Land Use Policy 100 (2021) 104860

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Can payment tools substitute for regulatory ones? Estimating the policy preference for agricultural land preservation, Tianjin, China

Zhu Chen[a,b,*], Anlu Zhang[c], Kehao Zhou[b], Lingxiang Huang[b]

[a] College of Management and Economics, Tianjin University, Tianjin 300072, China
[b] College of Economics and Management, Tianjin Chengjian University, Tianjin 300384, China
[c] College of Land Management, Huazhong Agricultural University, Wuhan, Hubei 430070, China

ARTICLE INFO

Keywords:
Agricultural land preservation
Policy preference
Choice experiment
Regulatory tools
Payment tools
China

ABSTRACT

As policies of agricultural land preservation, regulatory tools and payment ones usually operate independently or complementarily. However, under the policy of the dynamic balance of total cultivated land and taxes/fees of agricultural land conversion in China, there is a substitution relationship between the regulatory and payment tools. This article reviews this substitution mechanism, theoretically evaluates the policy system of Chinese agricultural land preservation from the perspective of nonmarket value and then estimates the public preference for those policy tools and agricultural land types using the choice experiment method. The results show that first, the effects of the regulatory and payment tools are different. While the regulatory tools preserve current agricultural land, the payment ones tend to improve cultivated land for the function of food security. Second, in the choice experiment, respondents support the hybrid tools combing the regulatory and payment tools, regulatory ones and payment ones from high to low, which means that the substitution relationship is reasonable to some extent. These suggest that the interaction of policies needs to be identified in the policy system of agricultural land preservation, and the theory of nonmarket value and choice experiment can be effectively used to evaluate the policy and provide references for the improvement of the policy system.

1. Introduction

Among the various policy tools of agricultural land preservation, regulatory tools and payment ones are the main policy types across countries (Duke and Lynch, 2006; Wilson, 2000). While regulatory tools are used to maintain the current quantity and quality of agricultural land, payment tools such as farmland consolidation and agri-environmental policies (AEPs) prompt agents to improve the agricultural land quality of agricultural production and ecological services (Baylis et al., 2008). Many countries' policy systems of agricultural land preservation combine these two types of tools to preserve agricultural land. In the US, agricultural zoning and conservation reserve programs (or land retirement programs), as regulatory and payment tools, respectively, are commonly used by states (Coughlin et al., 1981; Claassen et al., 2008). In Canada, while provinces are responsible for land-use planning, a national farm stewardship program encourages agricultural land protection and improvement (Agricultural and Agri-Food Canada, 2006). Western European countries such as the UK, Germany and the Netherlands are known for their strict implementation of land use planning. Meanwhile, payment policies in Europe have exerted enormous influence on agricultural and environmental issues. For instance, Western European countries have long adopted land consolidation policies (Jacoby, 1959). Moreover, after 1980, AEPs were initialed in the EU and became an important part of the Common Agricultural Policy (Baylis et al., 2008). With their dense populations, Eastern Asian countries, including Japan and South Korea, pay more attention to production capacity of farmland. As rapid economic development conflicted with energy crises and food shortages in the 1970s, they adopted land preservation tools comprising land-use planning/zoning, land consolidation/reclamation programs and agricultural subsidy programs to increase agricultural production. After that, Japan and South Korea consistently ameliorate related laws and policies (Hays, 2008; Im, 2013).

Compared with other Eastern Asian countries such as South Korea and Japan, China experienced its rapid economic development later, following the 1978 reform and opening-up policy. Under larger population pressures than other countries, China's rapid loss of agricultural land, especially high-quality arable land, attracted domestic and international attention during the 1978-1995 period (Brown, 1995; Ash and Edmonds, 1998). As a result, the Chinese central government

* Corresponding author. Post address: College of Management and Economics, Tianjin University, No. 92, Weijin Road, Nankai District, Tinjin 300072, PR China.
E-mail addresses: chenz3447@aliyun.com (Z. Chen), zhanganlu@mail.hzau.edu.cn (A. Zhang), kzhou@tcu.edu.cn (K. Zhou), hllxiang@126.com (L. Huang).

https://doi.org/10.1016/j.landusepol.2020.104860
Received 5 June 2019; Received in revised form 14 April 2020; Accepted 14 June 2020

adopted a series of policy tools and established the policy system of farmland quantity and quality preservation by enacting the new *Land Administration Law* in 1999 (Lichtenberg and Ding, 2008; Tan et al., 2009).

In the policy system, the policy called *dynamic balance of total cultivated land* (DBTCL) stipulates that every province (autonomous region or municipality)[1] must annually develop equivalent amount of new cultivated land to supplement the loss caused by agricultural land conversion. Therefore, the DBTCL set an important goal for Chinese agricultural land preservation. And the goal promotes the emergence of a payment-regulation substitution relationship. In the term of policy, the payment-regulation substitution can be understood as the regulatory tools failing to be used because decision-makers tend to use the payment tools to reach the goal. According to the payment tools, the land users of this converted land should pay taxes/fees to supplement an equal amount of cultivated land. As a result, as long as the equal amount of cultivated land is developed after cultivated land conversion, the goal of the DBTCL is reached. Moreover, if land regulation is relaxed in favor of more agricultural land conversion, it would be considered reasonable that the more taxes/fees revenue for the program of new cultivated land development maintains the balance of cultivated land. However, this substitution relationship is controversial (Le Coent et al., 2017; Ke et al., 2018). On the one side, research concerns that the new cultivated land is not qualified for the original cultivated land because of inequality of the soil properties or the fraud behavior (Glicksman and Kaime, 2013; Wu et al., 2017; Liu and Li, 2017); on the other side, this substitution relationship brings a chance for local governments to mitigate conflicts between urban development and land preservation. In this context, We attempt to address three problems in this paper: (1) what are the differences of effects between the regulatory tools and payment ones, (2)is it reasonable to substitute the payment tools for the regulatory ones, and (3)how to integrate these two tools into a system to effectively preserve agricultural land from urban expansion?

Our study relates to two categories of literature. The first category focuses on the policies of agricultural land preservation in China, which includes analysis on Chinese land use policy system and institution (Qu et al., 1995; Ding, 2001; Liu et al., 2014; Qian et al., 2016; Liu, 2018; Liu et al., 2018a), the policy system of agricultural land preservation (Skinner et al., 2001; Lichtenberg and Ding, 2008; Tan et al., 2009; Wu et al., 2017), evaluation of regulation and quota institution of agricultural land conversion (Tan and Beckmann, 2010; He et al., 2013; Xu et al., 2015; Zhong et al., 2018). However, few of them concentrate on comparison among different types of tools. Moreover, payment tools are not integrated and their substitution effects for regulatory tools are less discussed.

The second category is about the interaction of policy tools in agricultural land preservation. Although literature concentrates on the comparison of policy tools (Duke and Lynch, 2006; Turnbull, 2004; Petrini et al., 2016) and evaluates the effects of multiply tools in agricultural land preservation (Nelson, 1992; Bengston et al., 2004; Pester, 2004), the interaction of different policy tools is less discussed since most tools of agricultural land preservation are practiced independently. An exception is that transferable of development right is used to mitigate unfair welfare effects of zoning (Marquitz and MacRae, 2004). In this case, the relationship between the regulatory and payment tools is concerned in the comparison of zoning-integrative and zoning-alternative transferable development rights (Chiodelli and Moroni, 2016). However, in many fields, the research on the interaction of policy tools for policy innovation is not new (Mundell, 1962; Manchester Institute of Innovation Research, 2013) and the studies on environmental policy have discussed the different types of interaction among policy tools (Sorrel and Sijm, 2003; Flanagan et al., 2011; Yi and Feiock, 2012).

Our paper will contribute to literature from two aspects. Firstly, the study constructs a theoretical framework to analyze the effects of the regulatory and payment tools in Chinese agricultural land preservation. This framework elaborates on how these policy tools constitute and play roles in the policy system of agricultural land preservation, which can provide a persperctive for policy improvement under the background of Chinese socio-economical transformation (Liu et al., 2018b; Long and Qu, 2018; Yang et al., 2018a, b).

Secondly, we analyze the payment-regulation substitution relationship from the perspective of nonmarket value instead of the perspective of land quality. The merit of the theory of nonmarket value is that it provides both a general standard and access to empirical method for the evaluation of policy tools. Therefore, we provide a new case for the literature on the interaction of policy tools to present that the empirical method can be incorporated to evaluate the effects of policy tools which cannot be fully addressed by theoretical and qualitative analysis. In addition, the result of choice experiment (CE) would provide a reference for deepening reform and innovation of agricultural land preservation policy both for China and other countries with similar backgrounds.

The paper is structured as follows: Section 2 is the background of Chinese agricultural land preservation policies and the paper's theoretical framework; Section 3 is the data and empirical analysis; Section 4 is the results analysis; Section 5 is the discussion and Section 6 is the conclusion.

2. Background and theoretical framework

2.1. Background of Chinese agricultural land preservation policies

The policy system of Chinese agricultural land preservation is illustrated in Fig. 1. As every province, prefecture and township has its own *comprehensive land use planning* (CLUP), related sections of CLUP arrange and control the area and location of each agricultural land type during a period of 15 years. According to CLUP, *annual land use planning* allocates 3 quotas: the new construction land quota, the cultivated land retention quota and the cultivated land supplement quota. The State Council, not local governments, annually allocates quotas to every province, and the provincial-level government allocates these quotas into its prefecture, county and township. In the process, the sum of the low-level quotas should not exceed their upper-level.

As Fig. 1 shows, the quotas of *annual land use planning* are practiced by regulatory and payment tools. In the regulatory tools, the amounts and extent of regulation of land use are strictly enforced by the Ministry of Natural Resources and the Bureau of State Land Supervision as professional institutions. First, agricultural land conversion must be approved by the State Council or provincial governments.[2] Second, *Regulation of basic farmland protection* stipulates that every provincial government should designate 80 % of cultivated land as basic farmland, which is reserved permanently or during the period of CLUP. Third, the policy of *construction land saving and intensive use* is enforced to level up capital and labor investment in the unit area of construction land and to constrain the scale of urban sprawl (Hui et al., 2015).

The payment tools is combined by *cultivated land consolidation* (CLC), *cultivated land development* (CLD) and *agricultural subsidies*. Among them, CLC programs aim to level up production, living and ecological conditions by means of agricultural engineering, including field leveling, water projects, roads construction and tree planting (Li et al., 2018). CLC programs were formally launched when the Land

[1] In short, provinces include autonomous regions or municipalities which are also provincial-level districts in China.

[2] If converted land contains basic farmland over 35 ha or agricultural land over 70 ha, the application must be approved by the State Council. Otherwise, the application must be approved by provincial governments. http://english.agri.gov.cn/overview/201703/t20170301_247343.htm.

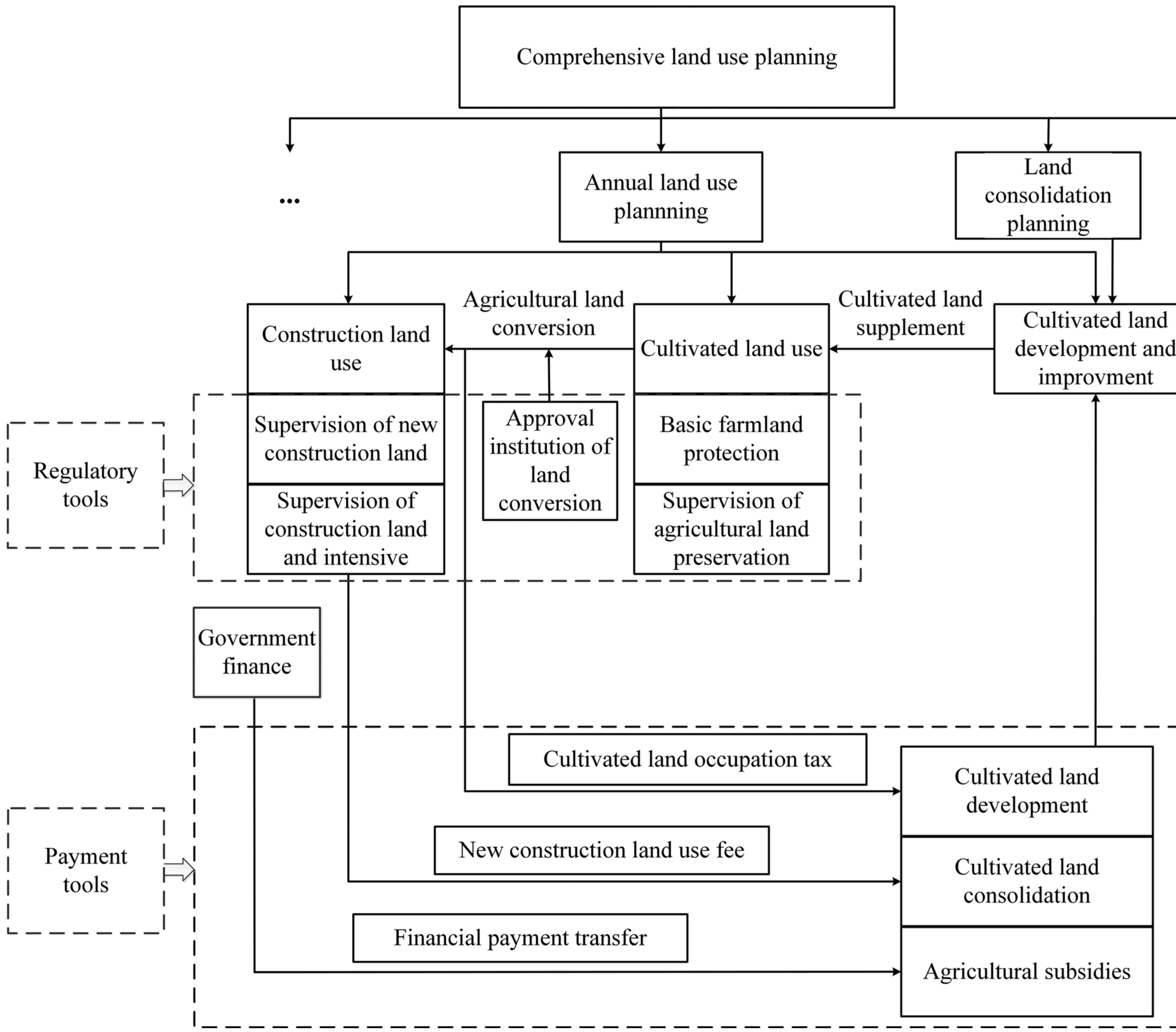


Fig. 1. Policy system of Chinese agricultural land preservation.

Consolidation and Rehabilitation Center, which belongs to the Ministry of Natural Resources (the Ministry of Land and Resources prior to 2018), was established in 1998. Then, in 1999, the administrative measures of *new construction land use fees* were enacted, which stipulated that the State Council and provincial governments collect these fees from land users whose application for new construction land was approved (Tang et al., 2017). According to these measures, CLC is financially supported by *new construction land use fees*. Since China is experiencing high-speed urban development, the investment for CLC have grown quickly in the last 20 years.

CLD is used to convert other types of agricultural or nonuse land (uncultivated land) into cultivated land for sufficient food production, which is the direct implementation of the cultivated land dynamic balance system. Similar to the "the polluter pays" principle, the financial basis of CLD is cultivated land occupation fees from land users. However, CLD consistently arouses discussion due to the loss of other types of agricultural land and the low quality of newly developed land (Lichtenberg and Ding, 2008; Liu and Li, 2017; Wu et al., 2017).

Agricultural subsidies include the direct subsidy for grain producers (in Chinese, liangshi zhijie butie), the subsidy for superior crop varieties (youliang pinzhong butie), the subsidy for the purchase of advanced farm tools and machinery (nongjiju butie), and the general subsidy for agricultural input (nongzi zonghe butie). Among these, the subsidy for grain producers and the general subsidy for agricultural input are determined by the State Council and reallocated to provinces according to the production of related crops. The subsidy for superior crop varieties is to facilitate farmers who adopt new and high-quality varieties. When authorized, dealers can sell those particular seeds at a discount to farmers. Similarly, the subsidy for the purchase of advanced farm tools and machinery is used for farmers who buy machines within manual range. In contrast to CLC and CLD, agricultural subsidies are not directly involved in the payment-regulation substitution relationship since they are sourced from financial payment transfers rather than from the process of rural-urban land conversion. However, we must consider agricultural subsidies as part of the payment tools that improves the production capacity of cultivated land.

In addition, we do not include some policy techniques which are also concerned with agricultural land preservation, such as the *green for grain program* aiming to conserve the ecological function and *rural habitat consolidation* for increasing farmland (Liu and Li, 2017; Cheng et al., 2019). Unlike above-mentioned tools, these techniques are not enacted commonly in every region as the nature conditions or social and financial limits (Li et al., 2014).

Therefore, the regulatory tools and payment ones constitute the entire policy system of agricultural land preservation. Meanwhile, the payment-regulation substitution is generated in the system since the fees/taxes in the payments tools are from benefits of agricultural land conversion. As a result, when the payment tools perform well, the land

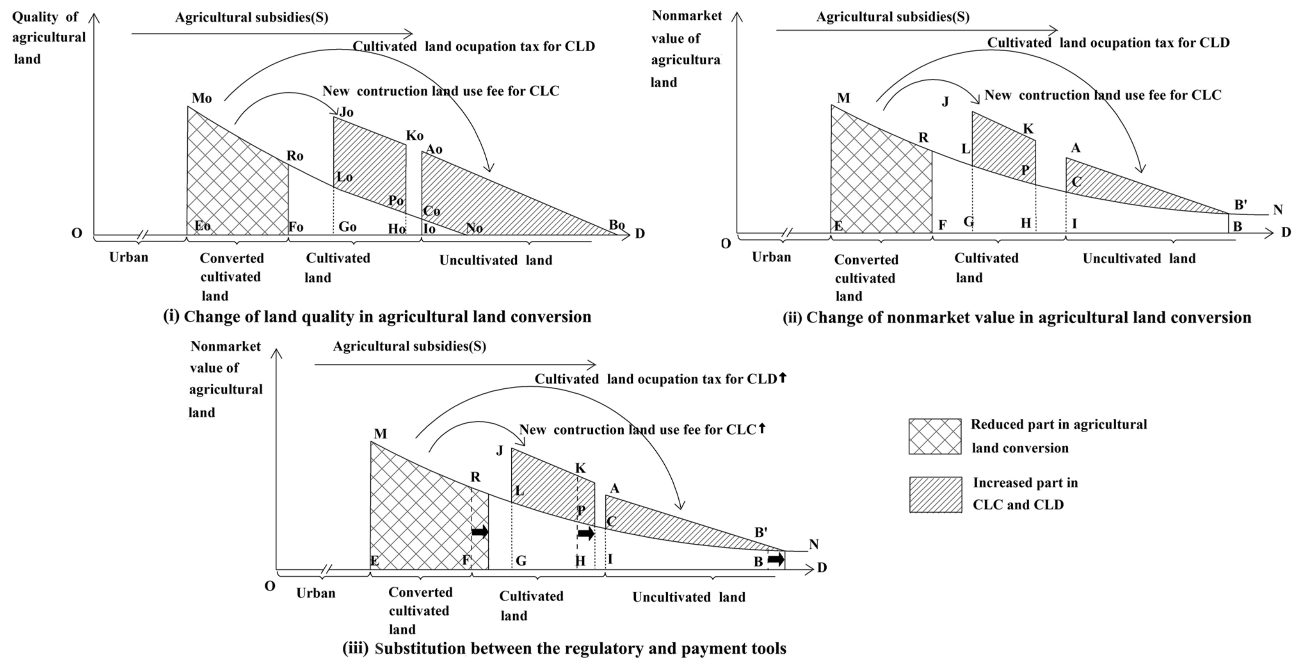


Fig. 2. Effects of the regulatory and payment tools in Chinese agricultural land preservation.

regulation can be relaxed in decision-making of agricultural land conversion. Generally, there are two elements cause the generation of the substitution relationship. At first, based on the DBTCL, the goal of agricultural land preservation is simplified to the quantity balance of cultivated land. In addition, governments take the responsibility of the DBTCL, regulatory and payment tools in the meantime. Therefore, they have the chance to choose policy tools when there are substitution relationships between different tools.

2.2. Theoretical framework of Chinese agricultural land preservation policies

To evaluate the different effects between the regulatory tools and payment ones, we construct a theoretical framework based on the single center bid-rent model (Alonso, 1964) and inspired by Barlowe's (1986) model for intensity of farmland use. Our framework is from the perspectives of agricultural land quality and nonmarket value. Agricultural land quality is considered because food security is almost the most emphasized function in the Chinese land policy system. Thus the Fig. 2(i) measures the quality level of agricultural land (Q) using the vertical axis and the distance (D) to the central business district (CBD) is measured by the horizontal axis, while NM is the quality function (Q= f(D)) which decreases as D increases.

In the process of land conversion, the regulatory and payment tools play different roles to maintain the amount of cultivated land. The regulatory tools are used to prevent urban from extending beyond the boundary R_0F_0. Meanwhile, according to the payment tools, the land users of the converted land E_0F_0 should pay *cultivated land occupation taxes* for CLD and *new construction land fees* for CLC, as shown by the two arrows in Fig. 2. After CLC, the cultivated land G_0H_0 would be improved to a higher level of quality presented as an integration increases from $L_0P_0H_0G_0$ to $J_0K_0H_0G_0$[3] . And following CLD, the uncultivated land I_0B_0 is developed to cultivated land and the quality level of I_0B_0 increases from $C_0N_0I_0$ to $A_0B_0I_0$. After the implementation of CLC and CLD, the quantity balance of cultivated land can be ensured by $I_0B_0 = E_0F_0$ and a quality balance can be reached if $J_0K_0P_0L_0 + A_0B_0N_0C_0 + S = M_0R_0F_0E_0$, where S is assumed as constant because agricultural subsidies are not directly influenced by the other policy tools in this framework.s

We then move to the perspective of nonmarket value which can provide a broader view to evaluate the performance of the policy tools for agricultural land preservation. Generally, the nonmarket value of agricultural land preservation is the utility citizens derive from agricultural land preservation which not only ensures food security, but also provides ecological, landscape, recreational services and so on (Kallas et al., 2007). In Fig. 2(ii), the horizontal axis still measures the distance (D) to CBD while the vertical axis measures nonmarket value (W) of agricultural land preservation. As the above illustrates, W comprises the food security function ($w_f(Q)$) and other functions (w_o) including ecological, landscape, recreational services and so on. Therefore NM is the curve of the nonmarket value function (W= $w_f(Q(D)) + w_o(D)$) which have a different slope from the quality function Q in Fig. 2(i). Therefore, Fig.2(ii) shows that from the perspective of nonmarket value, the quality balance ($J_0K_0P_0L_0 + A_0B_0N_0C_0 + S = M_0R_0F_0E_0$) in Fig. 2(i) does not mean that the nonmarket value satisfies the equation JKPL + AB'C + S = MRFE. Presumably, keeping the nonmarket value balance is more difficult than keeping the quality balance because the improvement of agricultural land quality, such as building roads or reclaiming land, may affect ecological services or landscape in that area.

In the payment-regulation substitution relationship, the movement of the boundary of the land regulation could change the amount of taxes and fees in the payment tools. Fig. 2(iii) illustrates that if RF moves to the right, the land regulation is relaxed and substituted by the payment tools. Then land users have to pay more the *cultivated land occupation taxes* and the *new construction land fees* for the larger area of land conversion. Then there is more investment in CLC and CLD to make KH and BB' move toward the right.

Based on above analysis, we can find that the DBCTL in China allows the regulatory tools to be substituted by the payment tools (RF moving toward the right) in some extent as long as IB = EF. However, the key question is that whether the degree of the substitution in the current policy of China is appropriate. This question can be addressed

[3] In reality, CLC could develop new cultivated land since areas such as E_0F_0 can have uncultivated parcels for reasons such as low soil quality, water shortage, etc. However, in this model, we assume the quality of agricultural land is only influenced by the distance to the CBD.

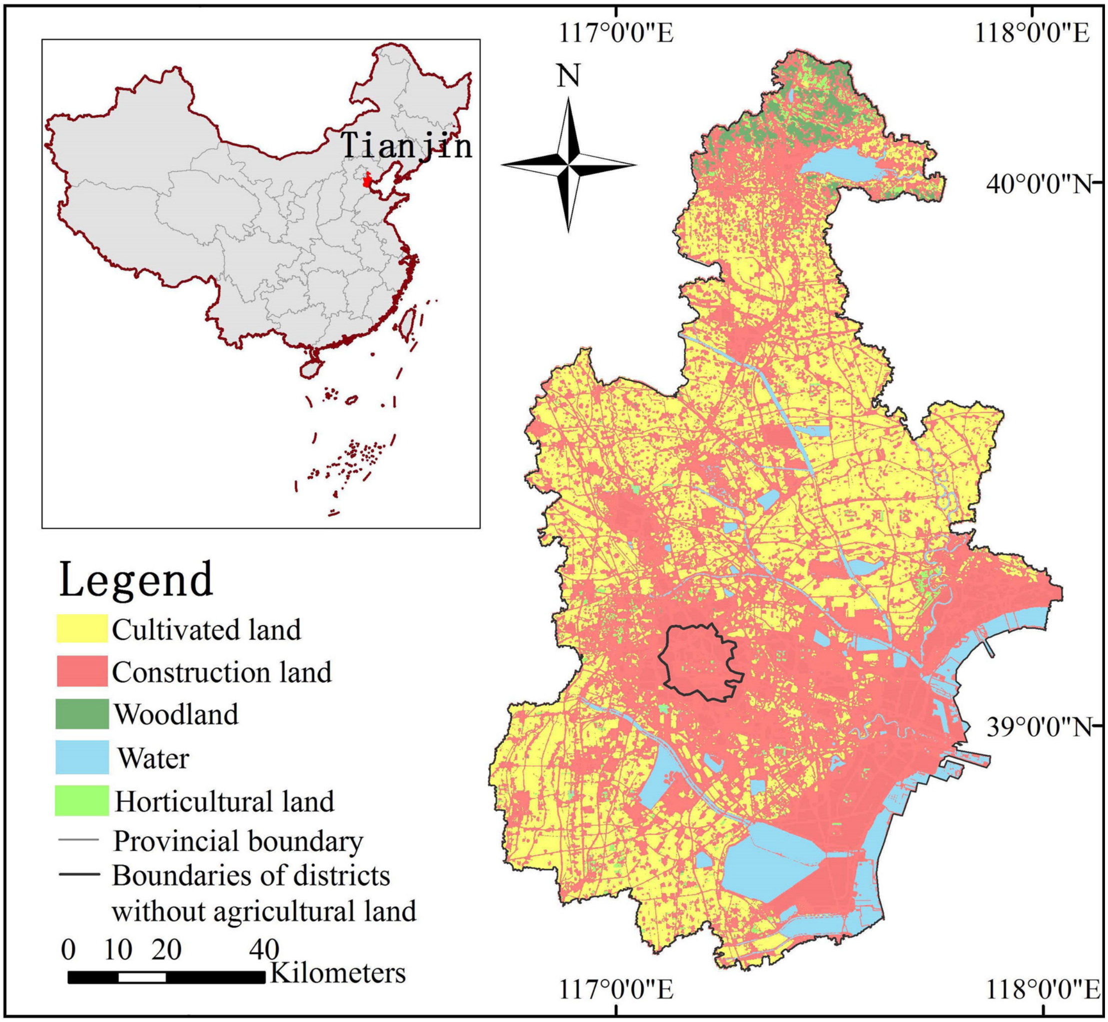


Fig. 3. Location and land use of Tianjin, China.

by methods for nonmarket value measurement. Specifically, we compare three types of policy tools, namely the regulatory tools, the payment ones and the hybrid ones which combine the regulatory and payment tools in proportion to the practical policy in China. The criterion is as follow.

(1) If the regulatory tools have the highest nonmarket value in the three types of policy tools, the degree of the payment-regulation substitution is larger than the ideal situation.

(2) If the payment tools have the highest nonmarket value, the degree of the payment-regulation substitution is smaller than the ideal situation.

(3) If the hybrid tools have the highest nonmarket value, the current substitution degree is close to the ideal situation and has no need to be improved.

3. The data and the method

3.1. Study area

Tianjin is a municipality and important economic center in northern China (Fig. 3). 16 districts belong to the city and 10 of them reserve agricultural land. Except for the mountain area in Jizhou district, most terrain in Tianjin comprises plains. As of 2017, the GDP of Tianjin was 179.00×10^9 CNY, the population was 15.57 million and the urbanization rate of the population was 78.28 %. For the land area, according to the Ministry of Natural Resources of China in 2016, the urban and town land area is 15.51×10^4 ha, cultivated land, horticultural land, woodland and rural ponds are 43.69×10^4 ha, 2.97×10^4 ha, 5.48×10^4 ha, and 7.40×10^4 ha, respectively.

The agricultural region in Tianjin can be divided into 4 parts, which are the Northern Uplands, Southeastern Seaboard, Northern and Southern Plains. In the Northern Uplands, forestry and horticulture are the main agricultural industries. In the Southeastern Seaboard fishing flourishes and there is a small amount of land used for crop production. The Northern and Southern Plains are the main regions for crop production in Tianjin. Grain crops, including wheat, corn and maize, are predominant and the major commercial crops are cotton, oil crops and vegetable.

The research chooses Tianjin as the study area because it is a classic representative of those cities who have the intense land use conflicts between urban expansion and agricultural land preservation. Specifically, Tianjin is not like those huge cities such as Beijing or Shanghai where there are very limited agricultural land for development, and it is also different from medium-sized or small cities in which the motivation for agricultural land conversion is not strong enough.

3.2. Implementation of agricultural land preservation in Tianjin

To describe the status quo of agricultural land preservation in the questionnaire, the study analyzes related policy performance in Tianjin in terms of policy effects. The statistic data is from 2009-2016, since China adopted a new caliber of land use data following The Second

National Land Survey.[4]

To illustrate the agricultural land use change in Tianjin, the whole area is divided into three categories, agricultural land, construction land and other land. Among them, agricultural land includes cultivated land, horticultural land, woodland and rural ponds. Other land, mainly mud flats, rivers and lakes, contains all the land except agricultural land and construction land.

Fig. 4 illustrates that in 2009–2016, only the area of construction land increased while the area of agricultural land and sother land decreased consistently. In 2010 and 2011, the area of construction land increased 12667 ha by occupying agricultural land 10267 ha and other land 2400 ha. In 2012 and 2013, the reduction of other land (5333 ha) almost equaled to that of agricultural land (5333 ha) because a large area of tidal flats beside the Bohai Sea were developed to construction land. Then in the period of 2014–2016, the increase of construction land slowed significantly for economic downturn while the area of agricultural land and other land did not decrease as much as previous years. Besides, we find from Fig. 4 that the decrease of cultivated land slowed a lot from 2010 − 2016. However, rural ponds decreased steadily over 1000 ha per year and even became the largest reduction in the types of agricultural land in 2015 and 2016.

In terms of policy implementation, Tianjin sets 284.7×10^3 ha of permanent basic farmland (29.8 % of Tianjin's area)[5] and 298.0×10^3 ha in the permanent ecological protection zone (39.2 % of Tianjin's area)[6] . Meanwhile, Tianjin should invest 992.0×10^6 CNY/year on CLC and 616.3×10^6 CNY/year on CLD and offset approximately 339.6×10^6 CNY/year on farmers complying with the standards of agricultural subsidies.[7]

3.3. Choice experimental design

The choice experimental design is divided into the following three stages: (1) setting attributes and levels; (2) setting choice sets and (3) designing questionnaires. In the first stage, we choose land types and policy tools as attributes of the experiment. Since cultivated land, horticultural land, woodland, grassland and rural ponds are the main category of agricultural land in Chinese current land use classification (GB/T21010-2017), we choose the first four land types excluding grassland due to its small area (11200 ha in 2016, 1.8 % of the agricultural land area in Tianjin). The four land type variables are set as dummy variables and have two states: "preserved" and "status quo".

As for the attributes of policy tools, the regulatory and payment tools represent the main preservation means in China. Based on these two tools, we design the hybrid tools which represent that the payment tools partly substitute for the regulatory tools. A pilot survey shows that respondents prefer the hybrid policy tools to a single policy and they would mostly choose the regulatory tools instead of the payment tools providing a single type of tool. Therefore, the two policy variables are the regulatory tools and the hybrid tools in every option of the questionnaire. The value of these two attributes being (0, 0) means that the option adopts the payment tools but no regulation, (1, 0) represents that the regulatory manner, but no payment, (0, 1) is the hybrid tools combining both, and (1, 1) will not happen. Accordingly, the coefficient of the regulatory variable shows the preference difference between the single regulatory and single payment tools, and the coefficient of the hybrid variable shows the difference between the hybrid tools and single payment tools (Table 1).

However, the attributes of land quality are not included in the experiment for 3 reasons (Yang et al., 2016; Jin et al., 2018). Firstly, the current land preservation policies do not stipulate standards of land quality concerning indicators such as soil fertility, water and species richness. Secondly, the introduction of land regulation, CLC and CLD in the questionnaire includes the information about location, infrastructure and production level. Thirdly, fewer attributes can help respondents to focus on the theme of policy tools.

In the second stage, the options are formed systematically according to fractional design. The attributes in Table 2 generate $2^4 \times 3 \times 4 = 192$ possible options. In the analysis, 27 choice sets are created by a randomized design using R software and 11 choice sets are excluded for containing meaningless options (Aizaki and Nishimura, 2008). Eleven choice sets are blocked into 2 questionnaire versions, and each version has 9 choice sets. The number of choice sets in a questionnaire is in line with the previous studies which consider both respondents' proficiency in making choices and fatigue with increasing questions (Lizin et al., 2015; Caussade et al., 2005). In the questionnaire, each choice set contains three options: two of them are the situation of program implementation and the rest is neither plan (status quo). In each block, choice sets are ordered differently in 3 versions to avoid order effect bias (Lizin et al., 2015; Day et al., 2012).

In the third stage, we develop a questionnaire in three parts: status quo description, option choice, and individual characteristics statements. The context of the current policy is introduced by Table 2. And an example of the scenario in the questionnaire is presented as Table 3. In the process of experiment, every respondent should make choice in 9 scenarios. In each scenario, a respondent need to choose an alternative from three alternatives to maximize the welfare of his/her household. And these alternatives are the programs with a set of attributes with different levels. By observing their choices, the marginal WTP of attributes can be measured. Thus we can estimate the total WTP for the program with a certain alternative.

Though not very widely, the policy tools have been emphasized and included in CE in natural resource, environment and medicine research to prevent bias in inappropriate policy assumptions of the SP method (Kahneman et al., 1993; Bosworth et al., 2010; Roesch-McNally and Rabotyagov, 2016). As in the literature, the single and inexplicit policy assumption may suppress information for WTP estimation (McGonagle and Swallow, 2005; Johnston and Duke, 2007; Rogers, 2013). Robinson and Hammitt (2011) indicate that a specific policy description may help to make the assumption more realistic to respondents by encouraging people to consider risk perception and to weight the coefficient of achievement aims (Rolfe and Windle, 2013; Onel, 2016; Gregg and Wheeler, 2018). Therefore, to get a confident result of public preference, we try to make a brief and clear introduction of the current policy condition as the policies row in Table 2 at the beginning of the questionnaire to avoid knowledge misunderstanding (Robinson and Hammitt, 2011).

3.4. Data collection

The data were collected in person between May 2017 and June 2018. Respondents are chosen from each district of Tianjin. A pilot survey of 52 respondents was conducted prior to the CE questionnaires to estimate the interval of payment choices and their attitude to the policy tools of agricultural land preservation. As a result, the interval of payment choices is appropriate at [0,200] CNY per year. In addition, respondents prefer the hybrid tools to the other two tools and most of them believe the regulatory tools are more effective than the payment tools. This information is the basis of the questionnaire design.

As a result, 438 respondents were investigated. The valid number of block A questionnaires is 282 (97.9 %) and the valid number of block B questionnaires is 144 (97.3 %). In total, the samples involved 3834 (426×9) choice observations. Table 4 presents the 426 valid respondents' characteristics.

[4] Data from the Chinese Ministry of Natural Resource.

[5] http://m.xinhuanet.com/2017 − 06/25/c_1121206230.htm

[6] https://baijiahao.baidu.com/s?id = 1610912900416203429&wfr = spider&for = pc

[7] Investment amounts of CLC and CLD are calculated by standards and corresponding land area, and agricultural subsidies are calculated by subsidies in 2016 and relevant data in the *Chinese Statistical Yearbook 2010 − 2017*.

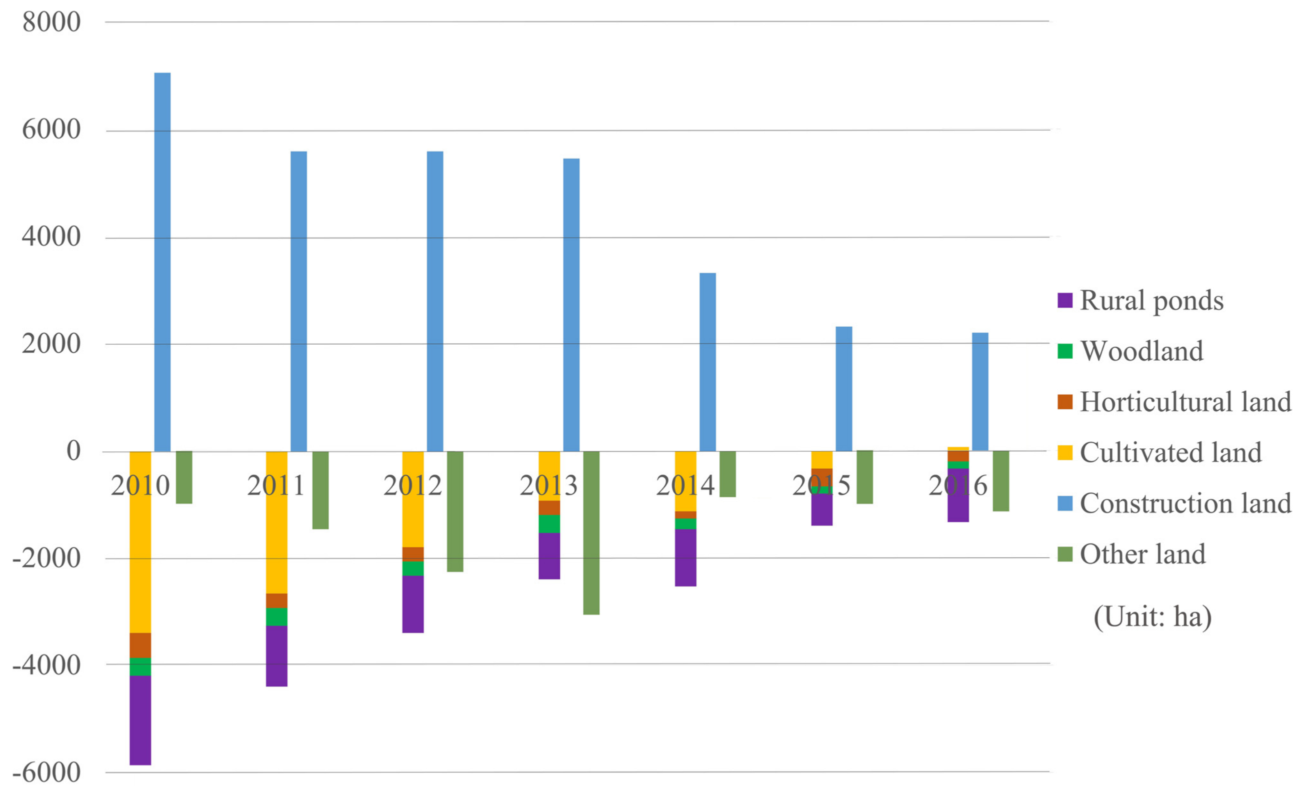


Fig. 4. Annual changes of agricultural land, construction land and other land in Tianjin in 2010-2016.

Table 1
Description of the attributes and levels in the CE exercise.

Attribute		Description	Level	Code name
Land Types	Cultivated Land	Attribute variable indicating whether cultivated land is preserved in the preservation program	preserved/status quo	Cult
	Horticultural Land	Attribute variable indicating whether horticultural land is preserved in the preservation program	preserved/status quo	Hor
	Woodland	Attribute variable indicating whether woodland is preserved in the preservation program	preserved/status quo	Wood
	Rural Ponds	Attribute variable indicating whether rural ponds are preserved in the preservation program	preserved/status quo	Pond
Policy Tools	Regulatory vs. payment	Attribute variable indicating whether to adopt regulation instead of payment tools	adopt/none	Regu
	Hybrid vs. payment	Attribute variable indicating whether to adopt a hybrid tool instead of payment tools	adopt/none	Hybr
Costs		WTP for the preservation program	¥50/¥100/ ¥150/¥200	Cost

In addition, in these respondents, there are only 39 rural residents, about 9.2 % of the total sample which is lower than the percentage of rural residents in Tianjin. Two causes accounted for the low rate of rural residents in our research. The first was that interviewers did not have chance to interview many rural residents. Actually, the rate of people living in rural is even lower than the registered rate of rural residents 21.7 % in 2017 and 17.10 % in 2018 for some rural residents working and living in the built-up area. The second cause was that some rural residents did not understand the hypothetical market because they thought that the program made them to pay for their own agricultural land. In this experiment, we do not identify the difference of WTPs between urban and rural residents but farmers need to choose "yes" for their work in Table 4.

3.5. Model specification

The probability for j plan options in choice set $\mathrm{C}(A, B, N)$ can be expressed as

$$P(j/C) = P(U_{iA} \geq U_{ik}) = P(v_{iA} + \varepsilon_{iA} \geq v_{ik} + \varepsilon_{ik})\, for\ k = B, N \tag{1}$$

As utility v_{ij} depends on the level of satisfaction that individual i obtains from an option j consisting of attribute levels,

$$v_{ij} = x'_{ij}\beta_i + \varepsilon_{ij} \tag{2}$$

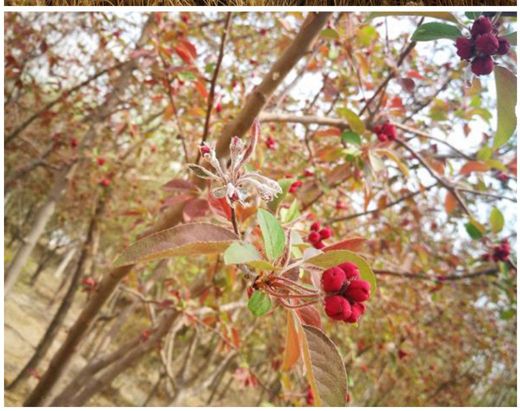
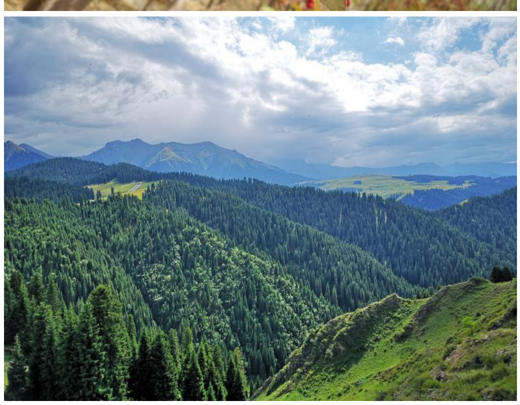
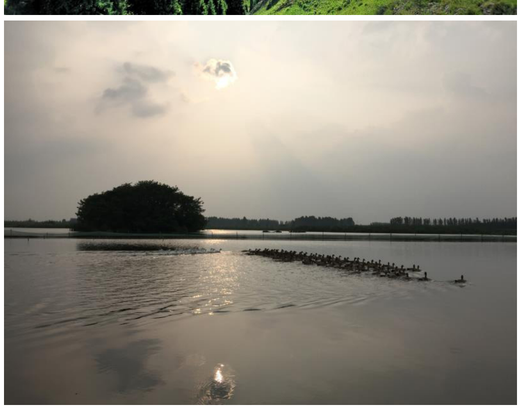
where x_{ij} are the attribute levels of option j, β_i is corresponding coefficients and ε_{ij} is the error term.

Based on the hypothesis that ε_{ij} satisfies independent and identically distributed (iid) and obeys type I extreme value distribution, we obtain a conditional logit model (CLM)

$$P(j/C) = \frac{\exp(x'_{ij}\beta_j)}{\sum_{j=1}^{J}\exp(x'_{i}\beta_j)} \tag{3}$$

where x_{ij} could also contain individual specific characteristics other than option attributes. As we focus on the influence of individual characteristics on WTP, we incorporate the interaction terms of costs and characteristics into the CLM. To consider heterogeneity of individuals' preferences for those policy tools, we also use a random parameter logit model (PRLM), which allows for individuals' policy preferences being various and each one's policy preference varying across those questions in different scenarios by making a hypothesis that the random parameters of the policy tools follow the normal distribution with their certain means and standard deviation. In addition, the PRLM considers the restriction of the independent and identically distributed (IID) assumption and does not require the independence of

Table 2
Description of the status quo and policy tools in the questionnaire.

Attributes	Status quo (2010 – 2016)		Goal of advanced preservation
Cultivated land		Decreasing average 1457.14 ha (0.3%) annually	Maintain current level of utilities (keeping all 436.9 × 10^3 ha or compensating utilities to the level)
Horticultural land		Decreasing average 276.19 ha (0.8%) annually	Maintain current level of utilities (keeping all 29.7 × 10^3 ha or compensating utilities to the level)
Woodland		Decreasing average 247.62 ha (0.4%) annually	Maintain current level of utilities (keeping all 54.8 × 10^3 ha or compensating utilities to the level)
Rural ponds		Decreasing average 157.14 ha (3.2%) annually	Maintain current level of utilities (keeping all 74.0 × 10^3 ha or compensating utilities to the level)
Policies	(Hybrid tools as status quo) **Regulation part:** Preserving 404.2 × 10^3 ha (80%) of agricultural land. **Payment part:** 340 × 10^6 CNY for farmers and 450 × 10^6 CNY/ha for cultivated land improvement per year.[a]		(Alternatives of advantage tools**)** **Single Regulation:** Preserving all 595.4 × 10^3 ha (100%) of agricultural land. **Single payment:** Increasing subsidies for farmers meeting criteria and agricultural land

(*continued on next page*)

Table 2 (*continued*)

Attributes	Status quo (2010 − 2016)	Goal of advanced preservation
		improvement. **Hybrid Policy:** Preserving agricultural land (535.9 × 10^3 ha, 90%) and increasing compensation for loss.

[a] In fact, the minimum standard of permanent basic cultivated land is 80 % of the current area of cultivated land. As a presumption for WTP estimation, we assume that the advanced minimum standard in the hybrid program is 90 %, and other agricultural land should also be preserved above 90 %. Additionally, under the scenario of a single regulation tool, we assume the scenario that all agricultural land should be preserved. The presumption may be deemed higher than in reality, but it is theoretically possible. For instance, Shanghai, another municipality of China, attempts to maintain all agricultural land and even to reduce the area of construction land.

Table 3
An example scenario question in the questionnaire.

Assuming these options for agricultural land preservation in Tianjin are public participating programs in addition to current policies. How would you vote?

Attributes	Option A	Option B	Option C
Cultivated land	preserved	preserved	status quo
Horticultural land	preserved	preserved	status quo
Woodland	status quo	status quo	status quo
Rural ponds	preserved	preserved	status quo
Policy tools	regulation	hybrid	status quo
Payment per year	100	200	0
I would choose:			

Estimation of PRLM requires the generation of a Halton sequence to stimulate independent draws from a uniform distribution. In our case, 100 draws are stable for the two policy tool parameters (Hensher et al., 2005). In addition, random parameters are usually relevant, the PRLM with correlated effects considers this relevance while the PRLM without correlated effects assume these random parameters are uncorrelated (Croissant, 2010).

Three tests (the Wald test, the score test and the likelihood ratio test) are applied in the study to test our hypothesis about models specification. The first null hypothesis tested is that the PRLM with uncorrelated effects is identical with the CLM, and the second is that the PRLM with correlated effects is identical with the PRLM with uncorrelated effects (Croissant, 2010). If the null hypothesis that the two models are equal at the 90 % level is rejected, then the latter model is fitter.

Table 4
Statistics of respondents' characteristics.

Variable	Code name	Description	Mean (Standard Deviation)
Gender	Gen	Respondents' gender: man = 1, woman = 0	0.61 (0.49)
Age	Age	Respondents' age: ≤30 = 0, 30−40 = 1, 40−50 = 2, 50−60 = 3, > 60 = 4	2.57 (1.11)
Liking	Liki	Binary (dummy) variable identifying if respondents like rural activities or not: yes = 1, no = 0	0.59 (0.49)
Work	Work	Binary (dummy) variable identifying if respondents' work relates to agricultural land or not: yes = 1, no = 0	0.41 (0.49)
Education	Edu	Dummy variable identifying respondents' education experience: no schooling = 0, primary school = 1, junior high school = 2, senior high school = 3, undergraduate = 4, master's = 5, Ph.D. = 6	3.78 (1.48)
Political[a,b,c]	Poli	Dummy variable identifying respondents' political status: politically unaffiliated = 0, member of the Communist Young League = 1, member of non-Communist parties = 2, Communist = 3	1.15(1.35)
Size	Size	Household size	3.57(1.11)
Dependency	Dep	Size of dependency members in household	1.38(0.94)
Income	Inco	Household income (Unit: × 10^3 CNY/year)	11.38(0.93)
District	Dis	District with agricultural land = 1, District without agricultural land = 0	0.70(0.46)

[a] Communist is the member of the Chinese Communist Party which is the sole governing party within mainland China. Communists should keep consistent with the party central committee and the central government. Therefore, literature in China usually supposes that Communists are positive to support public affairs such as land resource and environmental preservation.
[b] In China, non-Communist parties include eight parties. Many members of these parties are usually professionals in many fields such as lawyers, doctors. They are supposed to be knowledgeable and have awareness of land preservation.
[c] As the Communist Young League is the organization for young persons who want to become Communists, members of the Communist Young League may have preference for land resource preservation.

irrelevant alternatives (IIA), assuming that the alternatives chosen are unaffected by introducing or removing other alternatives (Hensher et al., 2005). In the PRLM, Eq. (2) is decomposed as

$$v_{ij} = x'_{im}\gamma_i + x'_{in}\theta_i + \varepsilon_{ij} \tag{4}$$

where x_{im} represents a fixed parameters array, x_{in} represents a random parameters array, γ_i and θ_i are corresponding coefficients, and ε_{ij} is a random error term.

As in our case, Eq. (4) is rewritten as

$$v_{ij} = \beta_{Cult}x_{Cult} + \beta_{Hor}x_{Hor} + \beta_{Wood}x_{Wood} + \beta_{Pond}x_{Pond} + \theta_{Regu}x_{Regu} + \theta_{Hybr}x_{Hybr} + \varepsilon_{ij} \tag{5}$$

Based on experiences of previous studies and on our foci, we select the coefficient of the policy tool attributes θ_{Regu} and θ_{Hybr} as random parameters obeying the normal distribution (Johnston and Duke, 2007).

We then estimate marginal WTP using suitable coefficients from models. As in CLM without interaction terms,

$$WTP_{Attributes} = -\beta_{Attribute}\big/\beta_{cost} \tag{6}$$

and in CLM or PRLM with interaction terms of costs and individual specific characteristics if there are N interaction terms significantly influence choice decision (García-Llorente et al., 2012; Westerberg et al., 2010).

$$WTP_{Attributes} = -\beta_{Attribute}\Big/\left(\beta_{Cost} + \sum_{n=1}^{N}\beta_{Cost*isc_n} * isc_n\right) \tag{7}$$

where $\beta_{Cost*isc_n}$ is the coefficients of interaction terms and isc_n is average value of each individual specific characteristics.

Finally, we can simulate the welfare changes of the agricultural land program using different attributes combinations.

$$\text{Welfare change} = -1/\beta_{Cost}(U_{SQ} - U_l) \quad (8)$$

Where U_{SQ} is the total utility in the status quo and U_l is the total utility in the scenario where agricultural land preservation programs are implemented.

Specifically, the typical program scenarios are as follows:

Scenario 1- Hybrid tools for all types of agricultural land: cultivated land, horticultural land, woodland and rural ponds are protected by the hybrid tools combing the regulatory and payment tools.

Scenario 2- Regulatory tools for all types of agricultural land: cultivated land, horticultural land, woodland and rural ponds are protected by the regulatory tools.

Scenario 3- Payment tools for all types of agricultural land: cultivated land, horticultural land, woodland and rural ponds are protected by the payment tools.

Scenario 4- Hybrid tools for cultivated land and rural ponds: cultivated land and rural ponds are protected by the hybrid tools combining the regulatory and payment tools; horticultural land and woodland retain the status quo.

Scenario 5- Regulation tools for cultivated land and rural ponds: cultivated land and rural ponds are protected by the regulatory tools; horticultural land and woodland retain the status quo.

Scenario 6- Regulation tools for cultivated land: cultivated land are protected by the regulatory tools; horticultural land, woodland, and rural ponds retain the status quo.

4. Results analysis

4.1. Utility coefficients estimation

Results for four models are illustrated in Table 5, including a MLM (multinomial logit model), a CLM, a PRLM with uncorrelated effects, and a PRLM with correlated effects. Table 6 summarizes the statistics results and hypothetical test results. Modes are statistically significant at better than $p < 0.001$.

Compared with Model 1 only containing attribute parameters, Model 2 includes the influence of individual characters on the individuals' utilities. As a result, this improvement is attained and Pseudo-R^2 increases from 0.2633 in model 1 to 0.2906 in model 2.

Model 3 is a PRLM without uncorrelated effects. And the tests of Model 3 versus Model 2 are used to identify whether it is an improvement to use the PRLM instead of the CLM. As a result, the PRLM is more suitable than the CLM for the study. Specifically, the score test rejects the null hypothesis of identically distributed errors ($\chi^2 = 2.118$, $\rho = 0.347$), yet the Wald test and likelihood ratio test of Model 3 vs. Model 2 fail to reject the null hypothesis of random effects ($\chi^2 = 31.307, \rho < 0.001$; $\chi^2 = 51.698$, $\rho < 0.001$ respectively). Generally, this set of tests shows that the individuals have heterogeneous preferences and/or each individual varies across questions in different scenarios.

Model 4 is a PRLM with correlated effects. In the tests of Model 4 vs. Model 3, the likelihood ratio test rejects the null hypothesis of identically distributed errors ($\chi^2 = 0.003$, $\rho = 0.954$), but the Wald test and score test fail to reject the null hypothesis of correlated effects ($\chi^2 = 28.687$, $\rho < 0.001$; $\chi^2 = 54.628$, $\rho < 0.001$ respectively). This set of test presents that these two policy tool parameters are relevant. Given the superior performance of Model 4 in the above models, we emphasize the result of the Model 4 specification.

Table 5 shows that all attribute parameters are significant ($p < 0.001$), and the pattern is robust across all specifications. As for the land type attributes, citizens have explicit awareness of these agricultural land types and their multifunctions, although some have rarely reached into open space. Given the low degree of suburbanization in Chinese cities, the results differ from reports in North America, where open space significantly influence household amenity and residence prices (Kline and Wichelns, 1996; Irwin and Bockstael, 2002).

The result of the policy tool parameters shows that the policy tools significantly influence WTP of agricultural land preservation. The coefficients also confirm that interviewees usually take land regulation as an effective tool to restrict overdue land development ($\beta_{Regu} = 0.8216$). However, if one combines the regulatory and payment tools, a hybrid manner increases the interviewees' WTPs for joining a land preservation program ($\beta_{Hybr} = 1.6030$). The results also show the distribution of the random parameters that reflect policy preference, and the significant preference heterogeneity between Hybr and Regu ($\sigma^2_{Regu \cdot Hybr} = 1.4987$).

Of all 10 individual parameters, 6 are statistically significant at $p < 0.10$ or lower. The interactions of individual variables with their costs present the influences of individual variables on WTP. Among these individual variables, respondents' gender, work category, income and district are not significant factors influencing their payments. WTPs rise with age ($\beta_{Age\times\text{cost}} = 0.0006$), and if individuals enjoy rural amenity, their payments increase ($\beta_{Liki\times\text{cost}} = 0.0020$). Respondents with a higher degree of education have more WTP for land preservation ($\beta_{Edu\times\text{cost}} = 0.0015$). The size of the household could affect WTP positively or negatively. Given that the dependency population is controlled in the model and that the household factor is not significant, $\beta_{Size\times\text{cost}} = 0.0011$ may result from a larger size of household with higher household income and lowers average payments for the program. For the political identity of individuals, the results show that the Communists would pay more to preserve agricultural land, and if individuals are members of non-Communist parties or the Communist Youth League, then their payments are also higher than people with no political affiliation ($\beta_{Poli\times\text{cost}} = 0.0006$). In addition, individuals with more dependents would pay less for land preservation ($\beta_{Dep\times\text{cost}} = -0.0007$). Generally, the estimations of $\beta_{Age\times\text{cost}}$, $\beta_{Liki\times\text{cost}}$, $\beta_{Popu\times\text{cost}}$, and $\beta_{Poli\times\text{cost}}$ are robust across three model specifications, but $\beta_{Dep\times pay}$ is only significant in Models 3 and 4.

4.2. Marginal WTP of attributes

According to the Eq. (7), the marginal WTPs of attributes are calculated as the mean values in the RPLM and the confidence intervals at 95 % are in brackets (Table 7).

The marginal WTPs of the policy tools present the average welfare differences among three different tools. The mean marginal WTP for the hybrid policy tools are 117.10 CNY higher than that for the payment tools, which means that with all other things being equal, each citizen would pay on average 117.10 CNY/year more if the payment tools are replaced by the hybrid tools in a program. Meanwhile, the WTP for the regulatory tools are 60.93 CNY higher than that for the payment tools, which illustrates that each citizen would pay on average 60.93 CNY/year more for the payment tools being replaced by the regulatory tools.

Generally, above results show that the public prefers the hybrid tools to the regulatory or payment tools, and if comparing the regulatory tools and the payment ones, the public prefers the regulatory tools. The results also indicate that the public preference is consistent with the current policies of agricultural land preservation. It is appropriate to substitute the payment tools for the regulatory tools in proportion to the current policy system. However, an excessive payment-regulation substitution would cause more loss of nonmarket value than insufficient substitution as the public prefers the regulatory tools.

Table 7 also presents the marginal WTPs for preserving the different land types in Tianjin. From high to low, the marginal WTPs for cultivated land, rural ponds, woodland and horticultural land are 193.58, 150.65, 86.31 and 31.50 CNY/year, respectively. Among them, the marginal WTP for cultivated land is the highest as each citizen would pay more on average 193.58 CNY/year if the preservation level of

Table 5
Result of parameter estimates in CE.

	Model 1		Model 2		Model 3		Model 4	
	MLM		CLM		PRLM without correlated effects		PRLM with correlated effects	
Asc	−0.3742	***	−1.4346	***	−1.4124	***	−1.4124	***
	(0.04916)		(0.0945)		(0.1076)		(0.1075)	
Cult	2.3277	***	2.3074	***	2.6207	***	2.6212	***
	(0.09458)		(0.0967)		(0.1172)		(0.1169)	
Hor	0.1384	**	0.4152	***	0.4637	***	0.4637	***
	(0.0474)		(0.0524)		(0.0650)		(0.0637)	
Wood	0.9368	***	1.1472	***	1.1542	***	1.1537	***
	(0.0636)		(0.0653)		(0.0884)		(0.0891)	
Pond	1.5057	***	1.8148	***	2.0305	***	2.0308	***
	(0.1018)		(0.1121)		(0.1255)		(0.1250)	
Regu	0.8441	***	0.7413	***	0.8218	***	0.8216	***
	(0.0514)		(0.0516)		(0.0737)		(0.07639)	
Hybr	2.0369	***	1.3351	***	1.6021	***	1.6030	***
	(0.1140)		(0.1180)		(0.1691)		(0.1757)	
Cost	−0.0142	***	−0.02340	***	−0.0254	***	−0.0254	***
	(0.0010)		(0.0012)		(0.0015)		(0.0015)	
Gen × cost			−0.0003		0.0006		0.0001	
			(0.0002)		(0.0006)		(0.0001)	
Age × cost			0.0009	***	0.0007	***	0.0006	***
			(0.0002)		(0.0003)		(0.0003)	
Liki × cost			0.0017	***	0.0020	***	0.0020	***
			(0.0006)		(0.0006)		(0.0006)	
Edu × cost			0.0014	***	0.0014	***	0.0015	***
			(0.0002)		(0.0002)		(0.0002)	
Size × cost			0.0010	**	0.0010	***	0.0011	***
			(0.0003)		(0.0004)		(0.0004)	
Work × cost			−0.0004		−0.0003		−0.0003	
			(0.0006)		(0.0006)		(0.0006)	
Poli × cost			0.0005	*	0.0006	**	0.0006	**
			(0.0002)		(0.0002)		(0.0002)	
Dep × cost			−0.0005		−0.0007	*	−0.0007	*
			(0.0004)		(0.0004)		(0.0004)	
Inco × cost			0.0000		0.0000		0.0000	
			(0.0000)		(0.0000)		(0.0000)	
Dist × cost			0.0014	*	0.0011		0.0011	
			(0.0006)		(0.0007)		(0.0007)	
Sd. Regu					−0.0648		−0.0500	
					(2.2747)		(2.7819)	
Sd. Hybr					1.4953	***	−0.07462	
					(0.2681)		(4.6683)	
Regu.Hybr							1.4987	***
							(2.8363)	

*, ** and *** represent significance at the 10 %, 5% and 1% levels respectively.

cultivated land is improved from “status quo” to “preserved” in the program of agricultural land preservation. The marginal WTP for horticultural land is the lowest for the possible reasons that interviewees pay less attention to horticultural land and there is a small percentage of horticultural land in Tianjin. Besides, we find that citizens have relatively high WTPs for rural ponds which might not be reported in previous research. As we presented interviewees the status quo of the rural ponds in Tianjin in the questionnaire, the continuous decrease of

Table 6
Statistic summary and hypothesis tests.

	Model 1 MLM	Model 2 CLM	Model 3 PRLM with uncorrection effects	Model 4 PRLM with correction effects
Likelihood χ^2	2341.3	2564.3	2583.5	2583.6
Pseudo-R^2	0.2633	0.2884	0.2906	0.2906
Likelihood ratio test Model 3 vs. Model 2	–	–	$\chi^2 = 19.257$, $\rho < 0.001$	–
Wald test Model 3 vs. Model 2	–	–	$\chi^2 = 31.115, \rho < 0.001$	–
Score test Model 3 vs. Model 2	–	–	$\chi^2 = 2.118, \rho = 0.347$	–
Likelihood ratio test Model 4 vs. Model 3	–	–	–	$\chi^2 = 0.0057$, $\rho = 0.940$
Wald test Model 4 vs. Model 3	–	–	–	$\chi^2 = 31.307$, $\rho < 0.001$
Score test Model 4 vs. Model 3	–	–	–	$\chi^2 = 55.698$, $\rho < 0.001$
Observation	3834	3834	3834	3834

Table 7
Marginal WTP of attributes (Unit: CNY/year).

Attributes	Marginal WTP (Confidence Interval at 95 %)
Cultivated land	193.58[176.50 – 210.66]
Horticultural land	31.50[14.42–48.58]
Woodland	86.13[69.05–103.22]
Rural ponds	150.65[133.57 – 167.73]
Regulatory vs. payment	60.93[43.85–78.02]
Hybrid vs. payment	117.10[100.02 – 134.18]

rural ponds may be the reason for the high marginal WTP. In this sense, the economical and ecological effects of the steadily decrease of rural ponds should be noticed in the future land use planning of Tianjin. In addition, the marginal WTP for woodland is less than a half of the marginal WTP for cultivated land, which is accord with our expectation. Although woodland would provide better ecological services and landscape, the function of food security in cultivated land is more emphasized by citizens in Tianjin (Table 8).

4.3. Welfare change

Based on Eq. (8) and the population of Tianjin, Table 9 presents 6 typical programs and the interviewees' WTPs for these programs. The WTPs are welfares these programs would bring to citizens.

Program 1–3 use respectively the hybrid, regulatory and payment tools to preserve all types of agricultural land. While the policy tools change from the hybrid tools to regulatory ones and then to payment ones, the total WTP decreases respectively about 9.39 % and 19.93 % from 3.35×10^9 CNY/year.

Program 4 uses the hybrid tools to preserve only cultivated land and rural ponds in Tianjin. Compared with Program 1, the total WTP for Program 4 decreases 19.93 %.

Program 5 uses the regulatory tools to preserve cultivated land and rural ponds and Program 6 uses the regulatory tools to preserve single cultivated land. Compared with Program 1, the total WTP for these two programs decreases 29.82 % and 55.85 %, respectively.

Generally, Program 4 can be treated as the moderate level, then the WTP for agricultural land preservation is 2.43×10^9 CNY/year. Therefore, the public has a strong sense of agricultural land preservation, which is not reflected in current policies. In addition, comparing these programs especially Program 3 and Program 4, we find that the policy tools of agricultural land preservation can largely influence effects of the programs.

Table 9
Comparison of WTPs for cultivated land preservation in China (Unit: CNY/year).

Source	Study region	WTP for cultivated land (Confidence interval at 95 %)
Our study	Tianjin	[176.50 – 210.66] (CE)
Jin et al. (2018)	Wenling	506.39 (CE)/452.10 (CVM)
Yang et al. (2016)	Wuhan	[516.00 – 886.00] (CE)
Ma and Zhang (2014)	Wuhan	[133.50 – 247.02] (CE)
Zhu et al. (2010)	Nanjing	208.33 (CVM)

5. Discussion

The study constructs a framework and uses CE to address the question that whether the payment-regulation substitution is reasonable in the policy system of agricultural land preservation in China. And the result supports this substitution in the current policy system. However, to get a comprehensive conclusion for the theme, some issues need to be discussed.

Firstly, the result shows that the payment-regulation substitution in China is reasonable although the nonmarket value of the policy tools is not yet clear in the previous literature. The possible reason is that the public preference is consistent with the current policy system especially in terms of the importance of cultivated land and its function of food security. Thus the result would mean that this substitution mechanism could also be used by the type of countries and regions where the public recognizes the threat of food security (Edelman, 2014). But it may not suitable for the countries and regions in which the citizens tend to emphasize landscape amenity and the accessibility to open space (Irwin et al., 2002).

Secondly, this study is related with the literature on policy innovation and the interaction of policies (Sorrel and Sijm, 2003; Flanagan et al., 2011; Yi and Feiock, 2012). These studies classify the types of the interaction of policies from different perspectives. Our case can also be included in those classification systems, because the interaction of regulatory and payment tools is similar with the cap-and-trade policies. However, our case has at least two differences from other cases in above studies. On the one side, the goal of the DBTCL is to preserve the total amount of cultivated land, not like other regulations such as that in the cap-and-trade policy which regulates a part of quotas and allocates the rest to actors. On the other side, the payment-regulation substitution occurs in the governments' decision-making process while most interaction cases in literature are concerned with market mechanism (Sorrel and Sijm, 2003; Yi and Feiock, 2012). However, the case of the payment-regulation substitution may provide inspiration for policy innovation especially in the situation that the cost is too high to

Table 8
WTPs for hypothetical programs (unit: CNY/year).

Attribute	Hypothetical Programs					
	Program 1: Hybrid tools for all types	Program 2: Regulation for all types	Program 3: Payment for all types	Program 4: Hybrid tools for cult + pond	Program 5: Regulation for cult + pond	Program 6: Regulation for cultivated land
Cultivated land	preserved	preserved	preserved	preserved	preserved	preserved
Horticultural land	preserved	preserved	preserved	status quo	status quo	status quo
Woodland	preserved	preserved	preserved	status quo	status quo	status quo
Rural ponds	preserved	preserved	preserved	preserved	preserved	status quo
Policy tools	hybrid policy	regulation	payment	hybrid policy	regulation	regulation
Annual WTP per household (Confidence interval at 95 %)	578.97 [493.55 – 664.38]	522.80 [437.38 – 608.21]	461.87 [393.53 – 530.20]	461.33 [410.08 – 512.58]	405.17 [353.92 – 456.41]	254.52 [220.35 – 288.69]
Annual total WTP (Confidence interval at 95 %)	3.35×10^9 [2.59×10^9-3.48×10^9]	2.75×10^9 [2.30×10^9-3.20×10^9]	2.43×10^9 [2.07×10^9-2.79×10^9]	2.43×10^9 [2.16×10^9-2.70×10^9]	2.13×10^9 [1.86×10^9-2.40×10^9]	1.34×10^9 [1.16×10^9-1.52×10^9]

establish a market for quotas.

Thirdly, we compare the marginal WTP of cultivated land with related studies in China as most studies in China focus only on cultivated land. Generally, from the perspective of model specification, our study is similar with Yang et al. (2016) in which the heterogeneity of individual preference is considered. However, our result is less than Yang et al.' s (2016). The most probable reason is that Yang et al.' s (2016) study only focuses on cultivated land while our study accounts for the four types of agricultural land and the policy tools. As mentioned in Section 3.3, we expect that knowledge gap causes the bias of WTP measurement. Thus our result based on the investigation with broader information may be more suitable for policy making.

Last but not least, the study area of Tianjin is a representative prosperous and highly urbanized city that does not undertake the main task of agricultural production. It is also necessary to investigate the public preference of major agricultural production provinces and ecologically fragile regions. In this case, estimation and comparison of WTPs in a variety of regions can provide further policy references.

6. Conclusions

Faced with the pressure of a large population, China innovatively adopts the policy system integrating the regulatory and payment tools to preserve agricultural land and to ensure stable quantity and quality of cultivated land. However, the generation of the substitution relationship between the regulatory and payment tools concerns with the performance of the policy system. This article investigates the mechanism of Chinese agricultural land preservation and the effects of the payment-regulation substitution relationship from the perspectives of agricultural land quality and nonmarket value. There are four conclusions drawn from the analysis.

(1) The study systematically examines the policy tools of Chinese agricultural land preservation by distinguishing the regulatory tools and payment ones, and illustrates the payment-regulation substitution mechanism. The substitution relationship generates when the taxes/fees collected from agricultural land conversion are invested in CLC and CLD to maintain the balance of quantity and quality of cultivated land. In our analysis, this substitution relationship is caused by the goal setting and governments' leading roles in agricultural land preservation of their districts.

(2) It is reasonable to partially substitute the payment tools for the regulatory ones in agricultural land preservation of China. In the CE including policy attributes, the marginal WTP for the hybrid tools, which represent the regulatory tools are partially substituted, is higher than the single regulatory tools and single payment ones. The result also shows that the regulatory tools have higher marginal WTP than the payment ones.

(3) It is possible to combine public programs into agricultural land preservation in China although agricultural land preservation is led by government. Our empirical study shows that the public in Tianjin largely supports the current policy and pays more attention to cultivated land and rural ponds preservation. In addition, citizens have recognized the nonmarket value of agricultural land and have significant heterogeneity in their WTPs.

(4) This paper may contribute to the literature on interaction of policy tools and on improvement of the policy system of agricultural land preservation. We present that nonmarket value is an important perspective for policy and plan making. Therefore, CE is an effective method to provide reference and feedback for implementation of policy tools across regions and periods. As concerned experiences are not wide enough for innovation and improvement of policy tools, further investigation can be made for comparative analysis and obtaining support from public in agricultural land preservation.

CRediT authorship contribution statement

Zhu Chen: Investigation, Conceptualization, Methodology, Writing - original draft, Writing - review & editing. **Anlu Zhang:** Conceptualization, Writing - review & editing. **Kehao Zhou:** Investigation, Software, Visualization. **Lingxiang Huang:** Conceptualization, Investigation, Writing - review & editing.

Acknowledgments

The study is supported by the National Natural Science Foundation of China (71704128, 71873053), the National Social Science Foundation of China (18ZDA054), the Ministry of Education of Humanities and Social Sciences Fund (17YJC630233). We especially thank the anonymous reviewers, Fu Yanhua from Tianjin Chengjian University, Xin Yang and Lanjiao Wen from Huazhong Agricultural University for suggestions.

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