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Dynamics of land use efficiency with ecological intercorrelation in regional development

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ABSTRACT

Arguments about side effects of economic growth in urbanization call for deeper research on land use efficiency (LUE) from the perspective of urban planning for the coordination of social production and environmental conservation. Rural-urban migration increases rural household earning from part-time jobs at urban area. This social transformation increases the transportation demands and the risk of regional environmental degradation through ecological intercorrelation among urban-rural ecosystems. In this research, we aim to study how urban-rural ecological intercorrelation can dynamically determine the *edge effects* between *backward-wave effects* and *spillover effects* to affect dynamics of land use efficiency on the pathway of regional development. We analyze the marginal percentage changes of population growth and rural/urban income growth influence the dynamics of land use efficiency of Beijing-Tianjin-Hebei region (BTH). Empirical analysis results show that the urban income rises have weak spillover effects, while rural income growth primarily influences land use efficiency changes when urban-rural ecological intercorrelation is weak. We also test with or without the innovation impacts, and find both methods reporting the violation of normal economic development that in fact *backward-wave effects* exceed *spillover effects* in BTH. It implies that urban income growth should drive more *spillover effects* when urban-rural ecological intercorrelation is strong, but in fact it fails in a highly urbanized region. Thus, it is debatable that the fast population growth is the root of environmental degradation, in fact, ecological intercorrelation determines the edge effects of regional economic scale. That affects the structural effects of urban-rural landscape changes being allocated by population and income rises dynamically. Policy implication for regional development is to identify landscape rights in advance to keep dynamics of land use efficiency in a relatively stable structure for coherently improving environmental quality and the standard of living.

1. Introduction

Friedmann (1986) stated that the history of a city development presents some comprehensive outcomes from agriculturalization to industrialization such as agricultural land increases then decreases for the increasing demand of living standard. World development follows this pathway in social transformation, and pushing towards regional agglomeration in distinctive development pathways. However, there are many theoretical arguments about the best way of sustainable development. The *development poles theory* states the unbalanced economic growths may induce *backward-wave effect* or *spillover effect* in a region because geographical characters may have uncertain impacts on regional development (Boudeville, 1966; Krugman, 1993; Perroux, 1950; Romer, 1993). The *backward-wave effect* reflects the unbalanced gap rises when a core region's economic growth is too fast than neighborhoods; while, the *spillover effect* presents a normal pathway when the core region's economic growth drives wages growths to neighborhoods *via* regional trade and knowledge spillover. Smith (1977) further proposed the *gradient development theory* to explain these effects can occur at the same stage of regional development, so that their *edge effects* may become more significant to identify the complex issues in a polycentric structure. However, there are arguments in theoretical and empirical studies about the function of spatial correlation on edge effects changes. Thus, we study the dynamics of land use

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efficiency (LUE) in Beijing-Tianjin-Hebei region of the People's Republic of China (PRC) to understand how the function of ecological intercorrelation affects edge effects, and aiming to clarify her nature for future planning in a feasible sustainable manner.

Why population and personal income are the core factors? Many other factors such as education, housing, recreation, and other consumption demands can contribute to urban transformation, but they are determinated by population and personal income (Deng, Huang, Rozelle, & Uchida, 2008; Harris & Shonkwiler, 1997; Heckman & Mosso, 2014; Zheng & Kahn, 2008). At different stages of regional development, the alternatives of population growth and income growth are arguable about which is the main diving force can have more *backward-wave effects* or more *spillover effects* to neighborhoods. Urban consumption demand drives more low-skilled job opportunities increase. This induced rural labors prefer to work at neighbor urban area for earning higher wages before 2000 s on mainland PRC (Zhang & Song, 2003). With urban accessibility improved, increasing rural-urban migration *via* long-distance transportation move to cities for relatively higher income. Urban economic growth may bring about more *backward-wave effects* to those large cities, and enlarging the inequality of urban-rural income. We have seen urban environmental degradation, even though urban residents yearn for environment quality improvement when their income and demand increasingly for higher quality of life (McConnell, 1997). Consequently, there are more people moving to the cities where have better environment, so that further polarizes the inequality of environmental quality in a polycentric region.

The structural changes in between *urban resident disposable income* and *rural resident net income* represent the structural changes of consumption demands in a real business cycle. These demands influence on market products sales, and leading to producers on the supply side to adjust labors for minimizing production cost. This leads rural-urban migration changes structural labor supply with responses to urban demand changes in remuneration (Zhang, Shen, & Zhao, 2014). Moreover, Hukou classifies rural or urban residents, which is the unique identification of population on mainland PRC. National statistics of rural and urban population is the 'basing points' to record the base number of labor. Although some official statistics at city-level have errors, the structure of rural-urban population present the evidence of rural-urban labor structural changes in regional development (Gibson & Li, 2017). However, new urban residents do not only be labor force but also are consumers. For instance, when housing price rises, we have not seen annual housing demand decreased, while in fact housing price is continually increasing in many cities of China because new urban residents are increasing faster. It may not mean classic economic theory fails. When we consider income and population as driving factors to regional economic scale over time, if the dynamic changes of factors can bare relatively balanced systematic changes, it means the changes of factors are not systematically asymmetric. Then, we may find a large proportion of new urban residents can afford a new house in a better urban environment when their income rises. While, if the factors changes cannot synchronize, we may see the opposite outcomes, such as urban water shortage, low quality of public service, and lack of *per capita* public resources. An economic model can provide a dynamic approach to study these structural changes for specifying percentage changes in each driving factor.

Land use changes can reflect conflicts and structural changes in land use planning, but lack of explanatory mechanism that can spatially reflect landscape hierarchy in urban planning (Wu, 2004). Studies on urban transformation need to absorb some methodologies that can reflect structural changes driven by more human-centered factors to urban planning adjustment. For instance, old cities have remnant trails and sites that limit new settlements having the equal rights for the same share of resource utilization as old residents have, so that makes the redevelopment of old cities become very hard to approach the target of 'sustainable urbanization'. Because there is a paradox that neoliberalism space creates housing market but also generates environmental externality with non-marketized characteristics (Wei, 1999, 2015). Because unbalanced economic growths consequently enlarge the gaps of environmental inequalities which cannot be entirely solved by liberal marketization. The human rights for holding resources ideally should, but, never reach the ideal equality. Because there are potential losses of resource use efficiency which can earn much high profits from rising price of these scarce resources allocated by that inequalities (Peck & Tickell, 2002). Consequently, these inequalities ultimately can induce inefficient spatial hierarchy such like increasing transportation demands that highly likely long last forever, so a key question in urban expansion is how structural landscape conversion plays a role in a process of economic development, and how we can approach to a better standard of living when an optimal efficiency can be improved in urban transformation.

Arguments about side effects of economic growth in urbanization call for deeper research on land use efficiency (LUE) from the perspective of urban planning for the coordination of social production and environmental conservation. Zhuangzi's philosophy advocates "unity of man with nature" developed from Laozi which delineates a system with some cohesive and coherent relationships between human beings and natural environment. (Chen & Wu, 2009; Morrow, 2016). Fu, Wang, Su, and Forsius (2013) pointed out that landscape conversion reflects ecosystem changes with complex linkages to human activities in the terrestrial system, and having significant impacts on improvement of human wellbeing in the process of urbanization. China are emerging many "hollow villages" and calling for rural revitalization (Liu & Li, 2017). This social transformation increases the transportation demands and the risks of regional environmental degradation through ecological intercorrelation among urban-rural ecosystems (Ewing et al., 2010; Wang, Deng, Wang, & Chen, 2017). Wang, Deng, and Wong (2016) defined this process of urbanization with ecological linkages as a new definition of 'eco-urbanization', which involves many spatial correlations such as "ecological flows, stocks, risks, utilization, conservation, functional changes, and economic cost-benefits for sustainable development across different scales and hierarchies through networks, nexus, and interdependence of both natural and social evolutionary processes."

How to define the land use efficiency (LUE) is priority when we try to answer whether ecological intercorrelation is good or bad for either estimation models or planning practices. Current urban planning schemes on mainland China stress the land price and its potential social production value. The LUE was used to calculate the Gross Domestic Product (GDP) *per square meter*, but in some cases, ecological infrastructure (EI) including dry/paddy (cultivated) land, woodland, grassland, water/wetland, and unused land have the function to enhancing environmental quality (Li et al., 2016), moreover, these neighbor EIs can influence the economic value of built-up area (Li et al., 2009). The hedonic housing price discusses the economic value of neighbor landscape at the urban fringes, such as housing price increases when beside woodland (Shonkwiler & Reynolds, 1986). That indicates people prefer to live the house surround by a good natural landscape, so that the additional economic value of natural landscape depends upon individual subjective satisfaction level. Individual willingness-to-pay then can represent potential consumption demand under the constrain of individual expenditure budget, so personal income is the predeterminate value of preferred landscape for a certain level of environmental quality. At this point, income and population in classical economic theory are endogenous variables to critically determine regional consumption demand with the opportunity cost of landscape conversion. To individuals, the less payment is the better to maximize their preferred utilities, and that means the higher economic efficiency can be reached. However, *economic efficiency* differs from *resource-use efficiency*. *Economic efficiency* is used to be understood in two parts: *the technical efficiency and the allocative efficiency*. The *resource-use efficiency* is used to calculate the ratio of outputs and resource-use with respect to the inputs in economic value, so that can be understood as the *technical*