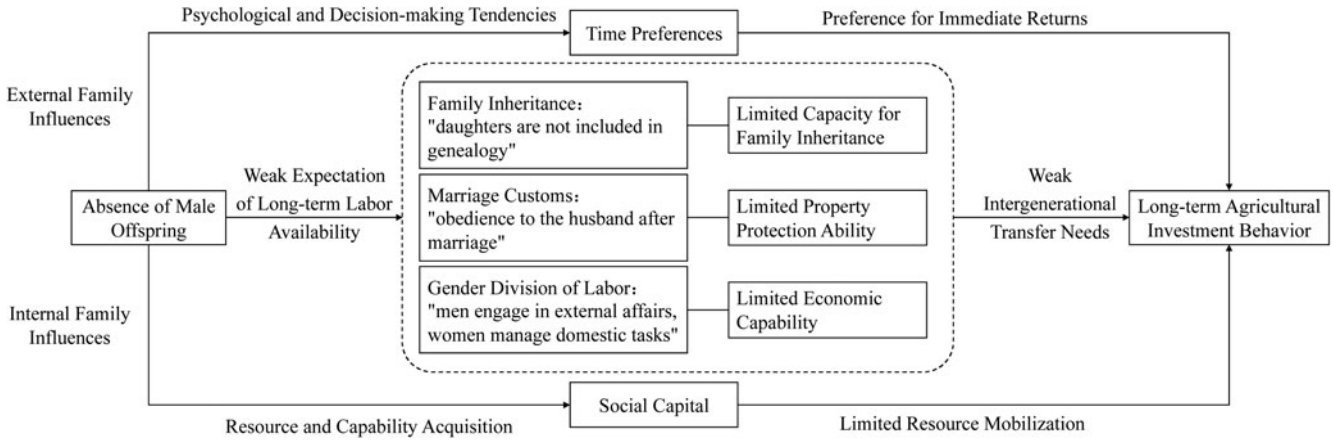

Figure 1. Theoretical framework for the impact of offspring gender composition on long-term investment behavior.

respondent received an incentive of 15 yuan, regardless of the completeness of their questionnaire responses. The regions surveyed included Zhijiang city, Qianjiang city, Xiantao city, Honghu city, Wuxue city, Jingshan city, Zhongxiang city, Shayang county, Qichun county, and Xinzhou district. The survey employed a multi-stage random sampling process: two to three townships or streets were selected in each area, followed by two to three administrative villages within those townships or streets, and finally, at least 25 rice-farming households in each village were surveyed.

This paper investigates how offspring gender composition shapes long-term agricultural investment behavior in farming households. The analysis includes only farming households with at least one second-generation offspring, excluding non-farming households, as they do not engage in agricultural investment decisions. Households without children are also excluded for two reasons. First, as the study centers on offspring gender composition, the presence of children is essential. Second, including childless households, which consist of newly formed families and established families without children, could distort the findings by diluting the focus on the latter. The final sample comprises 4090 households (1246 from 2021, 1469 from 2022, and 1375 from 2023) after excluding 383 non-farming households (7.77%) and 459 households without offspring (10.09%) from the initial pool.

Variable selection and measurement

Dependent variable

The dependent variable in this study is long-term agricultural investment behavior, measured by the expenditure on commercial organic fertilizer per mu (667 m^2) of land in the previous year (Zhou, Cheng and Zhang, 2022). This measure is appropriate because organic fertilizers provide lasting benefits beyond the current growing season, making them a recognized proxy for long-term agricultural investments (Jacoby, Li and Rozelle, 2002; Gao, Sun and Huang, 2017; Zhou, Cheng and Zhang, 2022). Unlike chemical fertilizers, which primarily offer immediate nutrients for crop growth, organic fertilizers improve soil structure and water retention capacity, supporting sustainable productivity over time (Zheng et al., 2024).

Organic fertilizers are broadly divided into commercial and homemade types. However, this study focuses exclusively on commercial organic fertilizers due to the significant decline in the use of homemade fertilizers in rural China. This decline is attributed to rising incomes, stricter environmental regulations, and changing rural lifestyles (Lui, Huang, and Zikhali, 2014). Policies such as the *Regulations on Pollution Prevention and Control of Livestock* and *Poultry Farming and the Animal Husbandry Law* have further accelerated the separation of livestock rearing from crop cultivation at the household level. Consequently, the proportion of rural households simultaneously engaging in both activities fell from 71% in 1986 to 12% in 2017, with this trend continuing (Jin et al., 2021). Additionally, the *Rural Living Environment Improvement Action Plan* (2021–2025), which mandates replacing traditional dry toilets with flushing systems, has further reduced the availability of human and animal waste for fertilizer production.

Core independent variable

Following Li and Qian (2021), we use the presence or absence of male offspring to represent gender composition. Specifically, if a household has no male offspring in the second generation, the variable is assigned a value of 1; if the household has male offspring in the second generation, the variable is assigned a value of 0.

In our sample, the average expenditure on commercial organic fertilizer per mu significantly differs between households with and without male offspring, which is statistically significant at the 1% level. Households with male offspring have an average commercial organic fertilizer expenditure per mu of 12.547, whereas households without male offspring have an average expenditure of 6.806 (Table 1). This suggests that the presence or absence of

Table 1. Long-term investment behavior by offspring gender composition

	Dependent variable: Long-term investment behavior	
Offspring gender composition	Mean	S.D.
No male offspring	6.806	1.097
Have male offspring	12.547	0.724
Difference	5.741***	

Note: The difference represents the mean difference in commercial organic fertilizer expenditure per mu between households with and without male offspring. Significance levels are indicated as follows: ***, **, and * are significant at 1, 5 and 10%, respectively.

https://doi.org/10.1017/S1742170524000358 Published online by Cambridge University Press

male offspring may influence long-term agricultural investment behavior.

Mediator variable

This study considers two mediator variables: time preference and social capital. Referring to the research by Frederick, Loewenstein and O'Donoghue (2002), two methods exist to estimate an individual's time preference. The first method indirectly infers time preference by analyzing individuals' decision-making and planning activities in daily life, using these behaviors as proxy variables. The second method asks respondents about their intertemporal choices to estimate time preference. Due to the indirect inference method's complexity and susceptibility to external factors, this study adopts the second, more direct approach by asking farmers, 'Do you prefer to choose crop varieties with shorter growth cycles?' Farmers with solid time preferences are likelier to select fast-maturing crop varieties because they provide quicker economic returns, satisfying their preference for immediate benefits.

This study measures social capital using three dimensions: social networks, trust, and norms, following the methodology of Guo, Chen and Zhang (2022). Precisely, social networks are measured by the number of relatives and friends visited during the previous Chinese New Year. Social trust is assessed by the respondent's satisfaction with neighborhood relations (ranging from 1 = very dissatisfied to 5 = very satisfied). Social norms are measured by the number of civil disputes in the village yearly. Considering the impact of the overall social capital level of the village on individual social capital—since the effect of a given amount of individual social capital can vary depending on the village's total social capital—we measure the relative advantage of individual social capital within the village's social capital, based on the study by Li, Lin and Jin (2019). The specific process is as follows: first, the scores for social networks, trust, and norms K_{ij} are assigned weights W_j determined by the entropy method, and each farmer's individual social capital S_i is calculated using a weighted sum (Equation (1)). Second, the total social capital of the village S is obtained by summing the individual social capital of all farmers (Equation (2)). Finally, the ratio of a farmer's individual social capital S_i to the village's total social capital S is used as the farmer's available social capital SCA_i within the village (Equation (3)).

$$S_i = \sum_{j=1}^{5} W_j K_{ij} \tag{1}$$

$$S = \sum_{j=1}^{n} S_i \tag{2}$$

$$SCA_i = S_i / S \tag{3}$$

In the above formulas, K_{ij} denotes the score of the i-th farmer on the j-th dimension. W_j is the weight assigned to the j-th dimension. S_i represents the individual social capital of the i-th farmer (where $i = 1, 2, 3, \ldots, n$). S signifies the total social capital at the village level. SCA_i indicates the available social capital for the i-th farmer within the village, and n is the total number of farmers in the sample.

Control variable

To minimize potential omitted variable bias, this study incorporates controls for several essential factors. Individual characteristics of the agricultural decision-maker—such as age, education, political affiliation, and health—are included to capture personal characteristics influencing decision-making (Foster and Rosenzweig, 2010; Guo, Chen and Zhang, 2022). Household-level characteristics, including the number of agricultural laborers, total annual income (including wage income, net business income, net property income, and net transfer income), household savings rate, hukou migration, and cooperative membership, control for variations in household resources that may affect long-term investment behavior (Wei and Zhang, 2011; Guo, Chen and Zhang, 2022). Land-related variables, such as the total area of cultivated paddy fields, number of field plots, soil fertility, distance from residence to fields, and land tenure certification status, account for differences in land endowments (Zhou, Cheng and Zhang, 2022). Beyond these intrinsic factors, village-level controls capture external influences on long-term investment behavior, such as farmland consolidation projects and the village's economic conditions (Corsi, 2009; Pun, Joshi and Pun, 2024). The model incorporates town-level fixed effects to account for regional variations, capturing factors such as climate, ecological conditions, availability of agricultural inputs, access to technology, and input prices (Bar-Shira, Finkelshtain and Simhon, 2006). Additionally, time-fixed effects are incorporated to account for macroeconomic and seasonal fluctuations.

Table 2 reports the definitions, assignments, and descriptive statistics of the variables.

Model setting

Baseline regression model

To investigate the impact of offspring gender composition on the long-term investment behavior of rural households, we specify the following baseline regression model:

$$LIB_{it} = a_0 + a_1 OGC_{it} + a_2 Control_{it} + \theta_r + \gamma_t + \varepsilon_{it} \tag{4}$$

In Equation (4), LIB_{it} represents the long-term investment behavior of household i in year t, measured as a continuous variable. The OLS method is employed for estimation. OGC_{it} denotes the absence of male offspring in household i in year t, $Control_{it}$ includes individual characteristics, household factors, land features, and village-level conditions. θ_r and γ_t represent regional and temporal fixed effects, respectively, to account for unobserved heterogeneity across regions and time periods. a_0 is the intercept, a_1 and a_2 are coefficients to be estimated, and ε_{it} is the random error term.

Mechanism effect test

Following Jiang (2022), we further identify the causal relationship between the core explanatory variable and the mediator variables to explore how offspring gender composition affects the long-term investment behavior of rural households. The specific model is set as follows:

$$M_{it} = \beta_0 + \beta_1 OGC_{it} + \beta_2 Control_{it} + \theta_r + \gamma_t + \varepsilon'_{it} \tag{5}$$

In Equation (5), M_{it} represents the mediator variables, including time preference and social capital. OGC_{it} denotes the absence of male offspring, and $Control_{it}$ includes the same control variables as in Equation (4). θ_r and γ_t capture regional and temporal

https://doi.org/10.1017/S1742170524000358 Published online by Cambridge University Press

Table 2. Descriptive statistics of variables

Variable	Description	Mean	S.D.
Long-term agricultural investment behavior	Expenditure on commercial organic fertilizer per mu (yuan)	11.580	40.331
Absence of male offspring	Whether there are no male offspring in the second generation: 0 = No, 1 = Yes	0.168	0.374
Time preference	Whether the household prefers short-growth cycle crops: 0 = No, 1 = Yes	0.067	0.250
Social capital	The ratio of an individual's social capital to the total social capital of their village as measured by SCA_i (see Formula (3)).	0.037	0.012
Age	Age of the agricultural decision-maker (years)	61.238	9.597
Education	Years of education of the agricultural decision-maker (years)	7.446	3.325
Political affiliation	Whether the agricultural decision-maker is a member of the Communist Party of China: 0 = No, 1 = Yes	0.120	0.325
Health	Self-assessed health status of the agricultural decision-maker: 1 = Very unhealthy, 5 = Very healthy	3.870	0.836
Agricultural labor stock	Number of agricultural laborers in the household over the past year (persons)	1.947	0.923
Household income	Total annual household income (yuan)	85,659.355	62,296.539
Household savings rate	The percentage of income that remains after deducting household expenditures	36.262	25.843
Hukou migration	Whether any household members have changed household registration in the past 5 years: 0 = No, 1 = Yes	0.182	0.386
Cooperative participation	Whether participated in rural cooperative: 0 = No, 1 = Yes	0.132	0.339
Field area	Total area of paddy fields managed over the past year (mu)	15.196	15.030
Field plots	Number of paddy field plots cultivated over the past year (blocks)	10.217	15.399
Soil fertility	Overall self-reported soil fertility: 1 = Poor, 2 = Average, 3 = Good	2.484	0.584
Distance from residence to field	Distance from the household residence to the paddy fields (km)	0.496	0.398
Land tenure certification	Whether the household has received the latest round of land tenure certification: 0 = No, 1 = Yes	0.926	0.261
Village farmland consolidation	Implementation of farmland consolidation in the village in the past 5 years: 0 = No, 1 = Yes	0.733	0.442
Village economic level	Whether the village is a poverty-stricken village: 0 = No, 1 = Yes	0.168	0.374

Note: Descriptive statistics for log-transformed variables are based on the original values; log transformation is applied in model estimation.

fixed effects, respectively. β_0 is the intercept, β_1 and β_2 are coefficients to be estimated, and ε_{it} is the random error term. If β_1 is statistically significant, it suggests that the absence of male offspring significantly influences the mechanism variable, thereby suggesting a causal pathway.

Results and discussion

Baseline results

Table 3 presents the regression results on the impact of offspring gender composition on long-term agricultural investment behavior. The estimates in columns (1) and (2) show that, after controlling for individual characteristics of the agricultural decision-maker, household characteristics, land endowment features, village-level conditions, as well as regional and temporal fixed effects, the absence of male offspring has a significant negative effect on long-term agricultural investment behavior. This effect is significant at the 1% level, confirming H1: the absence of male offspring significantly inhibits long-term agricultural investment behavior in households.

The control variables also provide important insights. The age of the agricultural decision-maker exhibits a significant negative effect, suggesting that older decision-makers are less inclined to pursue long-term investments. Hukou migration similarly has a statistically significant negative impact, reflecting how labor mobility can hinder such investments. Conversely, decision-makers who are members of the Communist Party of China are more likely to make long-term investments. Land-related variables, such as the total field area and the number of field plots, show negative effects, implying that larger operational scales may lead to management challenges that deter long-term investments, which are consistent with the findings of Cao, Bai and Zhang (2020). In addition, greater distances between residences and fields significantly hinder investment, underlining the critical role of geographic proximity in agricultural production. Land tenure certification positively influences long-term investments, supporting Zhou, Cheng and Zhang (2022), who emphasized the role of clear ownership rights in promoting long-term agricultural investments. Furthermore, village farmland consolidation significantly enhances investment behavior, aligning with the findings of Pun, Joshi and Pun (2024).

Endogeneity discussion

One major issue in this study is the potential endogeneity of offspring gender composition. The gender composition of offspring might be influenced by unobserved factors that could also affect

https://doi.org/10.1017/S1742170524000358 Published online by Cambridge University Press

Table 3. Baseline regression results for the impact of offspring gender composition on long-term investment behavior

	Dependent variable: Long-term investment behavior			
	(1)		(2)	
Variable	Coeff.	S.E.	Coeff.	S.E.
Absence of male offspring	−0.341***	0.056	−0.387***	0.057
Age			−0.009***	0.003
Education			0.011	0.008
Political status			0.195**	0.078
Health			0.006	0.027
Agricultural labor stock			−0.053**	0.023
Household income			−0.001	0.026
Household savings rate			−0.001	0.001
Hukou migration			−0.146***	0.056
Cooperative participation			0.271***	0.080
Field area			−0.008***	0.002
Field plots			−0.004***	0.001
Soil fertility			0.012	0.041
Distance from residence to field			−0.331***	0.054
Land tenure certification			0.249***	0.071
Village farmland consolidation			0.316***	0.083
Village economic level			−0.285***	0.106
Regional fixed effects	Yes		Yes	
Temporal fixed effects	Yes		Yes	
R^2	0.038		0.079	
Observations	4090		4090	

Note: ***, **, and * are significant at 1, 5 and 10%, respectively.

Table 4. Endogeneity discussion—instrumental variable regression results

	(1)	(2)
	Absence of male offspring	Long-term agricultural investment behavior
Variable	First stage	Second stage
Absence of male offspring		−0.393***
		(0.170)
Number of offspring	−0.213***	
	(0.008)	
Control variables	Yes	Yes
Regional fixed effects	Yes	Yes
Temporal fixed effects	Yes	Yes
Kleibergen–Paap rk Wald *F*	767.521	
Observations	4090	4090

Note: Standard errors are in brackets; control variables are the same as in Table 3.
***, **, and * are significant at 1, 5 and 10%, respectively.

long-term agricultural investment behavior, leading to omitted variable bias. To address this issue, this study employs the number of children as an IV to identify the absence of male offspring. Theoretically, as offspring size increases, the probability of having at least one male child rises significantly. This relationship is particularly pronounced in son-preference cultures, where parents often continue childbearing until a male child is born (Congdon Fors and Lindskog, 2023). Hence, the instrument satisfies the relevance criterion. Regarding exogeneity, the number of children predominantly reflects factors such as family fertility preferences, sociocultural influences, and policy environment (Huber, Zahourek and Fieder, 2017; Zhang, 2019), without directly affecting household decisions on long-term agricultural investments. Accordingly, this variable also fulfills the exogeneity requirement, as it does not exert a direct effect on the dependent variable.

Table 4 presents the estimation results of the two-stage least squares method. In the first stage, shown in column (1), the number of offspring exhibits a statistically significant negative coefficient for the absence of male offspring, confirming the instrument's relevance. In the second-stage results, presented in column (2), the absence of male offspring has a statistically significant negative effect on long-term agricultural investment behavior, consistent with the baseline regression findings. Additionally, the Kleibergen–Paap rk Wald *F* statistic of 767.521 far exceeds the Stock–Yogo critical value of 16.38 at the 10% maximal IV size threshold, further validating the instrument's strength. These findings confirm the robustness of the IV approach in addressing endogeneity concerns and substantiate the causal relationship between offspring gender composition and long-term agricultural investment behavior.

Robustness test

We conducted several robustness tests to verify the stability of our model estimation results. First, following Brodeur, Cook and Heyes (2020), we randomly selected 80% of the sample for regression analysis to evaluate the impact of sample selection on the estimation results (column (1)). Columns (2) and (3) use alternative dependent variables to test the robustness of the results. In column (2), the dependent variable is replaced with household investment in agricultural machinery, measured as the logarithm of the total value of machinery owned (yuan), following Liu, Li and Xu (2024). In column (3), long-term agricultural investment is proxied by adopting improved water conservancy facilities, including irrigation and drainage infrastructure. This variable is coded as 1 if such improvements are adopted and 0 otherwise, based on Cao, Bai and Zhang (2020). In column (4), we expand the scope of the independent variable by including households without second-generation offspring. This adjustment tests the generalizability of the findings beyond households with second-generation offspring. Column (5) introduces the proportion of female offspring as an alternative proxy for offspring gender composition. This measure captures the family's overall gender structure, addressing the limitations of the binary variable. Lastly, considering that some households may have zero long-term agricultural investments, we employed a Tobit model to examine the consistency and stability of our results

https://doi.org/10.1017/S1742170524000358 Published online by Cambridge University Press

under different model specifications (Zhou, Cheng and Zhang, 2022). The Tobit model results are displayed in column (6), reinforcing the robustness of our findings.

Table 5 summarizes the results of these robustness tests. Across varying samples, alternative dependent variables, and model specifications, the findings consistently demonstrate that the absence of male offspring has a significant negative impact on long-term agricultural investment. These results confirm the robustness of the baseline regression and reinforce the validity of the study's conclusions.

Mediation analysis

We conducted a mediation analysis to explore how offspring gender composition affects long-term agricultural investment behavior, focusing on time preference and social capital. As shown in Table 6, after controlling for individual characteristics of the agricultural decision-maker, household characteristics, land endowment features, village-level conditions and regional and temporal fixed effects, column (1) shows that the absence of male offspring significantly increases household time preference. This finding suggests that families without male offspring are more inclined toward immediate benefits, which inhibits long-term agricultural investment behavior, thereby verifying H2. The results in column (2) show that the absence of male offspring significantly reduces household social capital. Families without male offspring have weaker social networks and limited resource access, inhibiting long-term agricultural investment behavior, thereby verifying H3.

Heterogeneous results

The impact of offspring gender composition on long-term agricultural investment behavior is not uniform. Internal factors like the continuation of male offspring within the family and external factors such as land marketization levels can influence it. In our analysis, we define the gender of the agricultural decision-maker as a binary variable ('0' for female, '1' for male), while the level of land marketization is measured by the proportion of households that lease land through monetary transactions relative to the total number of households engaged in land transfers within the village (China's land system separates ownership rights, contract rights, and management rights. The collective retains ownership rights, while farmers hold contract and management rights, which they can transfer through two primary methods. Non-monetary transfers include informal arrangements such as social rentals, verbal agreements, and short-term leases, leading to higher transaction costs due to their non-market nature. Conversely, monetary transfers involve formal contracts and long-term leases, resulting in lower transaction costs due to their market-oriented approach.) (Liu et al., 2016). This analytical framework allows us to examine how offspring gender composition interacts with these internal and external factors to shape long-term agricultural investment behavior across varied family and market environments.

This study uses interaction term regressions to explore the heterogeneous effects of the agricultural decision-maker's gender on how offspring gender composition influences long-term agricultural investment behavior. Column (1) shows that the interaction between the absence of male offspring and the decision-maker's gender is statistically significant at the 5% level, with a negative coefficient. This finding suggests that when the decision-maker is male, the absence of male offspring further discourages long-term agricultural investments. This may reflect the reinforcement of traditional gender roles within the family, particularly through the intergenerational transmission of labor divisions that prioritize males (Daniele, 2024). For instance, resource allocation rights within the family typically default to male members, particularly in long-term economic planning and significant decisions where male opinions often predominate. Consequently, when the decision-maker is male, and there are no male offspring, their conservative attitude toward future agricultural investment may heighten due to insufficient expectations of continuing the family lineage (Duesberg, Bogue and Renwick, 2017). In contrast, female agricultural decision-makers are more likely to prioritize fairness in resource allocation and inclusivity in decision-making (Fertő and Bojnec 2024). Their focus on equitable development encourages balanced investment strategies within the household, regardless of offspring gender composition (Fernández, Fogli and Olivetti, 2004). This inclusive approach can help mitigate the negative effects of the absence of male offspring on long-term agricultural investment.

Column (2) shows that the interaction between the absence of male offspring and land marketization is statistically significant at the 5% level, with a positive coefficient. This finding suggests that higher levels of land marketization mitigate the negative effect of not having male offspring on long-term agricultural investment behavior. Increased land marketization reduces land transfer transaction costs, enabling farmers to adjust their land holdings

Table 5. Robustness test results for the impact of offspring gender composition on long-term investment behavior

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Absence of male offspring	−0.367***	−0.424**	−0.265***	−0.365***		−0.387***
	(0.062)	(0.166)	(0.073)	(0.047)		(0.063)
Proportion of female offspring					−0.290***	
					(0.067)	
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Regional fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Temporal fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3288	4090	4090	4549	4090	4090
R^2/pseudo-R^2	0.082	0.168	0.067	0.078	0.074	0.023

Note: Standard errors are in brackets; control variables are the same as in Table 3.
***, **, and * are significant at 1, 5 and 10%, respectively.

https://doi.org/10.1017/S1742170524000358 Published online by Cambridge University Press

Table 6. Mediation analysis of the effects of offspring gender composition on long-term investment behavior

Variable	(1) Time preference	(2) Social capital
Absence of male offspring	0.168***	−0.005***
	(0.016)	(0.000)
Control variables	Yes	Yes
Regional fixed effects	Yes	Yes
Temporal fixed effects	Yes	Yes
Observations	4090	4090
R^2	0.100	0.481

Note: Standard errors are in brackets; control variables are the same as in Table 3.
***, **, and * are significant at 1, 5 and 10%, respectively.

more flexibly and decreasing reliance on male labor (Liu et al., 2016). A market-driven land transfer mechanism allows farmers to lease land as needed, optimizing the match between land resources and household labor. For example, farmers can lease out excess land beyond their operational capacity, intensively reallocating resources to cultivate within their means. This flexibility improves land and labor use efficiency, enhancing agricultural productivity. Furthermore, higher levels of land marketization make long-term land investments more easily monetizable. Even with limited long-term family labor, an efficient land transfer market allows farmers to earn rent or capital gains, providing direct economic compensation for long-term investments. By reducing the uncertainty of future returns, land marketization increases farmers' incentives for long-term agricultural investments and offsets the negative influence of offspring gender composition on investment behavior (Table 7).

Table 7. Heterogeneity analysis of the effects of offspring gender composition on long-term investment behavior

	Dependent variable: Long-term investment behavior			
	(1) Gender		(2) Land marketization	
Variable	Coeff.	S.E.	Coeff.	S.E.
Absence of male offspring	−0.463***	0.050	−0.387***	0.057
Gender	−0.859***	0.134		
Absence of male offspring × gender	−0.536**	0.245		
Land marketization			0.103	0.110
Absence of male offspring × land marketization			0.476**	0.208
Control variables	Yes		Yes	
Regional fixed effects	Yes		Yes	
Temporal fixed effects	Yes		Yes	
R^2	0.103		0.080	
Observations	4090		4090	

Note: Control variables are the same as in Table 3.
***, **, and * are significant at the level of 1, 5 and 10%, respectively.

Limitations and future research

This study has several limitations: first, although mixed cross-sectional data provide a diverse horizontal perspective, they do not control for individual fixed effects. This limitation makes it challenging to address time-invariant omitted variables (Gao, Sun and Huang, 2017). Second, the research is confined to Hubei province, China. While this region's agricultural economic environment and policy background offer some representativeness, its unique local characteristics may limit the external validity of the findings. Third, this study uses expenditures on commercial organic fertilizer to indicate long-term investment behavior. While this reflects farmers' concern for maintaining soil fertility (Zhou, Cheng and Zhang, 2022), and robustness tests incorporate variables such as household investment in agricultural machinery and adoption of improved water conservancy facilities, these measures do not fully represent the breadth of long-term agricultural investments. Finally, the study focuses primarily on rice farmers. The production methods and investment behaviors of rice farmers may differ significantly from those of farmers growing economic crops like citrus and tea. Therefore, the applicability of the findings to other agricultural sectors may be limited.

Policy implications

The findings suggest several policy implications. In the short term, alternative human capital solutions, such as assistance with hiring machinery or outsourcing services, should be provided to counteract high-time preference and establish positive production expectations for households without male offspring (Qian et al., 2022). Strengthening rural community organizations and enhancing mutual assistance mechanisms among villagers are crucial. Community activities, like cultural and sports events, can foster interaction and communication among farmers (Mcmanus et al., 2012). Local governments can support these efforts by organizing training sessions and technical exchange meetings, helping farmers expand their social networks and build robust cooperative frameworks (Skaalsveen, Ingram and Urquhart, 2020). Additionally, transparent management and fair resource distribution systems can enhance trust among villagers. Establishing and promoting village regulations can standardize behavior, encouraging mutual assistance and collective development. Local governments should introduce incentive policies to reward farmers who actively participate in and contribute to community cooperation, thereby setting examples of mutual support. These measures will increase the availability of social capital through broader social interactions, enhancing farmers' willingness and capacity for long-term investment.

In the long term, fostering gender equality in rural areas by encouraging equal opportunities and resource allocation between male and female offspring is crucial for promoting overall family welfare and development (Liu et al., 2016). Besides, advancing land market reforms can enhance economic incentives for farmers by simplifying administrative procedures, reducing land transfer transaction costs, and improving the flexibility and efficiency of land use and allocation (Fei, Lin and Chunga, 2021). Establishing a scientific land evaluation system to accurately reflect the long-term investment value of land will boost farmers' confidence and capacity for long-term and effective land investments. Addressing these factors can drive sustainable agricultural development and improve the quality of agricultural investments.

https://doi.org/10.1017/S1742170524000358 Published online by Cambridge University Press

Conclusions

This paper examined the impact of offspring gender composition on long-term agricultural investment behavior, using household commercial organic fertilizer expenditure as an indicator. Based on survey data from 4090 grain farming households in 10 cities (counties) of Hubei province, China, collected from 2021 to 2023, the study reveals that the absence of male offspring significantly reduces long-term agricultural investment behavior. This effect is mediated by increased time preference and decreased social capital. Moreover, the inhibitory impact is more substantial when the current agricultural decision-maker is male and land marketization levels are low.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S1742170524000358.

Data availability statement. The data underlying the findings of this study can be accessed by contacting the corresponding author. Public availability of the data is restricted due to privacy and ethical considerations.

Acknowledgments. The authors gratefully acknowledge financial support from the National Natural Science Foundation of China (NSFC grant numbers 42071157 and 72473049). We sincerely thank the farmers who generously participated in this study and shared their valuable insights. Our gratitude also goes to the anonymous reviewers for their constructive feedback and to the editors for their dedication. We appreciate Qingmeng Tong and Zhihui Liang for their suggestions on the paper's structure, and Hongli Li and Shengpeng Sun for their encouragement, and guidance throughout the study's development.

Author contributions. Pengyu Chen: idea, conceptualization, writing—original draft, data processing, and editing. Lu Zhang: writing revision, supervision, project administration, and funding acquisition. Jorge Ruiz-Menjivar: writing—review and editing.

Funding statement. This work was supported by the National Natural Science Foundation of China (Grant No. 42071157).

Competing interests. None.

References

Abdulai, A. and Huffman, W. (2014) 'The adoption and impact of soil and water conservation technology: an endogenous switching regression application', *Land Economics*, **90**(1), pp. 26–43.

Adekiya, A.O., Ejue, W.S., Olayanju, A., Dunsin, O., Aboyeji, C.M., Aremu, C., Adegbite, K. and Akinpelu O. (2020) 'Different organic manure sources and NPK fertilizer on soil chemical properties, growth, yield and quality of okra', *Scientific Reports*, **10**(1), p. 16083.

Alesina, A. and Giuliano, P. (2010) 'The power of the family', *Journal of Economic Growth*, **15**(2), pp. 93–125.

Alesina, A., Giuliano, P. and Nunn, N. (2013) 'On the origins of gender roles: women and the plough', *The Quarterly Journal of Economics*, **128**(2), pp. 469–530.

Arends-Kuenning, M., Kamei, A., Garcias, M., Romani, G.E. and Shikida, P.F.A. (2021) 'Gender, education, and farm succession in Western Paraná State, Brazil', *Land Use Policy*, **107**, p. 105453.

Bar-Shira, Z., Finkelshtain, I. and Simhon, A. (2006) 'Block-rate versus uniform water pricing in agriculture: an empirical analysis', *American Journal of Agricultural Economics*, **88**(4), pp. 986–99.

Bavorová, M., Ullah, A., Garcia, Y.A. and Cavicchioli, D. (2024) 'Factors influencing farm succession decisions: evidence from coffee farmers of Colombia', *Environment, Development and Sustainability*, pp. 1–20.

Becker, G.S. (1985) 'Human capital, effort, and the sexual division of labor', *Journal of Labor Economics*, **3**(1), pp. S33–58.

Boserup, E., Tan, S.F. and Toulmin, C. (2007) *Womans role in economic development*. London: Routledge.

Breitenbach, R. and Foguesatto, C.R. (2023) 'Should I stay or should I go? Gender differences and factors influencing family farm business succession in Rio Grande do Sul, Brazil', *Land Use Policy*, **128**, p. 106597.

Brodeur, A., Cook, N. and Heyes, A. (2020) 'Methods matter: *p*-hacking and publication bias in causal analysis in economics', *American Economic Review*, **110**(11), pp. 3634–60.

Cao, Y., Bai, Y. and Zhang, L. (2020) 'The impact of farmland property rights security on the farmland investment in rural China', *Land Use Policy*, **97**, p. 104736.

Coleman, J.S. (1988) 'Social capital in the creation of human capital', *American Journal of Sociology*, **94**, pp. S95–120.

Congdon Fors, H. and Lindskog, A. (2023) 'Son preference and education inequalities in India: the role of gender-biased fertility strategies and preferential treatment of boys', *Journal of Population Economics*, **36**(3), pp. 1431–60.

Conley, T.G. and Udry, C.R. (2010) 'Learning about a new technology: pineapple in Ghana', *American Economic Review*, **100**(1), pp. 35–69.

Corsi, A. (2009) 'Family farm succession and specific knowledge in Italy', *Rivista di Economia Agraria*, **64**, pp. 13–30.

Daniele, B.-C. (2024) 'The farm succession effect on farmers management choices', *Land Use Policy*, **137**, p. 107014.

Du, H., Xiao, Y. and Zhao, L. (2021) 'Education and gender role attitudes', *Journal of Population Economics*, **34**(2), pp. 475–513.

Duesberg, S., Bogue, P. and Renwick, A. (2017) 'Retirement farming or sustainable growth—land transfer choices for farmers without a successor', *Land Use Policy*, **61**, pp. 526–35.

Edafe, O.D., Osabuohien, E., Matthew, O., Osabohien, R. and Khatoon, R. (2023) 'Large-scale agricultural investment and female employment in African communities: quantitative and qualitative insights from Nigeria', *Land Use Policy*, **127**, p. 106579.

Fei, R., Lin, Z. and Chunga, J. (2021) 'How land transfer affects agricultural land use efficiency: evidence from Chinas agricultural sector', *Land Use Policy*, **103**, p. 105300.

Fei, X., Hamilton, G.G. and Zheng, W. (1992) *From the soil: the foundations of Chinese society*. Berkeley, CA: University of California Press.

Fernández, R., Fogli, A. and Olivetti, C. (2004) 'Mothers and sons: preference formation and female labor force dynamics', *The Quarterly Journal of Economics*, **119**(4), pp. 1249–99.

Fertő, I. and Bojnec, Š. (2024) 'Empowering women in sustainable agriculture', *Scientific Reports*, **14**(1), p. 7110.

Foguesatto, C.R., de Vargas Mores, G., Kruger, S.D. and Costa, C. (2020) 'Will I have a potential successor? Factors influencing family farming succession in Brazil', *Land Use Policy*, **97**, p. 104643.

Foster, A.D. and Rosenzweig, M.R. (2010) 'Microeconomics of technology adoption', *Annual Review of Economics*, **2**, pp. 395–424.

Frederick, S., Loewenstein, G. and O'Donoghue, T. (2002) 'Time discounting and time preference: a critical review', *Journal of Economic Literature*, **40**(2), pp. 351–401.

Fredriksson, P.G. and Gupta, S.K. (2023) 'Irrigation and gender roles', *Journal of Development Economics*, **163**, p. 103076.

Gao, L., Sun, D. and Huang, J. (2017) 'Impact of land tenure policy on agricultural investments in China: evidence from a panel data study', *China Economic Review*, **45**, pp. 244–52.

Gao, Y., Liu, B., Yu, L., Yang, H. and Yin, S. (2019) 'Social capital, land tenure and the adoption of green control techniques by family farms: evidence from Shandong and Henan provinces of China', *Land Use Policy*, **89**, p. 104250.

Glauben, T., Petrick, M., Tietje, H. and Weiss, C. (2009) 'Probability and timing of succession or closure in family firms: a switching regression analysis of farm households in Germany', *Applied Economics*, **41**(1), pp. 45–54.

Guo, Z., Chen, X. and Zhang, Y. (2022) 'Impact of environmental regulation perception on farmers agricultural green production technology adoption: a new perspective of social capital', *Technology in Society*, **71**, p. 102085.

Hansen, C.W., Jensen, P.S. and Skovsgaard, C.V. (2015) 'Modern gender roles and agricultural history: the Neolithic inheritance', *Journal of Economic Growth*, **20**(4), pp. 365–404.

Harris, C. and Laibson, D. (2013) 'Instantaneous gratification', *Quarterly Journal of Economics*, **128**(1), pp. 205–48.

Huber, S., Zahourek, P. and Fieder, M. (2017) 'Living with own or husband's mother in the household is associated with lower number of children: a cross-cultural analysis', *Royal Society Open Science*, **4**(10), p. 170544.

Huffman, W.E. (1985) 'Human capital, adaptive ability, and the distributional implications of agricultural policy', *American Journal of Agricultural Economics*, **67**(2), pp. 429–34.

Jacoby, H.G., Li, G. and Rozelle, S. (2002) 'Hazards of expropriation: tenure insecurity and investment in rural China', *The American Economic Review*, **92**(5), pp. 1420–47.

Jiang, T. (2022) 'Mediating effects and moderating effects in causal inference', *China Industrial Economics*, **5**, pp. 100–20.

Jin, S., Zhang, B., Wu, B., Han, D., Hu, Y., Ren, C., Zhang, C., Wei, X., Wu, Y., Mol, A.P.J., Reis, S., Gu, B. and Chen, J. (2021) 'Decoupling livestock and crop production at the household level in China', *Nature Sustainability*, **4**(1), pp. 48–55.

Jobling, M.A. and Tyler-Smith, C. (2003) 'The human Y chromosome: an evolutionary marker comes of age', *Nature Reviews Genetics*, **4**(8), pp. 598–612.

Kansanga, M. M., Luginaah, I., Kerr, R. B., Dakishoni, L. and Lupafya, E. (2021) 'Determinants of smallholder farmers' adoption of short-term and long-term sustainable land management practices', *Renewable agriculture and food systems*, **36**, pp. 265–77.

Kassie, M., Jaleta, M., Shiferaw, B., Mmbando, F. and Mekuria, M. (2013) 'Adoption of interrelated sustainable agricultural practices in smallholder systems: evidence from rural Tanzania', *Technological Forecasting and Social Change*, **80**(3), pp. 525–40.

Kennedy, J. (2020) 'Subjective wellbeing and the discount rate', *Journal of Happiness Studies*, **21**(2), pp. 635–58.

Krishna, A. (2001) 'Moving from the stock of social capital to the flow of benefits: the role of agency', *World Development*, **29**(6), pp. 925–43.

Li, M.H. and Qian, W.R. (2021) 'Influence of childrens gender on migrant labors choice of working place: evidence from the CLDS data', *Research of Agricultural Modernization*, **42**(1), pp. 142–52.

Li, T., Lu, H., Luo, Q., Li, G. and Gao, M. (2024) 'The impact of rural population aging on agricultural cropping structure: evidence from Chinas provinces', *Agriculture*, **14**(4), p. 586.

Li, W., Lin, H. and Jin, Z. (2019) 'Social capital availability: the case of farmers and herdsmen from Inner Mongolia', *Economic Research Journal*, **54**, p. 16.

Liu, G., Li, Y. and Xu, D. (2024) 'How does financial literacy affect farmers agricultural investments? A study from the perspectives of risk preferences and time preferences', *Applied Economics*, pp. 1–15.

Liu, T., Cao, G., Yan, Y. and Wang, R.Y. (2016) 'Urban land marketization in China: central policy, local initiative, and market mechanism', *Land Use Policy*, **57**, pp. 265–76.

Liu, Y., Huang, J.K. and Zikhali, P. (2014) 'Use of human excreta as manure in rural China', *Journal of Integrative Agriculture*, **13**(2), 434–42.

Magnan, N., Spielman, D.J., Lybbert, T.J. and Gulati, K. (2015) 'Leveling with friends: social networks and Indian farmers demand for a technology with heterogeneous benefits', *Journal of Development Economics*, **116**, pp. 223–51.

Mao, H., Zhou, L., Ying, R.Y. and Pan, D. (2021) 'Time preferences and green agricultural technology adoption: field evidence from rice farmers in China', *Land Use Policy*, **109**, p. 105627.

McManus, P., Walmsley, J., Argent, N., Baum, S., Bourke, L., Martin, J., Pritchard, B. and Sorensen, T. (2012) 'Rural community and rural resilience: what is important to farmers in keeping their country towns alive?', *Journal of Rural Studies*, **28**(1), pp. 20–29.

O'Donoghue, T. and Rabin, M. (1999) 'Doing it now or later', *American Economic Review*, **89**(1), pp. 103–24.

Pun, R., Joshi, N.P. and Pun, S. (2024) 'Factors influencing farmers preference for farmland consolidation in Nepal: evidence from randomized conjoint experiment', *Agricultural Systems*, **219**, p. 104038.

Putnam, R.D. (1993) *Making democracy work: civic traditions in modern Italy*. Princeton, NJ: Princeton University Press.

Putnam, R.D. (2000) *Bowling alone: the collapse and revival of American community*. New York: Simon Schuster.

Qian, L., Lu, H., Gao, Q. and Lu, H. (2022) 'Household-owned farm machinery vs. outsourced machinery services: the impact of agricultural mechanization on the land leasing behavior of relatively large-scale farmers in China', *Land Use Policy*, **115**, p. 106008.

Rogers, E.M., Singhal, A. and Quinlan, M.M. (2008) *Diffusion of innovations, in an integrated approach to communication theory and research*. 2nd edn. London: Routledge.

Senda, T.S., Robinson, L.W., Gachene, C.K.K. and Kironchi, G. (2022) 'Formalization of communal land tenure and expectations for pastoralist livelihoods', *Land Use Policy*, **114**, p. 105961.

Sheridan, A., *et al.* (2023) 'Changing scripts: gender, family farm succession and increasing farm values in Australia', *Journal of Rural Studies*, **100**, p. 103024.

Shiferaw, B.A., Okello, J. and Reddy, R.V. (2009) 'Adoption and adaptation of natural resource management innovations in smallholder agriculture: reflections on key lessons and best practices', *Environment, Development and Sustainability*, **11**(3), pp. 601–19.

Skaalsveen, K., Ingram, J. and Urquhart, J. (2020) 'The role of farmers social networks in the implementation of no-till farming practices', *Agricultural Systems*, **181**, p. 102824.

Thaler, R. (1981) 'Some empirical evidence on dynamic inconsistency', *Economics Letters*, **8**(3), pp. 201–7.

Thaler, R.H. (2016) 'Behavioral economics: past, present, and future', *American Economic Review*, **106**(7), pp. 1577–600.

Wei, S.J. and Zhang, X. (2011) 'The competitive saving motive: evidence from rising sex ratios and savings rates in China', *Journal of Political Economy*, **119**(3), pp. 511–64.

Wheeler, S., Bjornlund, H., Zuo, A. and Edwards , J. (2012) 'Handing down the farm? The increasing uncertainty of irrigated farm succession in Australia', *Journal of Rural Studies*, **28**(3), pp. 266–75.

Wossen, T., Berger, T. and Di Falco, S. (2015) 'Social capital, risk preference and adoption of improved farm land management practices in Ethiopia', *Agricultural Economics*, **46**(1), pp. 81–97.

Xie, J., Yang, G., Wang, G. and He, S. (2024) 'How does social capital affect farmers environment-friendly technology adoption behavior? A case study in Hubei province, China, environment', *Development and Sustainability*, **26**(7), pp. 18361–84.

Zhang, J., Chen, M., Huang, C. and Lai, Z. (2022) 'Labor endowment, cultivated land fragmentation, and ecological farming adoption strategies among farmers in Jiangxi province, China', *Land*, **11**(5), p. 679.

Zhang, Y.J. (2019) 'Culture, institutions and the gender gap in competitive inclination: evidence from the communist experiment in China', *The Economic Journal*, **129**(617), pp. 509–52.

Zheng, X., Wei, L., Lv, W., Zhang, H., Zhang, Y., Zhang, H., Zhang, H., Zhu, Z., Ge, T. and Zhang, W. (2024) 'Long-term bioorganic and organic fertilization improved soil quality and multifunctionality under continuous cropping in watermelon', *Agriculture, Ecosystems & Environment*, **359**, p. 108721.

Zhou, L., Lu, H. and Zou, J. (2023) 'Impact of land property rights security cognition on farmland quality protection: evidence from Chinese farmers', *Land*, **12**(1), p. 188.

Zhou, N., Cheng, W. and Zhang, L. (2022) 'Land rights and investment incentives: evidence from Chinas latest rural land titling program', *Land Use Policy*, **117**, p. 106126.

https://doi.org/10.1017/S1742170524000358 Published online by Cambridge University Press