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論文題目	A Study on Low Carbon Development with a Computable General Equilibrium Model - Application to Vietnam - (一般均衡モデルを用いた低炭素発展評価手法の開発―ベトナムを例として―)		

　　Chapter 1 provides the rationales and describes objectives of this research. Since climate change has adverse impacts to the environment, societal and economic activities; developing countries including Vietnam should follow developed countries in considering mitigation measures into policy and decision making process. In which, socio-economic and energy scenarios development will provide benchmarks for the long-term policy making. As a result, the objectives of this research are to: (1) Propose a methodological framework and its application to support the low carbon policies analysis; and (2) Analyze the socio-economic implications of Low Carbon Development (LCD) in Vietnam by the year 2050.

　　Chapter 2 summarizes the methodological literature review in which this research stands on. Firstly, it summarizes previous studies on the national-based scenario development towards LCD in the world. As main tool which is used in this research, the previous applications of Computable General Equilibrium (CGE) models for LCD analysis are reviewed, especially the application of CGE models in Vietnam. Recently, many economic analysis models are extended for analyzing the LCD; such as model's structure change, disaggregation of energy commodities, and the improvement of consumption function; which are also reviewed.

　　Chapter 3 describes the overview of methodological framework of this research and its three detail methods, which are: (1) National-based scenario development, (2) [Asian Integrated Modeling]/ [Computable General Equilibrium_Basic] (AIM/CGE[basic]) model, and (3) the An Implicitly Directly Additive Demand System (AIDADS) estimation system. The national-based scenario development develops the platform of socio-economic and energy scenarios based on collected information from international and national sources. These scenarios (especially population, GDP, energy efficiency) are considered as inputted assumption in AIM/CGE[basic] model. As the main tool for this research, AIM/CGE[basic] model simulates the long-term performance (by 2050) of all activities in an economy by covering: (a) activity production & factor markets, (b) institutions (households, enterprises, government, and rest of the world), (c) commodity market (domestic outputs & imports), (d) macroeconomic balances (government balance, external balance, & savings-investment balance), (e) energy commodities, and (f) air pollutants & GHG emissions. Currently, Linear Expenditure System (LES) consumption function in the model cannot perform the change of household expenditure share when income increases; therefore it is replaced by AIDADS function in which the budget share coefficients are estimated based on historical household expenditure surveys so that the future simulation of future expenditure is closer to the actual preference, especially the change towards low carbon lifestyle.

Chapter 4 reviews the governmental outlook of Vietnam based on the national development targets and plans. This review is the background for the national-based scenario development conducted in Chapter 5 of this dissertation. In this chapter, "review" does not only mean gathering information of current governmental socio-economic outlook but also include back-casting the historical development of Vietnam from the LCD viewpoint. Moreover, the energy development outlook including the energy pricing system and detail content of latest Vietnam Power Development Plan (PDP7) is also reviewed.

Chapter 5 describes the characteristics of future societies in Vietnam and analyzes the implications of low carbon mitigation measures. A Scenario for Low Carbon Society (SLCS) is more positive and willing to innovate the social system, institution and technology for realizing next societies. Meanwhile, A Scenario of rather STAGnant Society (SSTAG) is more cautious and careful to these changes, putting more focus on transition cost for realizing next societies. The GDP of SSTAG in 2050 is around 300 bil.US$, while that of SLCS is much higher, around 906 bil.US$, showing the big different in economic development between the two societies. The results show that in order to reduce the Greenhouse gas (GHG) emission target in 2050 ($0.37GtCO_2eq$), SSTAG and SLCS have to reduce its emission around 12.4% and 54.3% compared to its total emission in 2050 under Business-as-Usual (BaU) case, respectively. This reduction leads to the GDP loss for both societies, which are 1.2% and 10.4% of its total GDP in 2050, respectively. There is also an income loss around 10.3% and 15.3% of its total income in 2050 for SSTAG and SLCS, respectively that lead to the reduction in future household expenditure. Under more stringent reduction target, both societies may face even higher losses. In order to achieve the reduction target, besides the measures for non-GHG emission (from agriculture, land use change), the main countermeasure for Vietnam are Carbon Capture and Storage (CCS), nuclear power, and renewable energies.

Chapter 6 is for the conclusion and suggestion. This research archived its objectives: (1) proposing a scientific and methodological framework for long-term scenario development; and (2) provides backgrounds for the implementation of LCD in Vietnam by applying the proposed method. The methodological suggestion is that in order to propose more detail mitigation options and well-designed scenarios for future LCD analysis; the AIM/CGE[basic] model should have more detail disaggregation of households (such as by income and living areas), as well as the necessity to couple with bottom-up energy model especially for households.

（論文審査の結果の要旨）

　本論文は、開発途上国や新興国において低炭素発展に向けた社会・経済シナリオの構築を、応用一般均衡モデルを用いて行う方法を提案し、ベトナムに適用することによって、その実用性を検証したものであり、次の成果を得ている。

1. 本論文では、まず、新興国に共通した特徴である急激なマクロ経済構造の変化、生活水準の変化及び温室効果ガス排出制約に代表される環境規制の強化が、家庭などの最終消費に及ぼす影響を、応用一般均衡モデルを用いて定量化する方法を開発している。そのため、既往のモデルをベースとして、エネルギー技術選択メカニズムの導入、エネルギー消費構造、及び、家計部門の消費構造の詳細化を行っている。特に、家計の消費関数については、従来から多用されている LES 関数に替え、AIDADS 需要関数を組み込み、観測データを用いた検定手法を組み込むことによって所得水準の変化が消費構造に及ぼす影響を構造的に取り込むことに成功している。

2. さらに、本論文では、構築したモデルを、経済成長が著しく、積極的な教育水準の向上や気候変動対策の導入を行っているベトナムに適用し、現在から 2050 年を対象期間として、社会革新の速度の緩速に関する二つのシナリオ（高成長シナリオ、及び、低成長シナリオ）を想定し、これらの社会に温室効果ガス排出量制約が課された時の影響を検討した。その結果、高成長シナリオでは無制約下に比べ GDP では最大 10%の、家計所得では最大 15%の減少が生ずるなどの大きな影響がみられた。一方、低成長シナリオでは、それぞれ最大 1.2%、最大 10%であるなど、温暖化抑制対策と経済成長の係わりを定量化することに成功している。

3. また、高成長シナリオにおける経済成長阻害の要因が、資源不足と資本投資低下が中心となって発生しているのに対し、低成長シナリオでは、相対的に緩和していることなどを機構的に説明している。

　以上のように、本論文は、開発途上国における低炭素発展に向けた長期シナリオを策定・評価するにあたって必須となる温暖化抑制対策と社会・経済発展の係わりを定量的に検討する手法を提案・検証したものであり、社会的重要性が高い研究である。また、本研究の成果は、低炭素社会を目指すアジア地域の低炭素社会実現にも大きく貢献するものである。これらの理由から、本論文は、学術上、実際上寄与するところが少なくない。よって、本論文は博士（工学）の学位論文として価値あるものと認める。また、平成 24 年 8 月 9 日、論文内容とそれに関連した事項について試問を行って、申請者が博士後期課程学位取得基準を満たしていることを確認し、合格と認めた。