氏名	LI ZHAOLING
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学位論文題目	Examining China's Industrial Structure Changes and Forecast the Carbon Emissions from Energy Intensity Industries Based on Simulation Model– Focusing on Iron and Steel Industry in China (中国における産業構造変化の考察とシミュレーションモデルを用いた エネルギー多消費産業からの炭素排出量の予測―中国の鉄鋼業を事例に)

主査	筑波大学准教授	博士（工学）	Helmut Yabar
副査	筑波大学教授	博士（農学）	張　振亜
副査	筑波大学准教授	博士（学術）	水野谷　剛
副査	筑波大学准教授	工学博士	雷　中方

論　文　の　要　旨
Abstract of thesis

This research identifies, through the use of Social Network Analysis (SNA), the iron and steel industry as one of the most energy intensive industry in China in order to estimate its carbon reduction potential. The author proposed a non-linear environmental-economic optimization model based on the industrial input-output relationship to assess the carbon emission reduction potential in medium-term (2007-2030), and evaluated the corresponding impact on environment and national development under different scenarios. The thesis is divided in 4 chapters. Chapter 1 makes an introduction of the research framework, identifies the main sources of GHG emissions in China and energy consumption and provides a summary of previous studies on the topic. Chapter 2 proposes a hybrid SNA-IO model to evaluate the industrial structure of China. Indicators, like degree centrality, betweenness centrality, cohesive subgroup and indirect carbon emissions from production and consumption perspective, are used to find the most influential industry. As the result shows, the secondary industries have relatively higher degree centrality and betweenness centrality, especially some energy intensive industries. About one quarter of indirect carbon emissions in iron and steel industry come from the industry itself, which means if we reduce its carbon emissions, the indirect carbon emissions in the whole industrial network would be reduced significantly. Chapter 3 forecasts the medium-term carbon emission of iron and steel industry using a non-linear environmental-economic optimization model. Technology upgrading including advanced environmental friendly techniques installation, electric arc furnace (EAF) route promotion and furnace upgrade, carbon tax policy, carbon trading scheme implementation and other factors, like energy recycle and reuse, nuclear power development, are fully considered in this research. Technology upgrading and environmental policies will be synergistic in the combination scenarios, as the carbon emissions reduction effects are stronger than the single measure. 49.07% of carbon emissions intensity reduction and only 0.29% of GDP loss in 2030 in

industrial upgrading scenario compared to BaU scenario. The impact of environmental policies is less effective than technology upgrade. Chapter 4 makes a summary of the main findings and highlights the concluding remarks. The study found that outdated technologies, unreasonable production structure and overcapacity are the main problems. Based on this analysis the study proposes six scenarios, including BaU, technology upgrading, carbon tax, carbon trading policy and two combination scenarios. According to the simulation results, after implementing these measures, the cumulative financial loss brought by different scenarios will be only 1.25% at most compared to the BaU scenario. While, carbon emissions reduction will be 28.53% compared to BaU scenario during the research period. National carbon emissions intensity will decrease more than 50% from 2007 to 2030. The effect on production structure changes is also obvious that the proportion of EAF route and nuclear power with low carbon emissions will be more than 30% in the total output. Comparing each measure, technology upgrading has the most effective inhibiting effect on over capacity, carbon emissions reduction and carbon emission intensity reduction. The financial loss brought by this scenario is limited. The possible reason of these results may be because most of the investment is devoted to the technology updating and production route conversion, instead of expanded production. Therefore, technology upgrading should be considered as the primary measure to be implemented. Carbon tax policy also has great promotion effect on production structure change and carbon emissions intensity decrease. Its effect on carbon emissions reduction is not obviously compared to the other two measures. However, considering the long-term advantages brought by EAF route development, this measure can be considered as the main lever over emissions reduction. These three measures cooperate well in the two combination scenarios. Both the carbon emissions and carbon emissions intensity will decrease the most during the six scenarios. This study optimized one industry to meet the national emissions intensity reduction target, because, on the one hand, the direct carbon emissions in iron and steel industry share the most of the industrial total carbon emissions, which is more than 25%. Therefore, optimizing the carbon emissions in iron and steel industry will bring a huge decrease in carbon emissions for the industrial network. On the other hand, from the indirect carbon emission point of view, more than 80% of total indirect carbon emissions came from the auto demand emissions.

審　査　の　要　旨

Abstract of assessment result

Using the iron and steel industry, one of the most intensive industries, as case study the research evaluated its influence on the national economy, environment and social welfare. The study identified that technology upgrading is the most effective solution to curb the high carbon emission intensity in the iron and steel industry. Facing the problem of production overcapacity, the study proposed the change in the investment object from production expansion to technology innovation. This measure will bring environmental benefit and limited GDP loss. The study also suggests that carbon tax policy will be beneficial for the medium-term development of iron and steel industry, and it can be implemented at appropriate times. However, carbon emission trading scheme has only short-term carbon emission reduction effect. The detailed evaluation on China's industrial structure changes during the past 15 years found that the energy, capital and labor intensive industries are still dominating the industrial sector in China. The government should further promote the development of tertiary industries, as well as improve the added value ratio and decrease the carbon emission in the service industries. Considering the industrial structure related carbon emission, the proportion of renewable energy should be further increased, and the government should guide the industries to transfer their energy intensity by choose the energy or material with lower embodied carbon.

The final examination committee conducted a meeting as a final examination on 10 October, 2017. The applicant provided an overview of dissertation, addressed questions and comments raised during Q&A session. All of the committee members reached a final decision that the applicant has passed the final examination.

Therefore, the final examination committee approved that the applicant is qualified to be awarded the degree of Doctor of Philosophy in Environmental Studies.