STUDY ON QUANTITATIVE APPROACHES IN SOLVING COMPLEX ENERGY-RELATED SOCIAL ISSUES

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論 文 名　：STUDY ON QUANTITATIVE APPROACHES IN SOLVING COMPLEX ENERGY-RELATED SOCIAL ISSUES （複合的なエネルギー関連問題を解決するための定量的アプローチに関する研究）

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論 文 内 容 の 要 旨

Energy significantly impacts people's quality of life and societal activities. Energy remains at the heart of many of the world's emerging issues and opportunities, including but not limited to poverty reduction, education, health, food security, gender equity, job creation, climate resilience, transportation, and sustainable cities. Energy has both positive and negative social implications. Humans benefit from abundant, affordable, safe, and clean energy. Energy extraction, transportation, and use, on the other hand, can have a negative impact on a society's health, environment, and economy. The impacts of energy actions are not the same for everyone. Poor or disadvantaged peoples are more likely to suffer the negative consequences of energy policy decisions because they have less adaptability and bargaining power than wealthier communities. As a result, advances in energy accessibility, security, or affordability can benefit disadvantaged people significantly. However, clean, affordable energy is not always a reality worldwide, resulting in many cases of energy poverty. In these circumstances, global energy poverty affects children, particularly in energy-poor nations. Therefore, this thesis investigates the impact of energy poverty on early childhood development and how it can be alleviated through women's empowerment, education, and employment (W3E), considering the cultural dynamics of energy systems. Finally, the role of imposing and reforming environmental taxes on technological innovation has been evaluated to ensure clean and affordable energy for all. This thesis consists of eight self-explanatory chapters.

Chapter 1 describes the background and motivation of the thesis. This chapter also includes the aims and objectives of the thesis.

Chapter 2 provides an overview of the literature relevant to the present research, which is divided into four sections. First, a detailed review related to energy poverty and health. Second, a comprehensive review related to energy poverty and economic development. Third, a review related to race and energy. Finally, a thorough review related to environmental taxes, technological innovation, and the environment. This chapter concludes by mentioning the scope of this thesis.

Chapter 3 discusses various indexes used in this thesis, such as the multidimensional energy poverty index (MEPI), early child development index (ECDI), and women's W3E index, to assess the energy poverty and child development nexus and the role of women's 3E in reducing energy poverty. This chapter discusses different robust statistical and econometric approaches, including generalized structural equation modeling, mixed-effect logistic regression model, ordered logistic regression model, and panel data estimation techniques.

Chapter 4 quantifies how energy poverty affects early child development by extracting data from 18 energy-poor countries in South Asia, Sub-Saharan Africa, and Caribbean Latin America using multiple indicator cluster surveys (MICS) data conducted by United Nations International Children's Emergency Fund (UNICEF). This chapter utilized mediation analysis to identify the direct and indirect effects of energy poverty on childhood development. According to the findings, energy poverty impedes childhood development by lowering living standards and negatively impacting child health. In comparison to non-energy-poor households, children from acute and severely energy-poor households experience developmental delays of 30% and 51%, respectively

Chapter 5 investigates the role of women's 3E (education, employment, and empowerment) in alleviating energy poverty through the proposed novel women's 3E (W3E) index based on data from the Demographic and Health Survey in South Asian countries from 2001 to 2018. In this chapter, the effects of W3E on energy poverty were evaluated using a mixed-effects logistic regression model. The likelihood of having energy poverty was reduced significantly in all assessed nations when women's 3E was achieved. Among households with high W3E scores, the chance of suffering from energy poverty was reduced by 57%, 80%, 87%, 75%, and 53% in Bangladesh, India, Nepal, Pakistan, and Afghanistan, respectively. The results revealed a significant disparity in energy poverty reduction progress between urban and rural areas.

Chapter 6 explores the role of culture (race) toward demographics, energy system preferences, and outcomes in the United States using an ordered logistic regression model. Results reveal that there exists a statistically significant relationship between race and energy. Besides, cultural and demographic differences play a significant role in designing an energy system supportive of reducing energy poverty in society.

Chapter 7 quantifies the role of environmental taxes on technological innovation and the development of cleaner technologies to alleviate energy poverty by ensuring clean energy for all. This study uses panel cointegration analysis with cross-sectional dependence using data from 1995 to 2018 in 42 high and middle-income countries. Long-run results suggest that environmental taxes stimulate technological innovation; for example, a 1% increase in environmental taxes was found to increase environment-related technological innovation by 0.57% and 0.78% on average using the common correlated effect mean group (CCEMG) and augmented mean group (AMG) techniques, respectively.

The last chapter (**Chapter 8)** provides the overall conclusions and policy implication suggestions. It can be concluded that energy poverty is a global issue that impedes the social well-being of disadvantaged people, mainly children, and women. The policymakers should develop appropriate energy policies to alleviate energy poverty considering the socioeconomic & cultural dynamics of energy systems. The governments should take long-term proactive steps to ensure energy services to prevent child development delays in countries with acute and severe energy shortages. Moreover, policymakers need to take immediate action to empower women via education and employment to significantly reduce energy poverty in South Asian countries. In addition, the deployment of technological innovation for a carbon-neutral society should be encouraged and ensured to achieve clean and affordable energy for all, contributing toward achieving SDG-7.