Acta Ecologica Sinica 36 (2016) 30–35

Contents lists available at ScienceDirect

Acta Ecologica Sinica

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

Measuring external costs of rural–urban land conversion: An empirical study in Wuhan, China☆

Zhu Chen [a,b,*], Anlu Zhang [b], Min Song [c], Zhi Zhang [d]

[a] College of Economics and Management, Tianjin Chengjian University, Tianjin 300384,China
[b] College of Land Management, Huazhong Agricultural University, Wuhan, Hubei 430070, China
[c] College of Business Administration, Zhongnan University of Economics and Law, Wuhan, Hubei 430073, China
[d] Urban Development Subcenter, Wuhan Land Consolidation and Reserves Center, Wuhan, 430022, China

ARTICLE INFO

Article history:
Received 31 August 2014
Received in revised form 3 May 2015
Accepted 24 July 2015

Keyword:
External costs
Rural–urban land conversion
Externality measurement
Wuhan, China

ABSTRACT

Externalities of rural–urban land conversion are major factors in the inefficiency of land resource allocation. Although many studies have proposed policy solutions of externalities, measuring externalities is still a challenge. According to definition of externalities, externalities of rural–urban land conversion are the sum of nonmarket externalities and market externalities during land conversion process excluding owner of converted land. Therefore, to measure external costs accurately, the identification of internal parcels (converted parcels) and external parcels (influenced parcels) is necessary, and both nonmarket and market external costs should be considered. This paper proposed an improved approach to measure external costs by division of parcels. Firstly, the approach distinguishes internal parts and external parts by GIS technique and field surveys, and uses the boundary where WTP just decrease to zero to define extent of external part basing on Loomis' linear equation. Secondly, the model enumerates and analyzes effects of externalities in rural–urban land conversion. Finally, to integrate these effects, the approach uses questionnaire survey and the method combining contingent valuation method (CVM) with analytical hierarchy process (AHP) to solve "whole-part bias" and to acquire results. In the empirical study, Dongxihu district, Huangpi district, Caidian district and Jiangxia district are chosen as study area according to extend direction of Wuhan, China. Our result shows that in Wuhan, the external cost of rural–urban land conversion is 1.2×10^4–32.6×10^4 yuan/hm^2/a. Among these effects, market external costs such as irrigation facility destruction, water pollution and local government restriction cause large damages. However, non-market external costs including deterioration of air quality, noise pollution, landscape broken and accumulation of refuse are common phenomenon in land conversion. The measurement process of external costs highlights that internal and external part division are essential in externality measurement. The result of externalities measurement could provide a standard for compensation and tax policy in rural–urban land conversion. Besides, space extent of externalities could provide reference for zoning and green belts policies.

1. Introduction

Most cities in China now experience the rapid economic growth process. As a result, urban land expansion and agricultural land loss become major features of land-use change [1-4]. The negative effects such as agricultural land loss, environmental degradation, and land conflict occurs during this process [5-8]. Externalities are crucial factors in market failure and resource allocation inefficiency. Therefore, including externalities of rural–urban land conversion into land use change decision could limit urban expansion and improve the efficiency of land use.

Externalities of rural–urban land conversion consist of external benefits and external costs. External benefits are mainly economical and social spillover from the converted area, and external costs concern with agricultural production, environmental problem and infrastructure inadequate. Theoretically, external benefits and external costs need to be considered since they could affect land allocation. However, as decision-makers of rural–urban land conversion in China, local governments' target of rural–urban land conversion is maximizing GDP and fiscal revenue in their jurisdiction to improve political and economical performance. As a result, local governments usually consider external benefits of rural–urban land conversion in their jurisdiction, but ignore external costs which affect welfare of relative individuals.

Literature focusing on external costs of rural–urban land conversion has confirmed that external cost could be an important factor in decision making of land conversion [9-13]. Measurement of external costs not only offers references for decision making, its result also can be taken as standard of policies of welfare equilibrium such as tax, fee or

☆ The authors would like to thank the financial supports from the National Natural Science Foundation of China (71373095, 71303260, 41201581), The Ministry of Education (13YJC630016, 14JZD009).

* Corresponding author at: College of economics and management, Tianjin Chengjian University, Tianjin 300384, China.
E-mail address: chenz3447@aliyun.com (Z. Chen).

http://dx.doi.org/10.1016/j.chnaes.2015.07.008
1872-2032/

compensation for externalities [14-16]. To accurately measure externalities, improvements have been made from the perspective of application of GIS technique, identification of influence extent and value aggregation of resources. [17-20].

This article tries to measure external costs of rural–urban land conversion for land conversion optimalization. Meanwhile, we also attempt to improve the measurement approach. Since with all above researches, there are some unsolved problems in externality measurement. Firstly, externality values and nonmarket values are different concepts but they were confused in some studies. In this article the externality is measured different from nonmarket value; Secondly, generator and recipient are basic elements in Pigovian solution besides quantity of externalities, but how to define the internal part (generator) and the external part (recipient) is still challenging, we make suggestions to solve the problem; Thirdly, externalities have market and nonmarket value, and either of them contains various effects. We integrate them in this paper.

The paper is organized as follows. Section 2 presents the methods of externalities measurement, including concept definition, parcels division and measurement of external costs. Section 3 is empirical study which measures external costs of sample converted parcels. Section 4 is the result of empirical study and Section 5 summarizes our findings and discusses the policy implications.

2. Methods

2.1. Definition of external costs in rural–urban land conversion

Buchanan and Stubblebine [21] defined externalities as: the situation that an agent's utility function or production function contain variables which were decided by other agents [21]. The expression is:

$$U_A = U_A(X_1, X_2 \cdots X_n; F_B) \tag{7}$$

or:

$$F_A = F_A(L_A; F_B) \tag{8}$$

where U_A denotes A's utility from consuming, $X_1, X_2, \cdots, X_n$ denote A's consumption combination, F_A and F_B is A and B's production. L_A is A's input.

Following that, externalities of rural–urban land conversion are the sum of nonmarket (utility) externalities and market (production) externalities during land conversion process excluding owner of converted land. Since rural–urban land conversion also causes external benefit losses of agricultural land which have been estimated by literature, in this research, external costs only contain negative effects apart from losses of external benefits of agricultural land.[1]

2.2. Identification of external part

According to above definition, the influence extent of externality is an essential issue in measurement. We use concepts the internal part and external part which are corresponding with the generator and the recipient to identify the extent. Obviously, the internal part is converted parcel, while the external part can be regarded as the area circled by inner boundaries and outer boundaries. Inner boundaries are boundaries shared by converted parcels and parcels affected by externalities; and outer boundaries are between affected parcels and unaffected parcels. Inner boundaries can be specified easily because the converted parcel is certain. But defining the outer boundary needs some rules and assumptions. Here we use the linear equation which was used in WTP (Willingness To Pay) measurement of public goods proposed by Loomis [20]:

$$WTP_i = a_0 + a_1 T_i + a_2 DISTANCE_i \tag{9}$$

where T_i is vectors of agent; $DISTANCE_i$ is distance from agent i to the converted parcel [20]. Normally, $a_2 < 0$, which means the farther from the developed parcel, the lower the recipient are affected by the external effects. Therefore, outer boundaries is in the place where just $WTP_i = 0$ caused by distance decay.

[1] The externality losses in rural–urban land conversion are the sum of external benefit of agricultural land and external cost of land conversion.

Table 1
Effects of market external costs (farmland and fisheries).

Effects	Description
Irrigation facility destruction	Once the main canal is destroyed by rural–urban land conversion, a large number of farmlands will be affected. We also found that losses of farmland due to destruction of irrigation system depend on farming pattern and climate. Non-irrigated plants are affected less if rainfall is sufficient, then the loss will be relieved.
Water pollution	Converted land for some factories generates pollution runoff. Once entering canals, polluted water has to be used for irrigation and crops would be contaminated.
Land fragmentation	Rural–urban land conversion could break up continuous agricultural land and turn large scale agricultural land into small scale. Usually, this effect is negative since scale diseconomies, Farmers even abandon farmland.
Local government restriction	To reduce cost of land acquisition, local government prohibits farming in the area where farmland will be converted recently. Although prohibition of farming could avoid compensating for farmers who plant just for compensation, wrong anticipation from local government damages farmers' profits for years.
Fisheries production reduction	Rural–urban land conversion could destroy fishing ponds and the noise and vibration reduce fisheries production.

2.3. Estimation of external effects

2.3.1. Effects of market external costs (farmland and fisheries)

As definition we made in Section 2.1, effects of external costs could be divided into market and nonmarket costs. Land types in external part include farmland, fishery and rural settlement. Obviously, farmland and fishery parcels correspond with their market external costs; otherwise, rural settlements are just used for living other than production, so we assumed that rural settlements correspond with nonmarket external costs. We considered market external costs (in farmland and fisheries) at first. Effects are listed in Table 1 according to our survey and summary.

To estimate market costs, we use data of costs per area and influenced area, and then sum each effect up.

Table 2
Effects of nonmarket external costs (rural settlement).

Effects	Description
Worsening crime	Public security could worsen after rural–urban land conversion in many districts. The effect is caused by landless farmers who are out of work or people who settle in from other places after the land use change.
Deterioration of air quality	Effects that affecting people's respiration such as dust increase, air pollution.
Noise pollution	Noise from converted land can affect residents' life and health. Traffic noise also reduce housing value. [22]
Landscape broken	Remain landscape is simplified and divided after land conversion, then landscape value will reduce.
Inadequacy of public facilities	Public facilities contain roads, sewage, etc. Provision shortage of public facilities usually relates with land conversion.
Accumulation of refuse	Refuse accumulation near habitation is negative to residents.
Potential safety hazards	From our survey, boilers, power stations and gas stations were built in some converted industry parcels. Residents who live near these parcels worry about safety and are willing to improve the condition.