学位論文及び審査結果の要旨

横浜国立大学

氏名	YU LUJUN
学位の種類	博士（経済学）
学位記番号	国府博甲第69号
学位授与年月日	令和４年９月１６日
学位授与の根拠	学位規則（昭和28年4月1日文部省令第9号）第４条第１項及び横浜国立大学学位規則第５条第１項
研究科(学府)・専攻名	国際社会科学府経済学専攻
学位論文題目	Impact of Water Policy on Chinese Economy Using Computable General Equilibrium Model Based on System of Environmental-Economic Accounting （環境経済勘定に基づく計算可能な一般均衡モデルを用いた水政策の中国経済への影響の分析）
論文審査委員	主査　横浜国立大学　氏川　恵次　教授
	横浜国立大学　シュレスタ　ナゲンドラ　教授
	横浜国立大学　張　馨元　准教授
	横浜国立大学　木崎　翠　教授
	横浜国立大学　居城　琢　教授

論文の要旨

Since the 1978 reform and opening-up, the Chinese government has pursued an open-door policy of economic growth. More than 60% of the demand for water is from the agriculture sector, but severe water shortages and pollution have reduced grain production in the country. As increasing population in China, so has the need to increase the water usage to increase grain yield to meet food demands. This has put even more pressure on irrigation, worsening the water problem. At the same time, industrialization and urbanization are also accelerating the demand for water resources. Besides the low quality of water resources, water use in China is also inefficient, which is a threat to economic development. With worsening water scarcity, pollution, sanitation, and related waste, we are set to witness greater limits on food production, the proper functioning of the ecosystem, and urban supply. Indeed, the severe and adverse effects on the Chinese economy can already be seen.

Because the supply of water seems inexhaustible and always available, it is usually not accounted in cost analysis. Without proper water policy and management, China now faces severe water resources shortages, increased water pollution, and deteriorating aquatic ecology and environment. With time, these problems will worsen, and put pressure on the waters supply.

So far, China has adopted three measures to protect water resources. The government established a “water law” that treats water as an essential resource for production, while also calling for a greater balance between economic growth and environmental protection. The law was formally promulgated in 1988 and serves as the fundamental guidance for water use and supply. Since 1999, public awareness of and education on water protection have been prioritized as well. Although the effect of reforms to water policy will be the greatest for water-sensitive sectors such as agriculture, the reforms would also indirectly affect manufacturing and services, as all sectors in an economy are interrelated. However, would changes in water supply and demand further complicate policy implementation?

In this article, I use a social accounting matrix (SAM) to detect the effect of water policy. This matrix describes water resources based on the system of environmental economic accounting (SEEA), and it can accurately demonstrate information from the System of National Accounts (SNA) by the United Nations. The related variables are exogenous and endogenous, and linked by a set of mathematical relations. Specifically, I demonstrate the water resource flow in China using the water social accounting matrix (WSAM) based on the SEEA for 2017.

The WSAM has three advantages that favor its use as a methodological framework. First, it presents the data on economic activity based on the SNA and the data on environmental resources using the SEEA. According to the SNA in 2008, water resources need to be valued as part of the national balance sheet in situations wherein water scarcity leads to restrictions on its use. The dependency relationship between economic activity and environmental resource is captured in this framework. We expect the SEEA framework to support various multinational analyses as more country-level research employ it.

Second, the WSAM based on the SEEA is a general framework for indicators. It captures the effects of policies on economic growth and national wealth. National wealth is indicated by the government's reports of, among others, households, firms, production, income, consumption, and investments. Environmental resource has same problems with isolation reports for resource stock accounting. The SEEA governs the principles relating to and provides the measurements for national balance sheet accounting and environmental resource changes based on standardized norms.

Third, the WSAM treats environmental resources dynamically under the SEEA. To estimate the water stock and flows, the SEEA was published based on international statistics standards and as a guideline for accounting that incorporates both the environment and economy. Conventional environmental resource accounting only focuses on representing the water stock, while ignoring the different purposes of water resource abstraction and reuse. The WSAM tracks the extraction of water from the environment to its consumptive use. In general, a policy analysis model for environmental economics could rely on the WSAM, which does provide reliable data for various analyses. The data can be expressed as physical quantities or in monetary units. This has made the SAM a useful database and tool with wide acceptance in national accounting in the twentieth century.

Furthermore, I employ the computable general equilibrium (CGE) model to compile the WSAM table under the SEEA framework using integrated water data for the analysis of environmental economic policy. More specifically, I apply a static CGE model to assess the macroeconomic effect of water use restrictions for the period of 2017. I further design a dynamic CGE, or DCGE, model to explore the effects of water policies for the 2017–2020 period. Ultimately, I hope to observe specific water-sensitive agriculture products in relation to the effect of water policy change.

In Chapter 3, I highlight the economic influence on surface water and groundwater at the national level through a static CGE model by integrating the water data and compiling the WSAM table under the SEEA framework. The effects of the “three red lines” water policy and the tax policy on the economy and environmental assets were illuminated. The findings confirm that the control of water is more beneficial than simply improving the efficiency of water use, especially for the tertiary industry. Moreover, a water policy could further sustainably develop the service sector. The model also provides an opportunity for some sectors to transform the extensive pattern to an intensive pattern. However, restricting water use does have a negative effect on economic growth, and improving the irrigation rate also shows a limitation effect for each sector. The results suggest that a sound water policy should concentrate on sectors that are highly dependent on water resources.

Nevertheless, the static CGE model yielded a reliable analysis to reveal the effect of water policy. In the next step, I use the DCGE model to observe and understand the economywide effects of the projected water management reform and structural economic change on water use in China.

In Chapter 4, I develop a DCGE model by accounting for water resources in order to explore the effect of water policy on the economic system from 2017 to 2020 at a national level. The DCGE mode is already popular for regional- and prefectural-level analyses. Further, water policy for surface water and groundwater is designed to estimate the economic effect in China. A nested Cobb-Douglas function has been applied in production function. We assumed that capital is time-separable in DCGE model. The model can determine the current account and the accumulation of investment asset. The stock accumulation and allocation are calculated based on capital revenue rate, the average rate of total capital and total supply of capital among sectors. The model makes it possible to allowance of the investment towards the most productive sectors in a flexible and realistic way. Overall, our findings confirm that water resources should be included in national account under the SEEA framework. Water is an important and sensitive factor in commodity production. The findings show that controlling water use has a more negative effect than improving the price of water, especially for the agriculture industry. I, therefore, suggest that a sound water policy should focus on sectors that are highly dependent on water resources. This way, the price change policy on surface water and groundwater would reveal a large difference on sectors in the long term. Because the demand for water resources will increase with social development, the government should carefully consider its water control policy and the definite negative effect it would have on production.

In Chapter 5, the DCGE model was applied to investigate the effect of current policy on agriculture production in China's economic system. Integrating water data and compiling the WSAM table under the SEEA framework provides general data to analyze the environmental economics policies through the CGE model. In the simulation, four scenarios are designed to estimate the effect of water policy on agriculture from 2017 to 2020. It is assumed that the quantity of import rice increased by 10% under the rice import water scenario (IMP). Rice is the most water-consuming agriculture product in China. The greater the proportion of imported rice, the less water needed for irrigation. The second scenario investigates the influence of augmenting investment (INV) by 10%. The Chinese government also stimulated private investment to promote economic development in 2017. Decreasing the household water consumption (HWD) by 10% is another target for sustainable development. Lastly, the government provides subsidies for water use and does not charge for the water resource fee on agriculture products if the water used for irrigation does not exceed its stipulated quota. Therefore, the water resource fee of rice, wheat, potatoes, and vegetables is assumed to be zero in the WRF scenario. Although the policies of free charge of water resource and increasing imports were beneficial for agriculture production in the long term, increasing investments ultimately had more negative effects on rice and wheat production. Notably, China produces more agriculture products while also increasing it imports. Thus, the results suggest the government’s water use quota should not be decreased below 10%.

審査結果の要旨

本論文は、経済統計分野における国民経済計算論の応用として、環境サテライト勘定の拡張による政策分析を目的としている。近年、国際基準となった環境経済勘定セントラルフレームワーク（the System of Environmental-Economic Accounting Central Framework、以下 SEEA-CF）に準拠し、中国を対象として、SEEA-CF を経済モデルに拡張した経済活動と水資源循環の定量的な明確化とシミュレーションによる政策の効果の検証を行うことを試みたものである。対象地域である中国では、世界の水資源の約 6%が賦存する一方で、1 人当り水供給の制約、水の世代間および地理的な観点での不公平な分配、継続的に増大し続ける水資源の需要といった多くの課題を抱えている。これに対して中国政府はとくに 2002 年の『中華人民共和国水法』の施行以降、2006 年にはこれに基づく『取水許可及び水資源費徴収管理条例』、2012 年に「三条紅線」に沿った水資源開発利用管理、用水効率管理、水機能区汚染制限の達成基準の明確化、2019 年に「国家節水行動方案」による水資源の使用効率の国際的な水準への引き上げといった数々の方策を試みてきた。

こうした中国一国の経済活動と水資源循環の定量的把握、また一国全体に係る政策効果の検証に際して、従来の先行研究では、第 1 に、とくに中国国内で数多く進められてきたものは限られた地域レベルでの研究対象となっており、上記のような研究課題に対して、十分な対応がなされてこなかった。第 2 に、地表水・地下水の細分化された部門別データ等による、水資源循環のフローの詳細な定量化やこれを用いた各種の経済モデル分析は、不十分であった。これに対して本論文では、第 1 に SEEA-CF の枠組みに沿い細分化された部門別データを用いて水資源分析用の SAM および CGE モデルを構築して、従来は十分に明らかにされてこなかった、中国一国の経済活動と水資源循環のフローを明らかにした。第 2 に SEEA-CF の枠組みを動学的 CGE モデルに拡張して、これまで検証されることのなかった、中国一国レベルの実際の政策効果を定量的に検証することを試みた。第 3 に国内で最も水の利用に関わる農業部門について、動学的 CGE を拡張して、主要作物別の複数の政策効果を定量的に評価し、あるべき農業および水政策の析出を目的とした。上記のような、国際基準である SEEA-CF の枠組みに沿った経済モデルの作成と政策効果の検証は、経済統計の分野での大きな貢献であるといえる。

以上から本論文審査委員一同は、本学府の博士号審査基準③に照らして、Yu Lujun 氏の学

位請求論文「Impact of Water Policy on Chinese Economy Using Computable General Equilibrium Model Based on System of Environmental-Economic Accounting」が博士（経済学）の学位を授与するに値するものとして、判断する。

令和4年6月13日

審査委員主査　横浜国立大学大学院国際社会科学研究院教授　氏川恵次
審査委員　横浜国立大学大学院国際社会科学研究院教授　シュレスタ　ナゲンドラ
審査委員　横浜国立大学大学院国際社会科学研究院准教授　張馨元
審査委員　横浜国立大学大学院国際社会科学研究院教授　木崎翠
審査委員　横浜国立大学大学院国際社会科学研究院教授　居城琢

参考：Yu Lujun 氏の指導委員会の構成員は以下の通りである。
責任指導教員　横浜国立大学大学院国際社会科学研究院教授　氏川恵次
指導教員　横浜国立大学大学院国際社会科学研究院教授　シュレスタ　ナゲンドラ
指導教員　横浜国立大学大学院国際社会科学研究院准教授　張馨元