An Approach to Economic Growth and Environment Effects in Northeast Asia

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Abstract. Global achievement of urbanization and farming revitalization in the past few years has taken significant environmental impacts linked to the relative industry sectors, including Northeast Asia and China-Russia Economic Corridor. The environmental degradation-energy shortage-farmland reduction-food security nexus need be urgently explored to improve the sustainability and environmental management, as significance of rural revitalization policies. Consequently, assessing agricultural emissions, livestock waste and the related biogas development is the crux in the nexus treatment. This paper focuses on a Northeast Asia context and analyse the environment-economy relationship applying panel cointegration and panel estimation methods, considering the features of agricultural emissions and animal wastes in Northeast Asia national economies from 1992 to 2016, and explore an open and international farming perspective for rural context. It is indicated a long-run co-integrated curve like Environmental Kuznets Curve between the agricultural environment and economy index. It could be one of the most significant cooperation issues around the region to improve this agriculture related ecology level and the corresponding trade and fund.

1. Introduction
Global achievement of urbanization and farming revitalization in the past few years has taken significant environmental impacts linked to the relative industry sectors, including Northeast Asia and China-Russia Economic Corridor. Agriculture has been being increasingly thought as the critical polluting source to environment all over the world \[1, 2\], such as water contamination \[3-6\] and the atmospheric pollution \[7-9\]. Sustainability and pollution issues related to agriculture are exerting more and more to the policy debating in developing countries and emerging economies \[8, 9\]. Additionally, food consumption structure has been increasingly turning to meat diet. Within the context of extensive breeding modes, a large amount of wastes from animal husbandry has generally been littered or pumped directly into the surroundings \[9\]. The world economy, especially emerging and developing economies, are thus growingly faced of the risks on special pollution sourced from rural area, in the meanwhile accompanied with the rural reform and green transformation.

In addition, there is a rapid energy use growth among the industrial and living sectors for some Northeast Asia countries, which resulted in the related environmental risks including water system and atmospheric issues \[10\]. Rural energy is a new energy philosophy, with the emphasis in energy issues of rural area, concentrated in developing countries, where sustainable and clean energy supply is the critical
living component, owing to lack of commercial sources and behindhand growth modes [11, 12]. The issue also brings about more and more social and ecological problems. Significantly, there are still few related literature on rural energy solutions, mainly in only general concepts proposed. In emerging and developing countries, it is critical to focus and advance the rural energy providing policies, relying on the present raw materials and GHG reduction in the existing energy use model, in the current rural community organization form and production mode.

In the past few decades of years, livestock industry increased more and more wastes, especially in developing countries significantly, which could be either critical rural industrial materials of biogas project or, if pumped into the environment without suitable treatment, a serious contamination source to soil and water systems [12, 13]. To analyze the quantitative relationship between the agriculture land cultivation, livestock breeding, and rural energy use, and the related environmental implications and sustainability potential in rural region, would be the core issue around the developing world. More literature on preventing water and air contamination, have been progressing and presenting effective methodology, in the nutrient-surplus region [14], but few of them are related to the rural waste and energy context, especially in the Environmental Kuznets Curve (EKC) progress and green development researches.

Therefore, this paper focuses on a Northeast Asia context and analyzes the environment-economy relationship base on EKC hypothesis applying panel cointegration and panel estimation methods, considering the features of agricultural emissions and animal wastes in Northeast Asia national economies from 1992 to 2016, and explore an open and international farming perspective for rural context. There are few previous studies focusing on these special agricultural and rural issues and judging the related EKC pattern, especially around this Northeast Asia area scale. Finally, some policy debating issues on rural biogas projects and waste control are presented in view of rural energy potential valuation.

2. Models and methods
The methods of nutrient and waste estimation are first presented. We explore the agriculture nitrogen surplus in the neighboring economies around China, according to ecosystem nutrient balance, in view of synthetic fertilizer and organic fertilizer use and farming modes, using the following model,

\[ SU_N = \left[ \sum F_m N_m - \sum Y_n NU_n - O \right] / S \]  

where \( SU_N \) represents the unit surplus of soil nutrients for arable land, focusing on nitrogen cycle, \( F_m \) is the synthetic fertilizer and organic fertilizer application and \( N_m \) is the nitrogen volume for the \( m \) fertilizer, \( Y_n \) is the agricultural harvest for the crop \( n \) and \( NU_n \) denotes nutrient absorption for crop \( n \). \( O \) is the original foundation fertility of cultivated land without fertilizer application, \( S \) is the farmland area.

The study proceeds with the waste assessment of animal breeding. Literatures of impacts on biogeochemical cycles sourced from human activities mainly concentrated on nitrogen [9]. The waste and excreta volume and the nitrogen contents are used as environmental index based on the statistical number of livestock and poultry breeding as the following model, the first model is the daily estimation and the second model is annual estimation.

\[ E = \sum_{i=1}^{n} L_i \times W_i \times Cd_i \times P_i \]  

\[ E = \sum_{i=1}^{n} L_i \times Cw_i \]  

where \( E \) is the livestock waste emissions. \( L_i \) is the livestock number. \( W_i \) denotes the waste production per day for animal \( i \). \( Cd_i \) represents the waste coefficient. \( P_i \) is the animal formative period. \( Cw_i \) is the waste amount per year for animal \( i \). Herein, the annual emission valuation method is mainly used, due to different distribution of the large region area.
The Environmental Kuznets Curve (EKC), as the classic relationship expression among the environment-economy system, has been the main environmental methodology based on various periods and econometrics, after the pioneer study of Grossman and Krueger [15] and Panayotou [16], where the inverted U relationship was analyzed.

This relationship has become the focus of a large number of theoretical explorations and empirical investigations in many countries, based mainly on the empirical estimation of time series and the dynamic panel data approach [7, 17], fist is for developed countries and then has extended to developing countries and emerging economies since the beginning of this century [18]. We here present one table summarize the main panel study results on EKC. However, there are few EKC literature on agriculture data [19], to the best of our cognition and knowledge on the environment-economy nexus. This study is very important for ecological risks prevention, especially in rural issues, and need to be worthy of more debating attention and researches.

Table 1. Summary of the panel EKC review.

| Study Region                  | Variables and Methods                  | Main Results                                      |
|-------------------------------|----------------------------------------|---------------------------------------------------|
| 27 developed countries        | CO₂ emissions; FMOLS                   | The validity of the inverted U-shaped EKC         |
| 11 Asian countries            | CO₂ emissions; Fixed and random effects| The invalidity of the EKC hypothesis              |
| 17 South and Southeast Asian countries | CO₂ emissions; Panel cointegration | The long-run equilibrium relationship             |
| 58 countries                  | CO₂ emissions; generalized method of moments | The existence of the EKC hypothesis in 58 countries |
| 5 ASEAN countries             | CO₂ emissions; panel dynamic ordinary least squares regression | The valid EKC hypothesis                         |
| 11 Asian countries            | CO₂ emissions; FMOLS and DOLS          | The validity of the U-shaped EKC hypothesis       |
| India                         | CO₂; ARDL                              | Existence of EKC                                 |
| China and India               | CO₂ emissions; ARDL, FMOLS, and DOLS   | The invalidity of the EKC hypothesis              |
| China                         | SO₂, NOx, and PM2.5; Fixed and random effects | The validity of EKC hypothesis                    |
| 113 countries                 | Agricultural N pollution; Predictive analysis | Existence of EKC                                |

3. Results and discussion

In this study, the nation-by-year panel environment and economy data are used from China neighboring economies in Northeast Asia, to establish the EKC model by using GDP per capita and output added per capita as the economic indicator, and agriculture emissions, as the agriculture ecology index. Agriculture total emissions contain all the emissions produced in the different agricultural emissions domains, like synthetic fertilizers, livestock manure, rice cultivation, enteric fermentation, crop residues, cultivation of organic soils, burning of crop residues, burning of savanna, and energy use.

The findings first indicate that, the inverted U-shaped relationship between agriculture and environment and ecology index like Environmental Kuznets Curve. The waste volume would increase at the first stage, and might decrease accompanied by income growth. Then, we further estimate the turning
points for these curves. There are different features and characteristics for these inverted U-shaped curves with different critical values according to various pollution and waste index. It can be seen from figure 1.

![Graphs showing total emissions, fertilizer emissions, and livestock emissions](image)

**Figure 1.** The examined EKC pattern based on agriculture emissions.

These critical values linked to agriculture related curve turning points show the far more risks and pressures than other pollution index sourced from industry sectors. So, agriculture related pollution...
prevention is much more tricky and difficult than the traditional pollutants such as NO$_x$ and SO$_2$, which could be more related to urban region and industrial sectors. This also indicate to some degree, that agriculture and rural environment issues might be neglected relatively and need more investment for environmental improvement, where direct sources are untraceable. And the environmental policies need be presented not to be standardized, according to various rural region and pollution conditions.

Finally, we estimated the possible biogas output potential based on livestock and poultry breeding in China. This amount is accessed based on various environmental conditions, which can be valued mainly based on COD or TS amount from animal wastes and the various climate areas. Similar to literature [12], this estimated type of raw materials consequently might produce biogas by the livestock wastes reaching over 25% of natural gas consumption, and might decrease air pollution emissions by more than 20%. These kinds of development of biogas projects could take a significant implication in rural region of developing world.

The estimation of a kind of EKC and its critical point can herein be estimated only based on empirical data, and the environmental degradation-energy shortage-farmland reduction-food security nexus is complex, in accordance with the explanation such as income growth pressure, livelihood environmental demand, management effects, and technology and structure effects [20-22]. The complex agriculture related environmental characteristics, and the thorny rural institutional and socioeconomic conditions might be worthy of attention a fortiori in China and the similar emerging and developing countries of East Asia.

4. Conclusion
This paper presents a general overview of the agro-environment and economy relationship in China and neighboring Northeast Asia countries, for a panel data set for the period from 1992 to 2016, using the panel cointegration techniques, which could contribute to the policy making, related to environment and farmland and livestock policies, and could be one of the most significant cooperation issues around the region to improve these agriculture related ecology level and the corresponding trade and fund, especially rural emerging and developing economies.

External cooperation in agriculture is an important domain of the “Belt and Road Initiative”, especially in China-Russia-Russia Economic Corridor. China-Russia agricultural cooperation is a mutually beneficial move. Russia can also take advantage of China’s economic development to achieve agricultural revitalization. China’s overseas investment and cooperation of arable land and livestock breeding should receive more efforts. While foreign investment in agriculture has increasingly become the focus of western scholars, it has not fully and sufficiently attracted the attention of China domestic scholars. At present, the investment in arable land and livestock breeding in Russia would become an important mode for China to ensure environment and food cooperation, which can also serve as a key direction for China-Mongolia-Russia comprehensive cooperation. It is significant to actively carry out the construction of cross border agricultural production belts and agricultural innovation cooperation zones in the adjacent region, and explore the establishment of a China-Mongolia-Russia food reserve base, which might play a key role in safeguarding region food security. Of course, agricultural international cooperation is a systematic project involving various aspects such as geo-politics, geo-economics, and resources and environment, including land selection, market research, investment entities, and product logistics sales.

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