Mechanism of Chinese farmers' land rental participation: The role of invisible markets and public intervention[☆]

Jian Zhang [a], Ashok K. Mishra [b,*], Xianlei Ma [c]

[a] Research Center for Land Use and Ecological Security Governance in Mining Areas, China University of Mining and Technology, Xuzhou 210095, PR China
[b] Kemper and Ethel Marley Foundation Chair, Morrison School of Agribusiness, W. P. Carey School of Business, Arizona State University, 7271 E Sonoran Arroyo Mall, Mesa, AZ 85212 USA
[c] College of Public Administration, Nanjing Agricultural University, Nanjing 210095, PR China

ABSTRACT

This study focuses on the impact of invisible markets such as price, supply, demand, and public intervention through building intermediary organizations on rural households' decisions to rent in or rent out land, and it compares factors that are critical in the current development of the land rental market. The study uses nationally representative farm and village survey datasets and the Box-Cox double-hurdle model. The study finds that public intervention, represented by intermediary organizations established at the grassroots level, plays a more significant role than invisible markets in improving the probability that farm households rent in or rent out land and increasing the amount of land rented. The intermediary organizations have increased the share of land area transferred to the total area at the village level. However, the price mechanisms, represented by the village-level land transfer rate and the village's average land rent, failed to guide the flow of land resources. We put forward policy implications for how public institutions and market intermediaries can promote China's land rental markets and how to perform price mechanisms more effectively.

1. Introduction

Land rental markets are vital for agricultural development, predominantly in Asian countries with small areas of arable land and large populations (Otsuka, 2007). A well-functioning land rental market (LRM) has proven to effectively optimize the allocation of rural production factors, improve farmers' welfare and reduce rural inequality (Deininger and Jin, 2005; Deininger, Jin, and Nagarajan, 2008; Zhang et al., 2020). Due to the importance of LRM, the influencing factors on LRM development, as well as its significance in terms of equality and efficiency in some Asian and African countries, have been widely studied

(Deininger and Jin, 2005; Feng, 2006; Deininger, Ali and Alemu, 2013; Chamberlin and Ricker-Gilbert, 2016; Ayala-Cantu and Morando, 2020). The land rental market in China has developed slowly under the long-term planned economic system and the administrative allocation of resources and factors (Deininger and Jin, 2005). According to the Ministry of Agriculture, the land area leased by farmers accounted for only about 2.9 percent of the total area of contracted land[1] in the 1990s (Chen and Zhai, 2015). However, recent statistics show that the percentage of the land area rented as a share of the total contracted land area increased from 15 percent to 37 percent from 2010 to 2017. The share of farmers renting out land rose from 15 percent to 31 percent of the total

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* Corresponding author.
 E-mail addresses: zhangjian89@cumt.edu.cn (J. Zhang), Ashok.k.Mishra@asu.edu (A.K. Mishra), maxianlei@njau.edu.cn (X. Ma).
 [1] In China, rural land is collectively owned, and farmers can contract land from the collective for free and have the contract management right. Farmers could not transfer the management rights legally until the 1988 Constitution of the People's Republic of China was promulgated.

contracted rural households (Committee of China Agriculture Yearbook, 2010 and 2017). Recently, the importance of China's labor migration and land tenure reform in developing its land rental market has been emphasized. With China's non-farm economy booming, more family members move from the agricultural sector for off-farm employment. As a result, those families need to rent out farmland because of labor shortage (Huang, Gao, and Rozelle, 2012; Ji et al., 2018). Meanwhile, farm households stranded in the agricultural sector can rent in farmland to expand farm size. The Chinese government has taken a series of land tenure reforms[2] to improve its tenure security and significantly stimulate its land rental market and labor market (Ma et al., 2015; Wang et al., 2015; Zhang et al., 2022).

Like Adam Smith's invisible hand, the invisible market has played a significant part in promoting farm households' decision to participate in the land rental market. The invisible market is essential in providing transaction information, guiding the flow of resources, and determining the best price and quantity. The invisible market mechanisms include the price and the supply-and-demand mechanisms. In theory, invisible market mechanisms bring a free market to equilibrium with levels of supply and demand by the actions of self-interested individuals. However, there are transaction costs in defining, enforcing, and trading property rights (Coase, 1960), which may hinder the invisible market's function. Market failure is a severe problem in rural China. China's land rental market faces high transaction costs, including information costs, the costs of negotiating with partners and signing contracts, and the costs of enforcing contracts. Insecure property rights, small farming systems, and land fragmentation put pressure on transaction costs upward (Kimura et al., 2011; Alene et al., 2008). Transaction costs in the land rental market may cause market failure and reduce market efficiency. In other words, because of transaction costs, the rental price is higher for farmers renting-in farmland than the price received by renting-out families—essentially excluding many potential traders from the land rental market (Ricker-Gilbert and Chamberlin, 2018). Therefore, the price and supply-and-demand mechanisms may not perform well in promoting farmers' participation in the land rental market.

Public intervention through establishing intermediary organizations (IOs) from local governments and village collectives has been implemented in China to compensate for market failure (Tang et al., 2019). The intermediary organizations generally include rural cooperatives, land transfer service centers or platforms, and liaison officers (Ito et al., 2016; Liu et al., 2016; Huang and Ding, 2016). The organizations collect land rental information and organize households to rent out land in a unified manner through collective action, thereby avoiding the transaction costs of searching and negotiating between the transferor and many small farmers (Liu et al., 2016). However, the intermediary organizations are not purely market institutions. Local governments or village collectives lead[3] and regulate rural households' land rental activities. The local government has the power and the incentives to control farmland transfers for its benefit because the farmland transfer regulation provides rent-seeking opportunities (Tao and Xu, 2007). Township officials and village cadres who provide land transfer services can charge management fees to the renting-in farmers[4]. They can obtain the rent of the newly added cultivated land through land consolidation[5]. This regulation may negatively affect rural households' land rental participation (Shi et al., 2018). Intermediary organizations may reduce transaction costs and accelerate land rental activities but may also distort the functioning of invisible market mechanisms, such as price and supply-and-demand. Although many studies noticed the intermediary organizations' impact on farm households' land rental activities, none discussed how the organizations impact the invisible market and whether the invisible market or the organization is more effective in promoting farm households' participation in land rental activities.

Therefore, using China's land rental market as an example, this study assesses the factors affecting farmers' participation in land rental activities and quantifies the effects of the invisible market and the intermediary organizations. The study also discusses the impact of intermediary organizations on the invisible market.

This study contributes to current literature in the following ways. First, most studies focus only on the role of the invisible market or only on the role of intermediary organizations in promoting rural households' land rental participation. This study examines the invisible market in local government or village collectives that have a decisive intervention in the land rental market. Second, this study enriches the market theory research by illustrating which intermediary organizations and invisible markets are more effective in facilitating rural households' participation in the land rental market. Third, village-level indicators, including average land rent, land area transferred as a proportion of total area, and whether there is an intermediary organization at the village level, were selected to represent market price, competitiveness, and public intervention. To our knowledge, this is one of the few studies attempting to quantify public intervention in the development of the land rental market (Huang and Ding, 2016; Shi et al., 2018; Tang et al., 2019), and no other article considers both indicators for the invisible market.

This paper is arranged as follows. The second part introduces the invisible market and the public intervention characteristics of China's land rental market development and then constructs a theoretical model for farmers' land rental decisions. The third part is the econometric model, the fourth part introduces the data and description, and the fifth part contains the results and analysis. We conclude in the sixth part.

2. Literature review

Due to its importance in agricultural production and rural development, the influences of land rental market development, as well as its economic impact, have been widely studied, especially in developing countries with a transition economy, such as China, Vietnam, India, and some African countries (Deininger and Jin, 2005; Feng, 2006; Awasthi, 2009; Deininger et al., 2013; Chamberlin and Ricker-Gilbert, 2016; Ayala-Cantu and Morando, 2020). Despite the vast different social-economic and institutional contexts, one can roughly draw the same conclusions from the literature. The land rental market can realize allocation efficiency, improve agricultural productivity and smallholder households' income, and reduce poverty (Carter and Yao, 2002;

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[2] These reforms include improving the transferability of rural land, extending farmers' land-use rights, restricting land reallocations, and issuing farm households' land certificates (Ma et al., 2015).

[3] In China, rural land is owned by village collectives, and farmers just have land use rights. The village collective is positioned as a grassroots autonomous organization. However, because the township government has great power in appointing village cadres and the finance is responsible for the salaries of the main village cadres, the village collective is more like the local government's policy executor at the grassroots level.

[4] The Administrative Measures for the Transfer of Rural Land Management Rights to be Implemented in 2021 stipulates that rural collective economic organizations that provide services for industrial and commercial enterprises to the transfer land management rights may charge an appropriate amount of management fees.

[5] In a case study from S county of Jiangsu Province, Zhang et al. (2017) found that the area of arable land leased to renting-in households through government intermediary organizations is 5 percent more than the rental area obtained by small farmers. There are ditches and ramps among the small and scattered farmland, the intermediary organization will obtain the extra arable land after leveling the ditches and ramps.

Deininger and Jin, 2005; Feng et al., 2010; Chamberlin and Ricker-Gilbert, 2016). Specifically, small farmers' participation decisions in the land renting-in or renting-out market are driven by a series of socio-economic factors such as land endowment, labor migration, productive assets, and other family characteristics (Jin and Deininger, 2009; Rahman, 2010; Zhang et al., 2021).

However, the land rental markets in developing countries face institutional constraints such as an unsecured property rights system, imperfect labor and credit markets, and legal restrictions (Jin and Deininger, 2009; Awasthi, 2009), which raises transaction costs and hinders farm households' land rental participation (Carter and Yao, 2002; Feng et al., 2010). For example, in Ethiopia, Holden et al. (2011) found that a low-cost land certification program had a relatively larger effect on women's participation in rental markets. In Dominican Republic, Macours et al. (2010) found that insecure property rights led to matching in the tenancy market along socio-economic lines, severely limiting the size of the rental market. The imperfect labor market in developing countries hinders farmers' labor migration and specialization and further limits the supply and demand of the land rental market (Deininger and Jin, 2005; Feng et al., 2010). In China, Li et al. (2020) find that farmers' access to credit can promote the adoption of yield-increasing technologies and investments in farm and non-farm businesses, thus further stimulating the demand and supply of the land rental market.

Due to its efficiency and equality, many countries take positive measures to encourage the development of the land rental market. However, some legal restrictions may harm farmers' land rental participation. For example, the Indian government has taken a series of land reform policies to regulate the market, such as the abolition of intermediaries, imposition of land ceilings, and regulation of tenancy contracts. These rental restrictions have limited the level of market activity and the ability of the most productive producers to access more land, thus reducing overall welfare (Deininger et al., 2008). In Northern Ethiopia, the government introduced a rental restriction policy—only 50% of farmland could be rented out—that had an adverse impact on weak and vulnerable households (often female-headed) that were unable to farm their land themselves and therefore rent it out (Holden and Ghebru, 2016).

China's rural property rights and the land tenure system have been insecure since the nation implemented the Household Responsibility System. The property rights system is the basis for market development and optimal allocation of resources (Coase, 1960). Under this system, village collectives owned the land, and farmers were allocated certain farmland areas and received land use rights according to egalitarian principles. Villages frequently reallocate land according to demographic changes. Under the insecure land tenure system, China's land rental market developed slowly, and farmers seldom participated in land rental activities. Rapid industrialization and urbanization have incentivized many rural Chinese workers to seek off-farm employment (Zhao, 2002). As a result, rural Chinese families face shortages of agricultural laborers and thus increased pressure on land transfers (renting out).

However, China's insecure land tenure system may prevent them from renting out farmland formally because it signals that they no longer need it. Village collectives may reclaim the farmland from them and redistribute it among the remaining needy rural families. Therefore, migration families where one or more family members migrate tend to rent out farmland to relatives or neighbors in villages privately (Chen et al., 2017; Tang et al., 2019). Literature shows migration families are less likely to rent-in farmland (Huang et al., 2012). In the millennium, China issued a series of laws to improve the land property rights system, such as the revised Land Administration Law[6] of 1998, the Rural Land Contract Law of 2002, and the Property Law of 2007. The 1998 revision of the Land Administration Law extended land use rights to 30 years,

and land certificates were issued to protect farmers' land use rights (Ma et al., 2015).

The Property Law strengthens the protection of land property rights. After a series of land tenure reforms, China established a more transparent system of rural land property rights, laying the foundation for the development of the land rental market. For the first time, the Rural Land Contract Law legally prohibits land reallocation according to demographic changes and limits land reallocation in cases such as natural disasters, land expropriation, or other exceptional circumstances (Ma et al., 2015). In 2016, the State Council promulgated the "Opinions on the Separation of Rural Land Ownership, Contracting Right and Management Right,"[7] which further divided rural land property rights into contracting and management rights and implemented the separation of ownership, contract rights, and management rights (Rada et al., 2015).

A large amount of literature discusses the main factors for China's accelerating rate of land transfers. Some attribute it to farm households' motivation to optimize resource allocation and expand farm scale (Deininger and Jin, 2005; Huang et al., 2012; Ji et al., 2018; Zhang et al., 2020; Zhang et al., 2021). Other households are motivated because laborers migrate to urban areas or take off-farm employment. Several studies found that labor migration has prompted the emergence of the land rental market, increasing the probability of renting out and the amount of area rented out (Kung, 2002; Huang et al., 2012; Ji et al., 2018). Rural households renting-out farmland due to labor shortage charge lower rents or zero rent (Chen et al., 2017). Meanwhile, households in rural areas can rent-in farmland and expand their farm size. Farm households with greater agricultural ability tend to rent-in farmland to realize agricultural specialization (Deininger and Jin, 2005). Recently, the importance of China's land tenure reform in developing its land rental market has been emphasized by Ma et al. (2015), Wang et al. (2015), and Zhang et al. (2022). Ma et al. (2015) reviewed a series of land tenure reforms enacted by the Chinese government. These reforms include improved tenure security, transferability of rural land, extending farmers' land-use rights, restricting land reallocations, and issuing farm households' land certificates. Wang et al. (2015) compared two kinds of land tenure forms issued to farmers to document their land-use rights. They found that land-use contract rights and certificates increased the probability that households would rent out land to non-relatives rather than relatives. Zhang et al. (2022) found that the new round of the Land Certificate Program initiated by China's central government in 2011 has significantly improved the probability of farmers renting in land and the amount of land rented.

China's land rental market consists of renting-in parties, renting-out parties, and many intermediary organizations (Ma et al., 2015). The renting-out parties are many small farmers with land management rights. In contrast, the transfer-in parties may be small farmers or new business entities such as family farms, cooperatives, and agricultural enterprises (Huang and Ding, 2016). Land rental activities between relatives and acquaintances have the characteristics of a few participating farmers and a small transfer scale. The transaction parties rarely charge rent[8] and rarely sign contracts (Chen et al., 2017; Tang et al., 2019). However, the large-scale land rental activities between new agricultural business entities and small farm households usually require the participation of intermediary organizations. The local government supports the development of large farms and agricultural enterprises by providing intermediary organization services for the land rental market.

In microeconomic theory, market supply, demand, and prices are

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[6] The Land Administration Law was first issued in 1986.

[7] The contracting right is a broad land use right including possession, use, and partial disposal rights. Management rights are attached to the contracting right, which is the right to use and transfer.

[8] Chen et al. (2017) found that the renting-in households usually repay the renting-out households with agricultural products, gifts on festivals, taking care of the elderly and the weak, and production assistance, even though the rent is zero.

important factors that reflect the law of market equilibrium. However, China's rural land rental market faces an unbalanced supply and demand. The average contracted land area per household is only about 0.6 ha, and plots may be scattered in several locations (Huang and Ding, 2016; Wan and Cheng, 2001). Therefore, to rent in a certain amount of land and achieve scale management, it is necessary to trade with many small farm holders, which raises the search and negotiation costs of those wanting to rent in the land (Kimura et al., 2011). Meanwhile, the insecurity of the land tenure system hinders renting-out households more than it hinders renting-in households. For fear of losing their land, farmers often choose to farm their land or transfer it to acquaintances for farming rather than transfer it to big family farms. Through a sample survey of rural households in six provinces in the middle of China, Cao et al. (2007) found that farmers' willingness to rent out land — the supply side — is lower than farmers' willingness to rent in the land — the demand side. Therefore, for China's land rental market, the demand side of the market is more competitive than the supply side, which means rural households must pay a monopoly rent higher than the market average to rent in farmland.

The low land rental rate reflects the informality of China's land rental market and fails to guide the supply and demand sides of the market. In a perfectly competitive land rental market, rental prices are determined by demand and supply and represent the actual value of land (Tang et al., 2019; Lin and Huang, 2021). However, evidence shows that China's land rental prices are lower than the actual value of the land. According to Qian and Ji (2016), a survey in four provinces of Jiangsu, Guangxi, Hubei, and Heilongjiang in 2013, >30 percent of the land rental activities were unpaid. Lower or unpaid land rents frequently occur among relatives, who make up for the lower rent by providing the renting-in households with holiday gifts, care for the weak or elderly, or production assistance (Tang et al., 2019; Ayala-Cantu and Morando, 2020).

Based on a survey of farmers in two cities in Jiangsu Province, Tang et al. (2019) found that the average rental prices for renting-out and renting-in households were much lower between relatives or familiar villagers than the average rental prices between other partners. When the invisible market mechanism cannot play an influential role, public interventions from local governments or village collectives have been imposed on the land rental market. One necessary means is establishing intermediary organizations (Tang et al., 2019). Such organizations include rural cooperatives, land transfer service centers or platforms, and liaison officers[9] (Ito et al., 2016; Liu et al., 2016; Huang and Ding, 2016). The intermediary organizations are responsible for the following land transaction matters (see Fig. 1):

Pooling transaction information. The organizations are responsible for searching for potential traders willing to rent in farmland and knowing their requirements, such as land rental scale, rent payment ability, and transaction terms. The organizations then will search for small farmers in villages willing to rent out land, negotiating with them about the land area and rent they can accept.

Organizing land rental activity. According to the rules of villager autonomy, when most farmers (usually two-thirds of the villagers' representatives) agree to participate in the transfer of land to large farms, the intermediary organizations will contact both parties to negotiate transactions on specific land. The organizations will consult on transfer matters, such as land rental price, terms, payment methods, land use patterns, etc. In this process, small farmers may not sign contracts directly with large farms but use intermediary organizations as principals to sign contracts.[10]

Standardizing the land rental process. To reduce the ex-post risk of contract enforcement, the intermediary organizations also provide a formal contract for land rental activities and require that the transactions be registered with local government authorities. The organizations also will mediate contract disputes.

Although the intermediary organizations significantly reduce transaction costs and promote land rental market development, they also may distort the markets or increase transaction costs. First, the organizations may crowd out other market institutions. Second, the organizations need to approve farmers' land rental activities to ensure that farmers' behavior in renting out land meets specific requirements, such as the usage of the transferred farmland[11], the identity of renting-in households[12], and the normative of contract.[13] The heads of rural cooperatives and liaison officers are usually village cadres, and they can get bonuses and services fees[14] for organizing land transfers (Chen, 2015). Therefore, they have incentives to act as a monopolistic intermediary in the land rental market.

3. Theory and model specification

3.1. A decision model of farmers' land rental decision

Farmers in our study refer to farm households that still live in rural areas,[15] although most of them may do off-farm jobs or some of the members migrate to urban areas. Therefore, let us assume that the family laborers L allocate their labor time L_a to agricultural production and L_o to off-farm employment and leisure l. The market labor wage is represented by w. Assume that the family owns and operates T amount of farmland. Household characteristics, market access, labor migration, and location variables are included in the Z vector. Farmers purchase production materials with their own money (K). With the development of the rural land rental market, rural households may choose to rent in or rent out the farmland. Assume that the actual land area operated by rural households is T^a. The area rented-in land for rural households is $T^{in} = T^a - T$, and the area rented-out land for rural households is $T^{out} = T - T^a$. Following Carter and Yao (2002) and Feng (2006), land rental market is incomplete, and rural households participating in the market face transaction costs.[16] Assume that rural households will face C^{in} increment of transaction cost when renting in an additional unit of farmland and that the transaction cost of renting out additional land is C^{out}. A rational farm household chooses L^a, L^o, l, T^{in} and T^{out} to maximize

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[9] There are usually two levels of intermediary organizations. At the village level, many rural cooperatives or liaison officers have been established by village collectives, which are responsible for land transfer organizer. At the township and county level, land transfer service centers or platforms established by local government provide trading services for land rental activities. However, it generally provides services for large-scale transactions after the concentration of land transfer. Therefore, it includes two stages with the intermediary organizations' intervention: First, farmland transfer is centralized by the rural cooperatives or liaison officers, and second, it will be traded on the platform after land is concentrated.

[10] According to Measures for the Administration of the Transfer of Rural Land Contract Management Rights issued by the Ministry of Agriculture, farmers can entrust the village-level intermediary organizations to transfer the land and sign the rental contract.

[11] For example, the transferred land is not allowed to be converted into construction land (Shi et al., 2018).

[12] Local governments have strict restrictions on the transfer of land from small farmers to urban residents or entrepreneurs.

[13] The revised Rural Land Contract Law in 2018 stipulates that those participating in land rental activity shall sign a formal written contract.

[14] The bonus usually comes from local governments that had financial funds for those villages with high land rental rates and scale management levels. Some village committees also can charge a certain service fee from large farms for which they provided services.

[15] Previously, when the whole rural family has moved to the urban areas, they may have completely withdrawn from the farmland according to policies.

[16] In China's land rental market, land fragmentation and the insecure property rights may cause high transaction costs and impede the automatic formation of a perfectly competitive market (Kimura et al., 2011; Wan and Cheng, 2001).
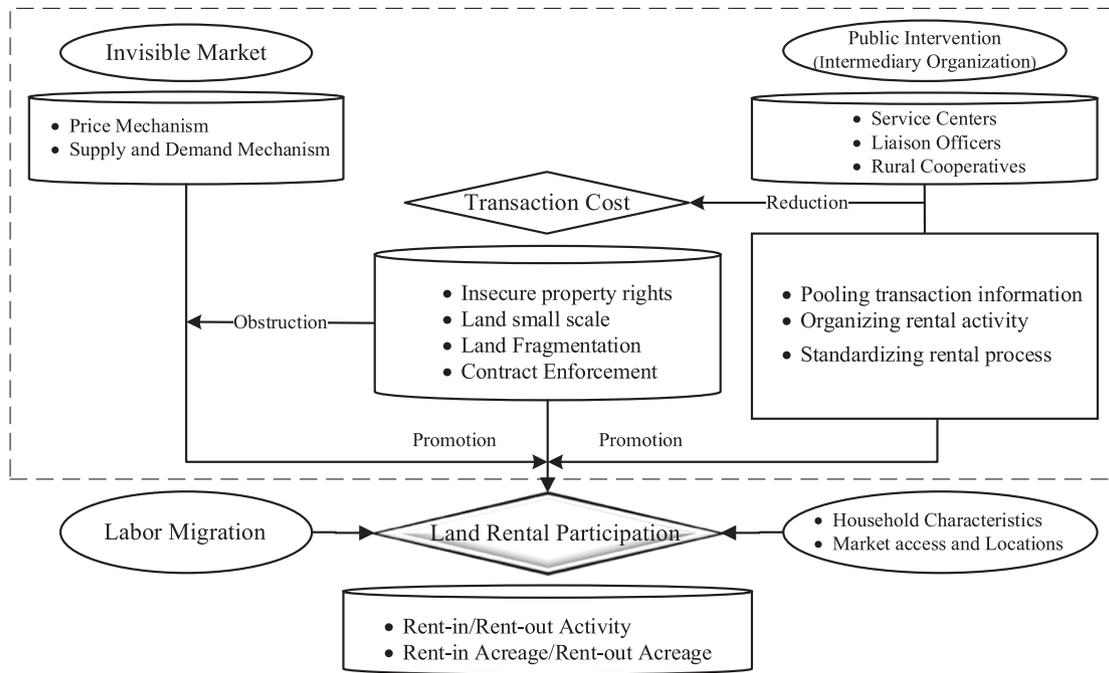
Fig. 1. . Invisible Market, government intervention and land rental participation.

utility:

$$Max_{L^a,L^o,l,T^{in},T^{out}} U(y,l,Z) \qquad (1)$$

Subject to:

$$y = f(L^a, T^a, K) + wL^o - T^{in}(r + C^{in}) + T^{out}(r - C^{out}) \qquad (2)$$

$$L^a + L^o + l = L \qquad (3)$$

$$T^a + T^{in} - T^{out} = T \qquad (4)$$

where y is the household income. $f(L^a, T^a, K)$ is agricultural production function which is defined as with some criteria that $f_L^a > 0, f_T^a > 0$ $f_{T^a} > 0$, $f_{LL}^a < 0, f_{TT}^a < 0$, and $f_{LT}^a > 0$. The average price of aggregated agricultural products is set to one. r is the market land rental rate. The land rent and labor wage are assumed to be the same for all households in a competitive market environment (Feng et al., 2010). Inserting (4) and (2) to (1), this model yields the following first-order conditions:

$$f_T = r + C^{in} \qquad (5)$$

$$f_T = r - C^{out} \qquad (6)$$

If rural households choose to rent out farmland, then:

$$f_T \leqslant r - C^{out} \qquad (7)$$

If rural households choose to rent in farmland, then:

$$f_T \geqslant r + C^{in} \qquad (8)$$

For rural households that did not participate in land rental activities, then:

$$r - C^{out} < f_T < r + C^{in} \qquad (9)$$

The above formula means that the high transaction cost in land demand side (which means a high C^{in}) makes renting-in parties to pay additional land rent that is above market rental rate r. In contrast, the high transaction cost in land supply side (which means a high C^{out}) ensures that the land rent received by the renting-out parties is lower than the equilibrium market rent. Thus, discouraging farmers from participating in land rental market (a low r-C^{out} but high $r + C^{in}$). In other

words, lowering the probability of farm households' participation in land renting-in and renting-out farmland (Carter and Yao, 2002). The transaction costs will decrease with the development of the land rental market. The price, supply-and-demand mechanisms, and public intervention will influence farm households' land rental participation through changes in the transaction costs.

A competitive market with enough supply and demand is supposed to reduce transaction costs and promote land rental participation. However, the low land rental rate under China's informal land rental market may deviate from the equilibrium land rent r under perfect market and fail to guide the flow of land use rights. Public intervention may have two but opposite effects on farm households' land rental decision. On the one hand, public intervention may reduce the transaction costs (C^{out} and C^{in}) for both land supply and land demand sides, thus promoting farm households' participation in land rental market. On the other hand, public intervention may crow out other parties and intermediaries in the land rental market, lowering the equilibrium market rental rate (r). Thus, excluding the potential participation of households in the land rental market. According to our observations, the positive effect of public intervention on land rental market dominates in China because China's land rental market is still underdeveloped with too much informal land transactions between acquaintances and relatives (Chen et al., 2017; Tang et al., 2019). The competition in the land rental market is slightly insufficient because of the lack of market intermediaries (Cao et al., 2007).

3.2. Model specification

In our conceptual framework, small farm households first decide whether to participate in the land rental activity and then choose the amount of land to rent in or rent out. The two-stage feature of land rental participation results in the observed land renting area being censored at zero, leading to bias and inconsistent estimates with the inappropriate treatment of zero observations (Amemiya, 1984). Several studies adopted the ordered probit or ordered tobit model for this two-stage problem, treating market participation and volume as sequential choices. For example, Jin and Deininger (2009) adopted the ordered probit model to investigate the influencing factors affecting farm households' land rental participation by setting land rental participation

as sequential variables (renting-out, autarkic, renting-in). Bellemare and Barrett (2006) studied the market participation of farmers in Kenya and Ethiopia in the livestock markets by using an ordered tobit model that consists of an ordered probit for classifying households into net buyers, autarkic, or net sellers and then regressions to estimate quantity bought or sold. Other studies adopted a double-hurdle model for this two-stage problem, treating land rental market participation as the first stage and transaction quantity as the second stage (Yan and Huo, 2016; Li et al., 2020).

In our case, we want to prove that the market mechanisms and public intervention variables impact farm households' renting-in and renting-out decisions. It is not a sequential order from renting out to autarkic to renting-in. Therefore, in this study, we use a double-hurdle estimation technique. The advantage of the double-hurdle model is that it relaxes the assumption that the determinants of participation (whether to participate in land rental activities) are the same as the determinants of the transaction amount (the amount of land rented in or rented out) (Jones and Yen, 2000; Bai et al., 2010). It, therefore, provides a valuable method for estimating the separate effects of variables on land rental participation and intensity.

However, the error terms of the participation equation and the transaction amount equation are assumed to be normally distributed, which may be costly when the data does not fit, resulting in inconsistent estimation. Therefore, Yen (1993) and Jones and Yen (2000) suggested adopting the Box-Cox double-hurdle model, transforming the dependent variable. The Box-Cox double-hurdle model has been applied in loan defaults, food consumption, and wildlife valuations (Jones and Yen, 2000; Bai et al., 2010; Martinez-Espineira, 2006). In the double-hurdle model, whether farm households participate in land renting-in or renting-out activities can be treated as a latent variable. The participation decision of a household to participate in land rental activities can therefore be modeled as follows:

$$R_i^{in} = \begin{cases} 1 & if\ f_T \geqslant r\ +\ C^{in} \\ 0 & if\ r\ -\ C^{out} \leqslant f_T \leqslant r\ +\ C^{in} \end{cases} \tag{10}$$

$$R_i^{out} = \begin{cases} 1 & if\ f_T \leqslant r - C^{out} \\ 0 & if\ r\ -\ C^{out} \leqslant f_T \leqslant r\ +\ C^{in} \end{cases} \tag{11}$$

$$\Pr(R_i^{in} = 1) = \begin{cases} Pr(f_T(L^a, T^a, K) \geq r + C^{in}) \\ Pr(Q^{in}(p, K, L^a, T^a, r, C^{in}, Z) > 0) \\ Pr(\alpha_1^{'} X_i > -u_{1i}; u_{1i} \sim N(0,1)) \end{cases} \tag{12}$$

$$\Pr(R_i^{out} = 1) = \begin{cases} f_T(L^a, T^a, K) \leq r - C^{out} \\ Pr(Q^{out}(p, K, L^a, T^a, r, C^{out}, Z) > 0) \\ Pr(\alpha_2^{'} X_i > -u_{2i}; u_{2i} \sim N(0,1)) \end{cases} \tag{13}$$

where the probability of a farm household renting in farmland $Pr(R_i^{in} = 1)$ is assumed to depend on L^a (labor input in farm production), T^a (land input in farm production), K (capital input in farm production), r (market land rent), C^{in} (transaction cost for renting-in households), and Z (household characteristics, market access, labor migration, and location). The probability of a farm household renting out farmland $Pr(R_i^{out} = 1)$ is assumed to depend on L^a, T^a, K, C^{out} (transaction cost for renting-out families) and Z. Q^{in} is the amount of land rented in, and Q^{out} is the amount of land rented out. X_i is a column vector of variables that affect rural households' land rental participation, including the invisible market (price, market supply and demand) and intermediary organization variables; household land, labor, and capital characteristics; village-level variables; and regional dummies (See Table 1). $\alpha_1^{'}$ or $\alpha_2^{'}$ is a row vector of parameters, u_{1i} or u_{2i} is the error term of the LRM participation decision.

In the second stage, farm households' decisions on the amount of land rented in or rented out can be treated as a latent variable, which may be observed when a farm household participates in land rental

Table 1
. Variable definition and summary statistics, China.

Variable	Description	Mean	Standard Deviation
Dependent variable			
Land renting-in	= 1 if rural households rented-in land; 0 otherwise	0.14	0.347
Land renting-out	= 1 if rural households rented-out land, 0 otherwise	0.19	0.393
Land renting-in area [1]	Land area rented in by rural households, *hectare*	1.14	2.212
Land renting-out area [2]	Land area rented out by rural households, *hectare*	0.34	0.511
Explanatory variable			
Owned farmland	Family-owned farmland area, *hectare*	0.59	0.753
Age, household head (HH)	Age of operator, *years*	57	11.72
Gender, HH	= 1 if HH male, 0 otherwise	0.91	0.286
Education, junior high school or more, HH	= 1 if HH has junior high school or higher education; 0 otherwise	0.47	0.499
Worker number	Number of members between 18 and 60 in the household, *numbers*	2.0	1.451
Average age, family labor [3]	Average age of members, 18 and 60 *years*	43	7.338
Average education, family worker [3]	Average years of schooling received by family laborers	8.4	2.314
Agricultural machinery asset value	Total value of agricultural machinery such as tractors, planters, and harvesters owned by the family, *yuan*	3,928	18,697
Migration share	The share of migrant workers divided by total population in the village	0.221	0.167
Per capita income	Annual disposable income per capita in the village, *yuan*	7,754	5,095
Land certificate	= 1 if the village where households located has conducted the registration of rural land rights confirmation and certification; 0 otherwise	0.91	0.285
Distance to farmer's market	The distance between the village and the nearest farmer's market (*kilometers*)	5.41	7.411
Market variables			
Land rent	The average land rent at the village level (*yuan/hectare*)	9,570	31,276
Land transfer rate	The share of the village's land renting area to total cultivated land area in the village, %	0.24	0.233
Intermediary organization [4]	Dummy, = 1 if local governments or village collectives provide land renting organization services through rural cooperatives, service centers or platforms and liaison officers	0.32	0.467

Note: [1] Only 793 rural households rented-in farmland. [2] Only 1,083 rural households rented-out farmland. [3] Only 3,379 rural households with workers between 18 and 60. [4] If farm households surveyed in villages reported participating in land rental market through rural cooperatives, service centers or platforms and liaison officers, we think that there are intermediary organizations in the village.

activities. The latent variable amount of farmland rented in ($Q^{in\,*}_i$) or rented out (Q^{out*}_i) and the observed amount of farmland rented in (Q_i^{in}) or rented out (Q_i^{out}) can be specified as:

$$Q_i^{in*} = Q(K, L^a, T^a, r, C^{in}, Z) + e_{1i}$$
$$= \beta_1^{'} Z_i + e_{1i}; e_{1i}\ N(0, \sigma_e^2) \tag{14}$$

$$Q_i^{out*} = Q(K, L^a, T^a, r, C^{out}, Z) + e_{2i}$$
$$= \beta_2^{'} Z_i + e_{2i}; e_{2i}\ N(0, \sigma_e^2) \tag{15}$$

$$Q^{in}_{\ i} = \{ \begin{array}{l} Q_i^{in*} \ if R^{in}_{\ i} = 1 \\ 0 \ if R^{in}_{\ i} = 0 \end{array} \text{ and } Q^{out}_{\ i} = \{ \begin{array}{l} Q_i^{out*} \ if R^{out}_{\ i} = 1 \\ 0 \ if R^{out}_{\ i} = 0 \end{array} \qquad (16)$$

where β'_1 or β'_2 is a row vector of parameters; e_{1i} or e_{2i} is an error term; and Z_i is a vector of variables affecting the amount of land rented, which can be the same as or different from X_i in Eq. (12) and Eq. (13) in the double-hurdle approach. Here the same variables are chosen in the land rental participation equation and the amount of land renting equation, similar to other studies (Deininger and Jin, 2005; Yan and Huo, 2016).

Now introduce the Box-Cox transformation on the observed dependent variable Q_i^{in} and Q_i^{out}, which gives

$$Q_i^{inT} = (Q_i^{in\lambda} - 1)/\lambda \text{ and } Q_i^{outT} = (Q_i^{out\lambda} - 1)/\lambda \ \ 0 < \lambda \leqslant 1 \qquad (17)$$

when $\lambda = 0$ and $\lambda = 1$ the Box-Cox transformations is a special case of logarithmic transformation and linear transformation separately. After the Box-Cox transformation, the observed Q_i^{inT} and Q_i^{outT} can be expressed as:

$$Q_i^{inT} = \{ \begin{array}{l} Q_i^{in*T} \ \text{if } R_i^{in} = 1 \\ -\dfrac{1}{\lambda} \ \text{if } R_i^{in} = 0 \end{array} \text{ and } Q_i^{outT} = \{ \begin{array}{l} Q_i^{out*T} \ \text{if } R_i^{out} = 1 \\ -\dfrac{1}{\lambda} \ \text{if } R_i^{out} = 0 \end{array} \qquad (18)$$

The log-likelihood function for the Box-Cox double hurdle model (Moffatt, 2005; Martinez-Espineira, 2006) is as follows:

$$LogL^{in} = \sum_0 Ln[1$$
$$- \Phi(X_i'\alpha)\Phi(\frac{Z_i'\beta + 1/\lambda}{\sigma})] + \sum_+ Ln[\Phi(X_i'\alpha)Q_i^{in(\lambda-1)}\frac{1}{\sigma}\phi(\frac{Q_i^{inT} - Z_i'\beta}{\sigma})]$$
$$(19)$$

$$LogL^{out} = \sum_0 Ln[1$$
$$- \Phi(X_i'\alpha)\Phi(\frac{Z_i'\beta + 1/\lambda}{\sigma})] + \sum_+ Ln[\Phi(X_i'\alpha)Q_i^{out(\lambda-1)}\frac{1}{\sigma}\phi(\frac{Q_i^{outT} - Z_i'\beta}{\sigma})]$$
$$(20)$$

where '0' indicates summation over the zero observations in the sample, while '+' indicates summation over positive observations (Moffatt, 2005). Finally, $\phi(\cdot)$ and $\Phi(\cdot)$ are the univariate standard normal density and distribution functions, respectively.

3.3. Identification issues

Potential endogenous problems are caused by omitted explanatory variables and simultaneity in the estimation. The omitted variable bias may be that the intermediary organization variable is likely correlated with an unobservable variable and is also associated with households' farmland rental decisions. For example, some economically developed villages with rapid labor migration may promote farm households' participation in the farmland rental market and are more likely to establish intermediary organizations. This endogenous problem may cause an upward bias in interpreting results by intermediary organizations. The simultaneity problem may be that farm households' decision to participate in the farmland rental market may also impact the market price, supply, and demand of land. When we use the cross-sectional data, farm households may participate in the land rental market before the study period (when the data was collected).[17] The reverse causality can cause potential simultaneity problems, and the maximum likelihood estimates described in Eq. (19) and Eq. (20) are biased and inconsistent.

To solve the endogenous problem caused by omitted explanatory

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variable, we add the village-level variables, such as the per capita income of the village and the labor migration rate of the village. To solve or reduce the endogenous problem caused by simultaneity, we take the following two measures in the robustness check. First, the two market mechanism variables representing market price and supply-and-demand, land rent and land transfer rate, are modeled with instruments. In detail, in the first stage (see Appendix Ta.ble A2), we model the two market mechanism variables, generate the predicted values, and then incorporate the predicted values into the Box-Cox double-hurdle model (see Table 5 and 6). Second, the price, supply-and-demand mechanisms, and public intervention variables are replaced with the earlier (2015) survey data.[18] The sample of rural households participating in the land rental market after 2015 was selected and estimated separately, hoping to reduce the reverse impact of land rental participation on the market (see Tables 5 and 6). To ensure robustness and consistency, results from the Logit-Tobit, and double-hurdle models are also reported and discussed (see Tables 7 and 8).

4. Data and description

The data used in this study comes from the Chinese Family Database (CFD) of Zhejiang University and the China Household Finance Survey (CHFS) of the China Family Finance Survey and Research Center of the Southwestern University of Finance and Economics implemented in 2017. To obtain the random and representative sample, the overall sampling plan and the end sampling plan have been adopted in the sampling design. The stratified, three-stage, proportional-to-the-population-size (PPS) sampling design method was finally adopted in the overall sampling plan. The end sampling adopts "residential distribution geographic information" to establish a sampling frame to conduct equidistant sampling (Zhejiang University China Rural Family Research and Innovation Team, 2018). The database contains information on the basic characteristics of Chinese households, production and operation, credit behavior, land rental activities and utilization, income and expenditure, and assets and liabilities. The database contains 12,732 rural households with 45,067 members living in rural areas in 29 provinces (cities, districts) across the country and an urban sample of 15,247 households with 49,880 members. This dataset is representative at the provincial and municipality levels and at the rural and urban levels. The dataset also contains family survey data and village survey data.

The data used in this study are mainly the 2017 rural survey data, including family and village survey data. We use the 2015 rural survey to generate the price, supply-and-demand mechanisms, and public intervention variables in the robustness test part. Even though we have 12,732 households living in 608 rural communities, only 366 of those rural communities reported that they had agricultural land resources in the villages, and 8,270 farm households were obtained by matching the village survey dataset with the household survey dataset. After that, 1,845 rural households reported that they had not received cultivated farmland from the village collectives were deleted. Finally, 5,680 valid samples were obtained after missing variables, outliers, and sample data that were both renting in and renting out land were deleted[19]. Of this sample, 793 were households renting in the land, 1,083 rented out the land, and 3,804 did not participate in the land rental market. The summary statistics of variables used in the current study is shown in Table 1. Among the 5,680 household samples, 14% are households that rent in farmland, which is a little lower than the share of households

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[17] We thank the reviewer for pointing this problem and the potential endogenous problems.

[18] We mainly used the survey data from 2017, the investigation also did survey in 2015. We merged the two datasets and generated the market price, supply-and-demand, and public intervention variables using the 2015 survey data.

[19] There were about 546 missing data, about 112 outliers, and 87 sample data that had both transferred in and out.

renting out the land (19%). This is understandable because one renting-in household usually trades with more than one renting-out household. The average land area rented in is about 1.14 ha, which is about twice the average area of family-owned farmland (0.59 ha). The land rented out averages about 0.34 ha.

Factors affecting rural households' participation in the land rental market, shown in Table 1, include household head characteristics, household characteristics, village variables, and regional variables (Feng and Heerink, 2008; Deininger and Jin, 2005; Yan and Huo, 2016; Zhang et al., 2021, 2022). These variables will affect farm productivity and transaction costs, indirectly affecting rural households' participation in the land rental market. The head of the household is an important economic decision-maker in rural households. Variables such as the household head's age, gender, and education are chosen. In our sample, 91% of household heads are male, and the average age is 57. The square of the household head's age is added to capture the life cycle effect of age on households' land rental decisions (Feng and Heerink, 2008; Zhang et al., 2022). The household characteristics that affect rural households' participation in the land rental market are divided into human (labor number, average age of the family labor force), natural assets (family-owned farmland area per capita), and physical assets factors (asset value of agricultural machinery).

Family assets are essential factors in determining rural households' allocation of resources, their off-farm employment, and their land rental participation (Liu and Liu, 2016). At the village level, we use the variable of labor migration rate, per capita income, land certificate, and distance to the farmer's market. Labor migration has prompted the development of the land rental market and is expected to promote farm households' participation in land rental markets (Kung, 2002; Huang et al., 2012). The two village-level variables, labor migration rate and per capita income, were also added as control variables to reduce the omitted explanatory variable bias. The land certificate variable is chosen to represent land tenure security. The village that conducted the registration of the rural land rights confirmation and certification can improve land tenure security and stimulate the development of the land rental market (Zhang et al., 2022). The distance to the farmer's market variable is chosen to represent the transaction cost of market access. Regarding the regional variables, we generate 28 provincial dummy variables to control for regional differences affecting the development of the land rental market.

The core variables in our study represented by the invisible market are the average land rent and the land transfer rate at the village level. The variable of the intermediary organizations represents the public intervention in the land rental market. As previously discussed, many land rental activities between relatives and acquaintances in China are free of charge under conditions of low market development (Tang et al., 2019). Therefore, the price mechanism of the land rental market is more effective in villages with higher land rents and can better guide the flow of land resources and reduce market transaction costs than in villages with lower land rents. The supply-and-demand sides of the land rental market cannot be observed directly but can be represented by the ratio of the village-level land renting area to the total area (Lin, 2002; Tian and Li, 2014). With an increase in a village's land transfer rate, market participants increase, and the information search cost to find potential transaction partners decreases (Tian and Li, 2014). Lastly, the variable intermediary organization captures the public's intervention in households' participation in land rental activities. The intermediary organizations established by local governments or village collectives can provide transaction information and services for rural families participating in the land rental market (Ito et al., 2016; Huang and Ding, 2016).

Table 2 reports the linear correlation of the invisible market and intermediary organization variables for the land rental market. The coefficient for the land transfer rate and the intermediary organization is 0.19, indicating a slightly positive correlation. However, there is a slightly negative correlation between intermediary organization and land rent; the coefficient is only −0.03. The multicollinearity test also

Table 2
Linear correlation test of market variables for LRM.

	Land rent	Land transfer rate	Intermediary organization
Land rent	1.00	−0.05	−0.03
Land transfer rate	−0.05	1.00	0.19
Intermediary organization	−0.03	0.19	1.00

Note: The Pearson correlation coefficient is reported in the table, a quantity to study the degree of linear correlation among the market variables.

confirms the above result in the econometric model. Table 2 reveals no high correlation coefficients among the three variables, and incorporating them into the model may not lead to multicollinearity problems.

5. Results and discussion

5.1. Factors affecting farm households' land renting-in decisions

Table 3 reports the estimates of the factors affecting rural households' decisions to rent-in farmland. Results show that the coefficient of land rent for renting-in participation is negative but insignificant. This finding confirms that the informal land rental market with lower or zero

Table 3
Results for Box-Cox double-hurdle model, participation in land renting-in activities, 2017 CFD and CHFS data.

	Renting-in Decision	Area Rented-in
Land rent (log)	−0.032	−0.049
	(0.024)	(0.030)
Land transfer rate	−0.020	0.452*
	(0.169)	(0.261)
Intermediary organizations	0.302***	0.171*
	(0.063)	(0.090)
Owned farmland area	0.147***	0.317***
	(0.046)	(0.096)
Age, HH	0.026	0.012
	(0.017)	(0.018)
Age squared, HH	−0.0003**	−0.0002
	(0.0002)	(0.0002)
Gender, HH	0.085	0.163
	(0.113)	(0.184)
Education junior high school or more, HH	0.008	0.143*
	(0.050)	(0.081)
Worker, number	0.057***	0.057**
	(0.021)	(0.029)
Average age, family worker	−0.004**	−0.004
	(0.002)	(0.003)
Agricultural machinery asset value (log)	0.071***	0.082***
	(0.009)	(0.014)
Labor migration	0.654***	0.041
	(0.207)	(0.275)
Per capita income (log)	−0.031	0.027
	(0.047)	(0.045)
Land certificate	0.123	0.093
	(0.131)	(0.228)
Distance to farmer's market (log)	−0.044	0.015
	(0.045)	(0.036)
Provincial Dummy	Controlled	Controlled
Constant	−1.272**	−1.646**
	(0.564)	(0.651)
Log-likelihood	−2250.82	
Number of Observations	4,597	

Note: ***, **, * indicates statistically significant at 1%, 5%, and 10%, respectively. The standard errors are corrected for clustering effect at the provincial level. The multicollinearity test using the variance inflation factor (VIF) shows that the mean VIF is 4.53 for all the independent variables. And the mean VIF for each single variable is <2. Therefore, we did not detect a multicollinearity problem.

land rent is not sufficiently incentivized for farm households to partic- ipate in the land rental market (Qian and Ji, 2016; Tang et al., 2019). The coefficient of land transfer rate for the land renting-in area is significantly positive, which means that a land rental market with enough land supply and demand is conducive to farm households' renting in more farmland. However, the effect of the land transfer rate on households' participation in renting-in is insignificant. The co- efficients of intermediary organizations for the decision to rent-in and land area rented-in are both significantly positive, suggesting that public intervention represented by the intermediary organization promotes farm households' participation in the land rental market and increases farm size. This finding conforms with Ito et al. (2016) and Huang and Ding (2016). Table 3 also shows that farm households owning larger farmland are more likely to rent in land and to rent in more land than farm households with smaller farmland. This finding is consistent with Ma et al. (2011) and Yan and Huo (2016). Large farms are more likely to expand the scale of their operations and realize economies of scale (Ma et al., 2011). Larger farms depend on farm income as an essential source of income and are motivated to rent in more farmland through the land rental market.

As for human assets' influences on rural households' land rental participation, Table 3 reveals that farm households with more laborers than average tend to participate in land renting-in activities. This is reasonable because labor-rich families have the time and ability to manage large farmland. We also find that farm households with an older average labor force have a lower probability of renting in farmland than households with a younger average labor force. The significantly posi- tive sign of agricultural machinery asset value in Table 3 suggests that farm households with rich agricultural physical assets would have a higher propensity than households with fewer such assets to participate in renting-in activities. The finding confirms the importance of physical holdings by farm households' participation in the land renting market (Yan and Huo, 2016; Zhang et al., 2021).

5.2. Factors affecting farm households' land renting-out decisions

Results for the factors affecting farm households' land renting-out decisions are reported in Table 4. Results show that land rent has a negative impact on farm households' decision to rent-out farmland and the amount of land rented out. Still, the coefficients are insignificant, implying that the low or zero land rental prices are not conducive to guiding farmers to rent out land (Tang et al., 2019). The coefficient of the land transfer rate is significantly positive for the likelihood of households' decision to participate in renting out farmland, implying that the supply side[20] of the farmland rental market increases renting-out farmland. It indicates that the land transfer rate encourages farm households to rent out more farmland. Table 4 shows that the inter- mediary organizations have a significantly positive effect on the households' decision to rent out farmland. Findings underscore the importance of public intervention (IOs) in reducing transaction costs in farmland rental markets (Ito, Bao, and Ni, 2016; Huang and Ding, 2016).

Rural households with rich land endowments are more likely to rent out more farmland than households with smaller land endowments (Table 4). Indeed, it is unsurprising that rich farmland can rent out more land through the land rental market—perhaps they are renting out low- quality land. Male head households have lower probabilities of renting- out land. In general, male household heads are more likely to keep farming and have the physical strength to engage in farm activities and, thus, less likely to rent out farmland. Farm household heads with the educational attainment of junior high school or above rent out more farmland than their counterparts. Educated household heads are more

Table 4

. Results of Box-Cox double-hurdle model, participation in land renting-out ac- tivities, 2017 CFD and CHFS data.

	Renting-out Decision	Area Rented-out
Land rent (log)	−0.006	−0.009
	(0.017)	(0.012)
Land transfer rate	1.399***	0.164**
	(0.142)	(0.083)
Intermediary organization	0.247***	0.025
	(0.051)	(0.032)
Owned farmland	−0.021	1.002***
	(0.037)	(0.151)
Age, HH	−0.018	0.006
	(0.012)	(0.008)
Age squared, HH	0.0003**	−0.00003
	(0.0001)	(0.0001)
Gender, HH	−0.202***	0.019
	(0.062)	(0.040)
Education junior high school or more, HH	0.124**	0.039
	(0.051)	(0.026)
Worker, number	−0.033*	0.011
	(0.017)	(0.008)
Average age, family worker	0.001	−0.0004
	(0.001)	(0.001)
Agricultural machinery asset value (log)	−0.087***	−0.019***
	(0.008)	(0.005)
Labor migration	−0.136	−0.067
	(0.232)	(0.091)
Per capita income (log)	0.023	0.002
	(0.044)	(0.029)
Land certificate	−0.037	−0.066
	(0.104)	(0.050)
Distance to farmer's market (log)	−0.029	0.009
	(0.041)	(0.024)
Provincial Dummy	Uncontrolled	Controlled
Constant	−0.826*	−1.848***
	(0.494)	(0.406)
Log-likelihood	−1484.32	
Number of Observations	4,887	

Note: ***, **, * Indicates statistically significant at 1%, 5%, and 10%, respectively. The standard errors are corrected for clustering effect at the pro- vincial level. For the renting-out decision model, the iterative process of the likelihood function cannot converge, so we deleted the province dummy variables.

likely to migrate to off-farm work since off-farm earnings are stable and reduce variability in household income (Mishra and Goodwin, 1997). In other words, educated family heads are more likely to migrate to off- farm work. Results from Table 4 show that households with more la- borers are less likely to rent out their farmland than those with fewer laborers. This is reasonable because these households are more capable of providing physical labor for agricultural production. Rural house- holds in China are more likely to rent out farmland with insufficient family labor (Yan and Huo, 2016). The coefficients for agricultural machinery value in Table 4 are significantly negative, indicating that households with more farm assets are less likely to rent out the land than households with fewer such assets. Once these families decide to rent out farmland, they rent out higher amounts of farmland.

5.3. Robustness check

As discussed earlier, there are potential endogenous problems when directly introducing the two market mechanism variables, land rent, and land transfer rate. Some farm households may have participated in the land rental market before the time of the survey. We first modeled land

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[20] Remember that the land transfer rate is the share of a village's land renting area to total cultivated land area, and that a higher land transfer rate means an active land supply market.

Table 5

. Robustness check I: Results of Box-Cox double-hurdle model, participation in land renting-in activities, 2015 and 2017 CFD and CHFS data.

	Renting-in Decision (1)	Area Rented-in (2)	Renting-in Decision (3)	Area Rented-in (4)
Land rent (predicted)	0.159	−0.031		
	(0.155)	(0.203)		
Land transfer rate (predicted)	−0.186	1.719		
	(1.283)	(1.458)		
Intermediary organization	0.300***	0.176*		
	(0.053)	(0.092)		
Land rent (2015)			−0.355***	0.037
			(0.105)	(0.061)
Land transfer rate (2015)			−0.011**	0.029***
			(0.004)	(0.006)
Intermediary organization (2015)			0.356**	0.190**
			(0.173)	(0.079)
Owned farmland	0.173***	0.307***	0.007	0.352***
	(0.044)	(0.098)	(0.041)	(0.092)
Age, HH	0.027	0.005	−0.008	0.083
	(0.017)	(0.019)	(0.040)	(0.080)
Age squared, HH	0.0003	0.0002	0.0001	−0.001
	(0.0002)	(0.0002)	(0.0004)	(0.001)
Gender, HH	0.086	0.147	−0.128	0.498
	(0.119)	(0.179)	(0.215)	(0.436)
Education junior high school or more, HH	−0.002	0.128	−0.128	0.149
	(0.049)	(0.087)	(0.211)	(0.402)
Worker, number	0.052***	0.067**	0.116**	−0.046
	(0.020)	(0.032)	(0.052)	(0.100)
Average age, family worker	−0.004**	−0.004	−0.009***	0.003
	(0.002)	(0.002)	(0.003)	(0.005)
Agricultural machinery asset value (log)	0.070***	0.085***	0.012	0.062***
	(0.009)	(0.015)	(0.019)	(0.025)
Labor migration	0.753***	−0.020	1.573*	−1.890***
	(0.252)	(0.333)	(0.824)	(0.495)
Per capita income (log)	−0.060	0.005	−0.215**	0.240*
	(0.054)	(0.044)	(0.082)	(0.124)
Land certificate	0.164	0.092	0.431	−0.204
	(0.130)	(0.228)	(0.263)	(0.278)
Distance to farmer's market (log)	−0.050	0.026	−0.036	0.111
	(0.055)	(0.046)	(0.057)	(0.151)
Provincial Dummy	Controlled	Controlled	Uncontrolled	Controlled
Constant	−2.254**	−1.823*	3.040**	−6.310**
	(1.045)	(1.093)	(1.494)	(2.703)
Log-likelihood	−2254.53		−669.463	
Number of Observations	4,597		2,139	

Note: ***, **, * indicates statistically significant at 1%, 5%, and 10%, respectively. The standard errors are corrected for clustering at the provincial level. Column (1) and (2) are the results of the second stage of the instrumental variable regression and the variables of land rent and land transfer rate are predicted values. Column (3) and (4) are the results for the selected samples. The variables of land rent, land transfer rate and intermediary organization, and other independent variables (including education of HH, worker number, average age of family labor, average education of family worker, agricultural machinery asset value, migration share, per capita income, land certificate, and distance to farmer's market) are from the 2015 round of survey data. The other independent and dependent variables are from the 2017 round of survey data. Farm households who participated in land rental market after the year of 2015 were retained in the estimation. The 2015 round and 2017 round survey datasets were merged and final 2,369 farm households were retained. Among them, 180 were households renting in the land, 231 rented out the land, and 1,959 did not participate in the land rental market. For the renting-in decision model in Column (3) the iterative process of the likelihood function cannot converge, so we deleted the province dummy variables.

Table 6

. Robustness check I: Results of Box-Cox double-hurdle model, participation in land renting-out activities, 2015 and 2017 CFD and CHFS data.

	Renting-out Decision (1)	Area Rented-out (2)	Renting-out Decision (3)	Area Rented-out (4)
Land rent (predicted)	0.040	−0.015		
	(0.064)	(0.080)		
Land transfer rate (predicted)	2.682***	1.466**		
	(0.449)	(0.725)		
Intermediary organization	0.328***	0.041		
	(0.080)	(0.036)		
Land rent (2015)			0.001	−0.004
			(0.024)	(0.016)
Land transfer rate (2015)			0.001	−0.001
			(0.002)	(0.001)
Intermediary organization (2015)			0.422***	−0.072
			(0.158)	(0.048)
Owned farmland	−0.039	0.983***	0.024	0.582**
	(0.031)	(0.154)	(0.037)	(0.240)
Age, HH	−0.023**	0.001	−0.012	0.011
	(0.011)	(0.009)	(0.031)	(0.028)
Age squared, HH	0.0003***	0.00002	0.0002	0.0001
	(0.0001)	(0.0001)	(0.0003)	(0.0002)
Gender, HH	−0.239***	−0.014	−0.080	−0.104
	(0.069)	(0.047)	(0.137)	(0.072)
Education junior high school or more, HH	0.112	0.028	0.067	0.005
	(0.051)	(0.026)	(0.061)	(0.036)
Worker, number	−0.014	0.020**	−0.015	0.015
	(0.018)	(0.008)	(0.040)	(0.023)
Average age, family worker	0.001	0.00001	0.0001	−0.002
	(0.001)	(0.001)	(0.003)	(0.002)
Agricultural machinery asset value (log)	−0.082***	−0.016***	−0.053***	−0.006
	(0.007)	(0.006)	(0.016)	(0.015)
Labor migration	−0.196	−0.163	−0.108	−0.381
	(0.197)	(0.103)	(0.713)	(0.232)
Per capita income (log)	−0.058	−0.020	−0.131*	−0.011
	(0.039)	(0.037)	(0.074)	(0.068)
Land certificate	−0.048	−0.072	−0.057	−0.137
	(0.135)	(0.055)	(0.198)	(0.122)
Distance to farmer's market (log)	−0.008	0.030	−0.098*	0.004
	(0.043)	(0.026)	(0.054)	(0.054)
Provincial Dummy	UnControlled	Controlled	Controlled	Controlled
Constant	−0.547	−1.834***	0.338	−0.820*
	(0.579)	(0.541)	(1.202)	(0.460)
Log-likelihood	−1541.37		−657.35	
Number of Observations	4,597		2,190	

Note: ***, **, * indicates statistically significant at 1%, 5%, and 10%, respectively. The standard errors are corrected for clustering at the provincial level. Column (1) and (2) are the results of the second stage of the instrumental variable regression and the variables of land rent and land transfer rate are predicted values. Column (3) and (4) are the results for the selective samples. The variables of land rent, land transfer rate and intermediary organization, and other independent variables (including education of HH, worker number, average age of family labor, average education of family worker, agricultural machinery asset value, migration share, per capita income, land certificate, and distance to farmer's market) are from the 2015 round of survey data. The other independent and dependent variables are from the 2017 round of survey data. Farm households who participated in land rental market after the year of 2015 were retained in the estimation. The 2015 round and 2017 round survey datasets were merged and final 2,369 farm households were retained. Among them, 180 were households renting in the land, 231 rented out the land, and 1,959 did not participate in the land rental market. For the renting-out decision model in Column (1), the iterative process of the likelihood function cannot converge, so we deleted the province dummy variables.

Table 7

. Robustness check II: Results of Logit-Tobit, and double-hurdle model, participation in land renting-in activities, 2017 CFD and CHFS data.

	Renting-in Decision	Area Rented-in	Renting-in Decision	Area Rented-in
	Logit (1)	Tobit (2)	Double-Hurdle (3)	
Land rent (log)	−0.056*	−0.026*	−0.032*	−0.026*
	(0.034)	(0.016)	(0.019)	(0.016)
Land transfer rate	0.018	0.069	−0.020	0.069
	(0.218)	(0.102)	(0.124)	(0.102)
Intermediary organization	0.505***	0.248***	0.302***	0.248***
	(0.094)	(0.044)	(0.053)	(0.044)
Owned farmland	0.232***	0.173***	0.147***	0.173***
	(0.058)	(0.026)	(0.034)	(0.026)
Age, HH	0.049	0.014	0.026	0.014
	(0.031)	(0.014)	(0.017)	(0.014)
Age squared, HH	−0.0006**	−0.0002	−0.0003**	−0.0002
	(0.0003)	(0.0001)	(0.0002)	(0.0001)
Gender, HH	0.186	0.055	0.085	0.055
	(0.178)	(0.080)	(0.095)	(0.080)
Education junior high school or more, HH	0.022	0.018	0.008	0.018
	(0.089)	(0.041)	(0.050)	(0.041)
Worker, number	0.100***	0.054***	0.057***	0.054***
	(0.037)	(0.017)	(0.021)	(0.017)
Average age, family worker	−0.008**	−0.004***	−0.0044***	−0.0039***
	(0.003)	(0.001)	(0.002)	(0.001)
Agricultural machinery asset (log)	0.129***	0.068***	0.071***	0.068***
	(0.011)	(0.005)	(0.006)	(0.005)
Labor migration	1.214***	0.506***	0.654***	0.506***
	(0.283)	(0.133)	(0.158)	(0.133)
Per capita income (log)	−0.043	−0.012	−0.031	−0.012
	(0.055)	(0.025)	(0.032)	(0.025)
Land certificate	0.221	0.124	0.123	0.124
	(0.173)	(0.078)	(0.094)	(0.078)
Distance to farmer's market (log)	−0.066	−0.033	−0.044	−0.033
	(0.053)	(0.024)	(0.030)	(0.024)
Provincial Dummy	Controlled	Controlled	Controlled	Controlled
Constant	−2.427**	−1.049**	−1.272**	−1.049**
	(0.944)	(0.418)	(0.517)	(0.418)
Log-likelihood	−1857.62	−2080.80	−1857.09	−2080.80
Pseudo R²	0.12	0.15	0.12	0.15
Number of Observations	4,597		4,597	

Note: ***, **, * indicates statistically significant at 1%, 5%, and 10%, respectively. The standard errors are corrected for clustering at the provincial level.

Table 8

. Robustness check II: Results of Logit-Tobit, and double-hurdle model, participation in land renting-out activities, 2017 CFD and CHFS data.

	Renting-out Decision	Area Rented-out	Renting-out Decision	Area Rented-out
	Logit (1)	Tobit (2)	Double-Hurdle (3)	
Land rent	−0.056*	−0.026*	−0.032*	−0.026*
	(0.034)	(0.016)	(0.019)	(0.016)
Land transfer rate	0.018	0.069	−0.020	0.069
	(0.218)	(0.102)	(0.124)	(0.102)
Intermediary organization	0.505***	0.248***	0.302***	0.248***
	(0.094)	(0.044)	(0.053)	(0.044)
Owned farmland	0.232***	0.173***	0.147***	0.173***
	(0.058)	(0.026)	(0.034)	(0.026)
Age, HH	0.049	0.014	0.026	0.014
	(0.031)	(0.014)	(0.017)	(0.014)
Age squared, HH	−0.0006**	−0.0002**	−0.0003**	−0.0002**
	(0.0003)	(0.0001)	(0.0002)	(0.0001)
Gender, HH	0.186	0.055	0.085	0.055
	(0.178)	(0.080)	(0.095)	(0.080)
Education junior high school or more, HH	0.022	0.018	0.008	0.018
	(0.089)	(0.041)	(0.050)	(0.041)
Worker, number	0.100***	0.054***	0.057***	0.054***
	(0.037)	(0.017)	(0.021)	(0.017)
Average age, family worker	−0.008**	−0.004***	−0.0044***	−0.0039***
	(0.003)	(0.001)	(0.002)	(0.001)
Agricultural machinery asset (log)	0.129***	0.068***	0.071***	0.068***
	(0.011)	(0.005)	(0.006)	(0.005)
Labor migration	1.214***	0.506***	0.654***	0.506***
	(0.283)	(0.133)	(0.158)	(0.133)
Per capita income (log)	−0.043	−0.012	−0.031	−0.012
	(0.055)	(0.025)	(0.032)	(0.025)
Land certificate	0.221	0.124	0.123	0.124
	(0.173)	(0.078)	(0.094)	(0.078)
Distance to farmer's market (log)	−0.066	−0.033	−0.044	−0.033
	(0.053)	(0.024)	(0.030)	(0.024)
Provincial Dummy	Controlled	Controlled	Controlled	Controlled
Constant	−2.427**	−1.049**	−1.272**	−1.049*
	(0.944)	(0.418)	(0.517)	(0.418)
Log-likelihood	−2178.75	−1810.14	−1857.09	−2080.80
Pseudo R²	0.16	0.18	0.12	0.15
Number of Observations	4,887		4,887	

Note: ***, **, * indicates statistically significant at 1%, 5%, and 10%, respectively. The standard errors are corrected for clustering at the provincial level.

rent and land transfer rates using different instruments.[21] Specifically, we generated the predicted values and incorporated them in the Box-Cox double-hurdle models. The instruments and other independent variables and first-stage regressions are shown separately in Ta.bles A1 and Appen.dix A2. Besides, the three market mechanisms and public intervention variables, land rent, land transfer rate, and intermediary organization, are replaced with the earlier (2015) round of survey data.

Except for some invariant variables such as household head characteristics, the other independent variables are replaced with the earlier (2015) round of survey data. Farm households participating in the land rental market after 2015 were retained to ensure that land rental activities happened before the market mechanisms and public intervention.

Results for renting-in activities are presented in Table 5. Columns (1) and (2) are the results of the second stage of the instrumental variable regression. Here we included the predicted values of land rent and land transfer rate as independent variables in the regression. Results show that the coefficient of the intermediary organization is positive and statistically significant. Findings indicate that public intervention has encouraged (promoted) farm households' decision to rent in farmland and increased the amount of farmland rented in. However, the effect of land rent and land transfer rate on farm households' land rental decisions and the amount of land rented in is insignificant. At the same time, the effect of the land transfer rate on the amount of land rented in is significantly positive in Table 3. Thus, it suggests that the instrumental variable method reduces the upward trend caused by the reverse causality between land rental decisions and farmland's market supply and demand. The significance and directional impact of the coefficients for

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[21] Land rent was instrumented with the proportion of idled arable land in the village, and land transfer rate was instrumented with the proportion of machinery adoption and village-level income. The proportion of idled arable land is assumed to have a negative effect on village-level land rent, and may affect farm households' land rental participation through land rent. We did necessary tests on this instrument and proved its validity. However, the IV may affect the probability of land rental activities through other factors, such as quality of plot. Unfortunately, we could not test this potential relationship due to the lack of plot quality information. The two instruments for land transfer rate, the proportion of machinery adoption and village-level income, are also found to have a significantly positive effect on village-level land transfer rate, it is understandable that developed machinery market can also stimulate land rental market.

most variables in Column (1) and Column (2) in Table 5 are all the same compared with the results for other variables in Table 3.

Table 5, Columns (3) and (4) present the estimates for the selected samples. The land rent, land transfer rate, and intermediary organization variables are from the 2015 round of survey data. Results show that land rent has a significantly negative effect on the probability of farm households' land renting-in, proving that the villages' zero or low land rent has hindered farm households' land rental participation. Interestingly, we also find that land transfer rate has significantly reduced farm households' probability of renting-in farmland while significantly improving the amount of land rented-in. The reason may be that the competitiveness of the land supply of the land rental market has promoted land concentration and discouraged small farm households from renting-in land. The coefficient of the intermediary organization variable has a positive and statistically significant effect on farm households' decision to renting in land and the amount of land rented in. For brevity we do not discuss the results of other control variables in Table 5.

Results for renting-out activities is presented in Table 6. Columns (1) and (2) show the estimates of the second stage of the instrumental variable regression. In comparison, Columns (3) and (4) show the parameter estimates of the selected samples. We can see that the effect of land transfer rate on the probability and intensity of land renting-out decisions is insignificant in the regression for the selected samples. However, in Column (1) and Column (2), the coefficient of the land transfer rate is positive and statistically significant, which means that the land transfer rate has a significantly positive effect on the probability of land renting-out and the area rented out by Chinese farming households. The coefficients of the intermediary organization on the likelihood of land renting-out in Columns (1) and (3) are positive and statistically significant. In contrast, the coefficient on the amount of land rented-out are insignificant in Columns (2) and (4). The results are similar to Table 4, indicating that public intervention through intermediary organizations indeed promotes farm households' land renting-out decisions, while not necessarily improving the amount of land rented out.

Results of the logit-Tobit and double-hurdle models for farm households' land renting-in or renting-out activities are reported in Tables 7 and 8, respectively. Table 7 shows the impact directions and significance of the coefficients of the two estimation strategies. The impact direction of the coefficients for the variable land transfer rate in the double-hurdle model is inconsistent. Besides, on average, the logit model standard errors are higher than those obtained in the first stage of the double-hurdle model. In Table 7, we find that the coefficient of land rent is significantly negative for the renting-in decision and the area rented-in, which means that the higher land rent decreased the probability of farm households' participation in the land rental market. The land rent estimation results differ from those estimated using the Box-Cox double-hurdle model in Table 3 (coefficients are insignificant). Remember that the Box-Cox double-hurdle model relaxes the assumptions that the participation decision and transaction amount equations have the same error terms and may have a more robust standard error. Again, we find that the coefficient of the intermediary organization variable has a significantly positive effect on farm households' land renting-in decision and the amount of rented-in. Thus, confirming the consistency of the estimation results obtained in Table 3.

Results for land renting-out activities from Table 8 show that the coefficients for land rent and land transfer rate are different than those obtained using Box-Cox double-hurdle model (Table 4). The coefficient of land rent has a significantly negative effect on land renting-out decisions and the amount of rented-out (Table 8). However, the coefficients are insignificant in Table 4. In Table 8, the coefficients for land transfer rate is insignificant on land renting-out decisions. In contrast,

the land transfer rate significantly increased the probability of participation in land renting out and the amount of land rented out in Table 4. In Table 8, the intermediary organization variable is positive and statistically significant in explaining farm households' decision to participate in land renting-out and the amount of rented-out. The above finding confirms the consistency of the estimated results in Table 4.

5.4. Further discussion: The relationship between public intervention and invisible market

We further estimate the intermediary organizations' impact on land rent and land transfer rate using the 366 observations from the village sample data and Tobit models (the variables are in Appendix A1). The result in Table 9 reveals that the intermediary organizations has a significantly positive effect on the land transfer rate. The intermediary organizations' impact on village-level average land rent is negative and insignificant. The above finding confirms that public intervention represented by intermediary organizations has promoted the land rental market at the village level.

The proportion of idle arable land has a significantly negative effect on land rent, which means that the larger the share of idled arable land in the village, the lower the transaction value in the land rental market. The coefficient of the proportion of machinery adoption is significantly positive, which means that machinery usage can promote the development of the land rental market. Our finding is consistent with Liu et al. (2022). Results also show that per capita village-level income has a positive and statistically significant effect on the land transfer rate, indicating that rich villages (with high per capita income) have a more developed land rental market.

6. Conclusions and policy implications

After decades of development in China's rural land rental market, the participation rate has gradually increased. China's land rental market

Table 9
. Results of the Tobit model for the impact of IO on land rent and land transfer rate at village level, China.

	Land rent (log)	Land transfer rate
Intermediary Organization	−0.174	0.107[***]
	(0.211)	(0.029)
Arable land per capita	0.279[**]	−0.030
	(0.136)	(0.019)
Proportion of idled arable land	−2.382[***]	−0.089
	(0.685)	(0.099)
Proportion of machinery adoption	0.040	0.084*
	(0.323)	(0.046)
Village-level income	−0.028	0.005*
	(0.020)	(0.003)
Labor migration rate	−0.292	0.150*
	(0.600)	(0.085)
Land certificate	0.148	0.001
	(0.332)	(0.047)
Distance market	−0.012	−0.012
	(0.116)	(0.016)
Constant	9.858[***]	0.076
	(0.805)	(0.113)
Provincial dummy	Controlled	Controlled
Log-likelihood	−718.96	−25.36
Pseudo R^2	0.044	0.67
Number of Observations	366	366

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

has developed to a certain extent, and the price, supply, and demand mechanisms have steadily emerged. However, evidence shows China's land rental market faces high transaction costs. In recent years, the government or village-level organizations have established intermediary organizations to formalize farm households' land rental behavior and reduce transaction costs. Using nationally representative household and village survey datasets and the Box-Cox double-hurdle model, we modeled the intermediary organizations and invisible market mechanisms in promoting farm households' participation in land renting-in or renting-out activities. The instrumental variable method and selected samples were used to solve potential endogenous problems. In addition, Logit-Tobit, and double hurdle modeling techniques were used to perform robustness checks.

Results show that the public intervention represented by the intermediary organizations can play an essential role in reducing transaction costs for farmers to participate in land rental activities and encourage them to rent in or rent out more farmland. The results are consistent in different models. The supply-and-demand mechanism represented by the village-level land transfer rate has also been proven effective in promoting farm households' land-renting activities, especially in encouraging them to rent in or rent out farmland. However, results for the effects of land transfer rate were inconsistent in various models. The price mechanism represented by the village-level land rent shows no impact or even negative impact on renting-in or renting-out decisions by farm households in the Box-Cox double hurdle model. It negatively affects land renting-in and renting-out decisions in the Logit-Tobit, and double hurdle models. Results showed that the price mechanism in the land rental market has failed to guide the flow of land resources. Overall, public intervention has played a more significant role in promoting farm households' participation in the farmland rental market than the invisible market mechanisms, such as price, demand, and supply.

Using the village survey data, the results from this study confirm that the intermediary organizations have increased the share of and the amount of farmland transferred in villages, thus improving the supply of and demand for land in the farmland rental market. These findings are consistent with previous studies that intermediary organizations have stimulated the development of the land rental market (Ito et al., 2016; Huang and Ding, 2016). In China's land rental market, many big farms, cooperatives, and entrepreneurs indirectly rent land through intermediary organizations. To realize farmland scale management, land transfers organized by intermediary organizations are generally larger in scale, more concentrated, and less spontaneous than land transfers among small farmers (Liu et al., 2016).

Currently, China has an imperfect land rental market. The invisible market, especially land rental prices, cannot thoroughly guide the flow of land resources to realize farm-scale management, hindering agricultural transformation and modernization. Thus, the intermediary organizations could provide price evaluation services, regularly publish standard land rents for different areas and land quality levels, and offer transaction price references. The intermediary organizations should also better disclose market supply and demand information and promote the role of market supply and demand in farm households' land rental participation.

Constrained by dataset and length, we must point out several limitations of the present study. First, we have to assume that the set independent variables in the model occurred before farm households' land rental participation or did not change after their land rental involvement because some of the farmer's characteristics and village variables were investigated in 2017. The cost is the possibility of reverse causality and potential simultaneity problems in the estimation because most farm households participated in the land rental market between 2010 and 2016.[22] Although we adopted the instrumental variable (IV) method, we could not rule out this possibility. Second, the proportion of idled arable land is may not a perfect IV for the land rent theoretically[23]. It may affect the probability of land rental activities through other factors, such as the quality of the plot. We made several tests to make it satisfy the basic criteria for a good IV. However, we could not test this potential relationship due to lacking plot-quality information. Last, this paper could not investigate the relationship between the government-led intermediary organizations and market-oriented intermediary organizations, as well as their differential impact on the equality and efficiency of the land rental market. Therefore, future research should pay attention to the solution of potential estimation problems and focus more on the role of various intermediary organizations under public intervention, their effect on land rental development, farm production, and income, and the future reform of these organizations.

CRediT authorship contribution statement

Jian Zhang: Conceptualization, Methodology, Writing – original draft, Validation. **Ashok K. Mishra:** Methodology, Visualization, Writing - original draft, Writing - review & editing. **Xianlei Ma:** Methodology, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

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Appendix A. 1: Village-level variable definition and summary statistics

Variables	Description	Mean	Standard Deviation
Land rent	The average land rent at the village level (*yuan/hectare*)	9,570	31,276
Land transfer rate	The share of village's land renting area to total cultivated land area in the village, %	0.25	0.254

(continued on next page)

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[22] We thank an anonymous reviewer for raising this issue.

[23] We thank an anonymous reviewer for raising this issue.

(continued)

Variables	Description	Mean	Standard Deviation
Intermediary Organization	= 1 if local governments or village collectives provide land renting organization services through rural cooperatives, service centers or platforms and liaison officers; 0 otherwise.	0.32	0.467
Arable land per capita	Arable land per capita at village level, %	0.15	0.331
Proportion of idle arable land	The share of the area of idle arable land to total farmland area in the village (%)	0.060	0.150
Proportion of machinery adoption	The share of land area using machinery in farming to the total farmland area in the village (%)	0.747	0.352
Village-level income	The sum of various incomes such as operating, property and transfer income for the village (*yuan*)	919,807	6924,195
Labor migration rate	The share of migrant workers to the total population in the village, %	0.22	0.171
Land certificate	= 1 if the village has conducted the registration of rural land rights confirmation and certification; 0 otherwise.	0.90	0.294
Distance market	The distance between the village and the nearest farmer's market (*kilometers*)	5.41	7.411

Source: Calculated from the 2017 CFD and CHFS data.

Appendix A. 2: Results for the first-stage of the factors affecting land rental market mechanisms (instrumental variable method)

	Land rent (log)	Land transfer rate
Proportion of idled arable land	−1.651*** (0.127)	
Proportion of machinery adoption		0.001*** (0.0001)
Village-level income		0.004*** (0.001)
Owned farmland	−0.136*** (0.029)	0.006 (0.005)
Age, HH	−0.001 (0.011)	0.003* (0.002)
Age squared, HH	0.00003 (0.0001)	0.0003* (0.0002)
Gender, HH	0.038 (0.058)	0.023** (0.010)
Education junior high school or more, HH	0.042 (0.035)	0.006 (0.006)
Worker, number	0.017 (0.014)	−0.006** (0.002)
Average age, family worker	0.0005 (0.001)	0.0001 (0.0002)
Agricultural machinery asset (log)	0.001 (0.005)	−0.002** (0.001)
Labor migration	−0.322*** (0.110)	0.084*** (0.019)
Per capita income (log)	0.169*** (0.024)	0.016*** (0.004)
Land certificate	−0.147** (0.061)	0.001 (0.011)
Distance market	0.025 (0.021)	−0.014*** (0.004)
Provincial dummy	Controlled	Controlled
Constant	5.004*** (0.362)	−0.063 (0.063)
Provincial dummy	Controlled	Controlled
Pseudo R^2	0.185	0.184
Number of Observations	5,680	5,680

Note: ***, **, * indicates statistically significant at 1%, 5%, and 10%, respectively. The models are estimated using ordinary least squares. We modeled the two market mechanism variables, generated the predicted values, and then incorporated these predicted values into the Box-Cox double-hurdle model (Table 5 and Table 6). In the first stage, the variable proportion of idle arable land was chosen as the instrumental variable for land rent. The two variables, proportion of the machinery adoption and village-level income were chosen as the instrumental variables for land transfer rate.

References

Alene, A.D., Manyong, V.M., Omanya, G., Mignouna, H.D., Bokanga, M., Odhiambo, G., 2008. Smallholder market participation under transactions costs: maize supply and fertilizer demand in Kenya. FoodPolicy 33 (4), 318–328.
Amemiya, T., 1984. Tobit models: a survey. J. Econ. 24 (1–2), 3–61.
Awasthi, M.K., 2009. Dynamics and resource use efficiency of agricultural land sales and rental market in India. Land Use Policy 26 (3), 736–743.
Ayala-Cantu, L., Morando, B., 2020. Rental markets, gender, and land certificates: evidence from Vietnam. Food Policy 94, 101842.

Bai, J., Wahl, T.I., Lohmar, B.T., Huang, J., 2010. Food away from home in Beijing: effects of wealth, time and "free" meals. China Econ. Rev. 21 (3), 432–441.
Bellemare, M.F., Barrett, C.B., 2006. An ordered Tobit model of market participation: evidence from Kenya and Ethiopia. Am. J. Agric. Econ. 88 (2), 324–337.
Cao, J.H., Wang, H.Y., Huang, X.M., 2007. Study on supply and demand willingness of rural land transaction and evaluation of transaction efficiency, China Land Science (5), 54-60 (In Chinese).
Carter, M.R., Yao, Y., 2002. Local versus global separability in agricultural household models: the factor price equalization effect of land transfer rights. Am. J. Agric. Econ. 84 (3), 702–715.

Chamberlin, J., Ricker-Gilbert, J., 2016. Participation in rural land rental markets in Sub-Saharan Africa: who benefits and by how much? Evidence from Malawi and Zambia. Am. J. Agric. Econ. 98 (5), 1507–1528.

Chen, H., 2015. State power and village cadres in contemporary China: the case of rural land transfer in Shandong province. J. Contemp. China 24 (95), 1–20.

Chen, F., Zhai, W.J., 2015. Land transfer incentive and welfare effect research from perspective of farmers' behavior. Econ. Res. 10, 163–177. In Chinese.

Chen, Y.S., Zhong, F.N., Ji, Y.Q., 2017. Why does "Zero Rent" exist in farmland transfer: an empirical analysis from the perspective of rent type. China Rural Survey 2017 (4), 43–56. In Chinese.

Coase, R., 1960. The problem of social cost. J. Law Econ. 3, 1–44.

Committee of China Agriculture Yearbook, 2010 and 2017. China Agriculture Yearbook 2010 and 2017. China Agriculture Press (in Chinese).

Deininger, K., Ali, D.A., Alemu, T., 2013. Productivity effects of land rental market operation in Ethiopia: evidence from a matched tenant–landlord sample. Appl. Econ. 45 (25), 3531–3551.

Deininger, K., Jin, S., 2005. The potential of land rental markets in the process of economic development: evidence from China. J. Dev. Econ. 78 (1), 241–270.

Deininger, K., Jin, S., Nagarajan, H.K., 2008. Efficiency and equity impacts of rural land rental restrictions: evidence from India. Eur. Econ. Rev. 52 (5), 892–918.

Feng, S., 2006. Land Rental Market and Off-farm Employment: Rural Households in Jiangxi Province. Wageningen University and Research, PR China.

Feng, S., Heerink, N., 2008. Are farm households' land renting and migration decisions inter-related in rural china? NJAS - Wageningen J. Life Sci. 55 (4), 345–362.

Feng, S., Heerink, N., Ruben, R., Qu, F., 2010. Land rental market, off-farm employment and agricultural production in southeast china: a plot-level case study. China Econ. Rev. 21 (4), 598–606.

Holden, S.T., Deininger, K., Ghebru, H., 2011. Tenure insecurity, gender, low-cost land certification and land rental market participation in Ethiopia. J. Dev. Stud. 47 (1), 31–47.

Holden, S.T., Ghebru, H., 2016. Land tenure reforms, tenure security and food security in poor agrarian economies: causal linkages and research gaps. Glob. Food Sec. 10, 21–28.

Huang, J., Ding, J., 2016. Institutional innovation and policy support to facilitate small-scale farming transformation in China. Agric. Econ. 47 (S1), 227–237.

Huang, J., Gao, L., Rozelle, S., 2012. The effect of off-farm employment on the decisions of households to rent out and rent in cultivated land in China. China Agri. Econ. Rev. 4 (1), 5–17.

Ito, J., Bao, Z.S., Ni, J., 2016. Land rental development via institutional innovation in rural Jiangsu, China. Food Policy 59, 1–11.

Ji, X., Qian, Z., Zhang, L., Zhang, T., 2018. Rural labor migration and households' land rental behavior: evidence from China. Chin. World. Econ. 26 (1), 66–85.

Jin, S., Deininger, K., 2009. Land rental markets in the process of rural structural transformation: productivity and equity impacts from China. J. Comp. Econ. 37 (4), 629–646.

Jones, A.M., Yen, S.T., 2000. A Box-Cox double-hurdle model. Manchester School 68 (2), 203–221.

Kimura, S., Otsuka, K., Sonobe, T., et al., 2011. Efficiency of land allocation through tenancy markets: evidence from China. Econ. Dev. Cult. Chang. 59 (3), 485–510.

Kung, J.K.S., 2002. Off-farm labor markets and the emergence of land rental markets in rural China. J. Comp. Econ. 30 (2), 395–414.

Li, C., Ma, W., Mishra, A.K., Gao, L., 2020. Access to credit and farmland rental market participation: evidence from rural China. China Econ. Rev. 63, 101523.

Lin, Y.Z., 2002. Measurement and empirical analysis of China's rural Marketization Process. World Investigation 2002 (6), 26–29. In Chinese.

Lin, W., Huang, J., 2021. Impacts of agricultural incentive policies on land rental prices: new evidence from China. Food Policy 104, 102125.

Liu, Y., Heerink, N., Li, F., Shi, X., 2022. Do agricultural machinery services promote village farmland rental markets? Theory and evidence from a case study in the North China plain. Land Use Policy 122, 106388.

Liu, Z., Liu, L., 2016. Characteristics and driving factors of rural livelihood transition in the east coastal region of China: a case study of suburban shanghai. J. Rural. Stud. 43, 145–158.

Liu, Z., Müller, M., Rommel, J., et al., 2016. Community-based agricultural land consolidation and local elites: survey evidence from China. J. Rural. Stud. 47 (Part B), 449–458.

Ma, L., Liu, H., Yan, Xu, Z.G., 2011. Stagnant farmland transfer: Insufficient economic incentives or constraints from external market conditions?—Analysis of farmland transfer behavior of 600 farmers in 4 provinces of China from 2005 to 2008. China Rural Econ. (11), 36-48 (in Chinese).

Ma, X., Heerink, N., Feng, S., Shi, X., 2015. Farmland tenure in China: comparing legal, actual and perceived security. Land Use Policy 42, 293–306.

Macours, K., De Janvry, A., Sadoulet, E., 2010. Insecurity of property rights and social matching in the tenancy market. Eur. Econ. Rev. 54 (7), 880–899.

Martinez-Espineira, R., 2006. A box-cox double-hurdle model of wildlife valuation: the citizen's perspective. Ecol. Econ. 58 (1), 192–208.

Mishra, A.K., Goodwin, B.K., 1997. Farm Income Variability and the Supply of Off-farm Labor. Am. J. Agric. Econ. 79 (3), 880–887.

Moffatt, P.G., 2005. Hurdle models of loan default. J. Oper. Res. Soc. 56 (9), 1063–1071.

Otsuka. K., 2007. Efficiency and Equity Effects of Land Markets. In: Evenson, R., Pingali, P. (Eds.), Handbook of Agricultural Economics. Elsevier, vol. 3, 2007, pp. 2671–2703.

Qian, Z.H., Ji, X.Q., 2016. The Status Quo of China's Agricultural Land Transfer and Policy Improvements—Based on the Analysis of Survey Data in Jiangsu, Guangxi, Hubei, and Heilongjiang Provinces (Regions) (In Chinese).

Rada, N., Wang, C., Qin, L., 2015. Subsidy or market reform? Rethinking China's farm consolidation strategy. Food Policy 57, 93–103.

Rahman, S., 2010. Determinants of agricultural land rental market transactions in Bangladesh. Land Use Policy 27 (3), 957–964.

Ricker-Gilbert, J., Chamberlin, J., 2018. Transaction costs, land rental markets, and their impact on youth access to agriculture in Tanzania. Land Econ. 94 (4), 541–555.

Shi, X., Chen, S., Ma, X., Lan, J., 2018. Heterogeneity in interventions in village committee and farmland circulation: intermediary versus regulatory effects. Land Use Policy S0264837717303101.

Tang, L., Ma, X., Zhou, Y., Shi, X., Ma, J., 2019. Social relations, public interventions and land rent deviation: evidence from Jiangsu Province in China. Land Use Policy 86, 406–420.

Tao, T., Xu, Z.G., 2007. Urbanization, rural land system and social security for migrants in China. J. Dev. Stud. 43 (7), 1301–1320.

Tian, C.H., Li, M.K., 2014. The impact of land market development on off-farm employment of labor force: based on the experience of Zhejiang, Hubei and Shaanxi Provinces in China. Agri. Technol. Econ. (8), 11–24 (in Chinese).

Wan, G.H., Cheng, E., 2001. Effects of land fragmentation and returns to scale in the Chinese farming sector. Appl. Econ. 33 (2), 183–194.

Wang, H., Riedinger, J., Jin, S.Q., 2015. Land documents, tenure security and land rental development: panel evidence from China. China Econ. Rev. 36, 220–235.

Yan, X., Huo, X., 2016. Drivers of household entry and intensity in land rental market in rural China: evidence from north Henan province. China Agricultural Economic Review 8 (2), 345–364.

Yen, S.T., 1993. Working wives and food away from home: the box-cox double hurdle model. Am. J. Agric. Econ. 75 (4), 884–895.

Zhang, L., Cao, Y., Bai, Y., 2022. The impact of the land certificated program on the farmland rental market in rural China. J. Rural. Stud. 93, 165–175.

Zhang, J., Wang, M., Zhu, P., Li, X., 2017. Deviation of policy implementation in farmland transfer and farmers' land rights and interests protection: taking a traditional agricultural county in Jiangsu province as a case. J. Nanjing. Agricultural University (Social Sciences Edition), 2017, (2): 82–91, 152.

Zhang, J., Mishra, A.K., Zhu, P., Li, X., 2020. Land rental market and agricultural labor productivity in rural China: a mediation analysis. World Dev. 135, 105089.

Zhang, J., Mishra, A.K., Hirsch, S., 2021. Market-oriented agriculture and farm performance: evidence from rural China. Food Policy 100, 102023.

Zhao, Y., 2002. Causes and consequences of return migration: recent evidence from China. J. Comp. Econ. 30 (2), 376–394.

Zhejiang University China Rural Family Research and Innovation Team, 2020. China Rural Family Development Report 2018 Edition[M]. Zhejiang University Press, Hangzhou, p. 05.