ECONOMIC IMPLICATIONS OF THE PARIS AGREEMENT ON TAIWAN: A GLOBAL ECONOMY-WIDE ANALYSIS

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Abstract

This study develops a recursive-dynamic computable general equilibrium (CGE) model on analyzing global climate commitment on Taiwan's economy and its interaction with government's energy policy. The main purpose of this study aims to evaluate the following questions: What is the economic implications for Taiwan's mitigation cost, generation mix, welfare, and emissions trajectories by adopting emission quantity constraints both in terms of CO_2 and non-CO_2 emissions? What is the policy implication for implementing economic-wide Nationally Determined Contributions (NDCs), and its interaction with Taiwan's renewable energy policy? How Taiwan's mitigation cost responses to the government's energy policies—given Taiwan undertakes 2025 non-nuclear homeland policy and achieves its own energy transition target i.e., the generation mix is composed of renewables (20%), nature gas (30%) and coal (50%) (Bureau of Energy, 2018). We find: (1) the mitigation cost more while the economic-wide reduction effort in terms of CO_2 is carried out rather than based on non-CO_2 greenhouse gases (GHGs). Since Taiwan's research measures abatement cost based on CO_2-only policy, the quantitative constraints focus on one specific gas and is more stringent. While the NDCs are based on GHGs, the CO_2-only policy results in higher carbon price that equilibrates the market; therefore, the abatement cost could be over-estimated (Chai et al., 2017). On the other hand, the endogenously represented GHGs and their high global warming potential (GWP) allow more feasibility in emissions constraints—result in lower carbon price that modifies the negative impact on economic cost. (2) The industrial structure, sectoral production and generation mix of Taiwan will be affected by high renewable penetration (e.g., solar 20 GW and wind 4.2 GW) given global climate pledges. (3) In general, the abatement cost could be much higher when 2025 non-nuclear homeland policy and energy transition target are undertaken, simultaneously. Taiwan's higher abatement cost comes from phasing out the zero-emit generation option i.e., nuclear; on the other hand, the energy transition path allows coal-fired power contributes a substantial share (50%) in grid which emits more anthropogenic CO_2. Consequently, all these strategic measures together significantly raise the mitigation cost for Taiwan to meet its climate commitment.

JEL classification: Q01, Q48, Q54
Keywords: CGE model, Energy policy, Nationally Determined Contributions (NDCs)

Methods

Strategy in modeling electricity sectors

The existing literature adopted various strategies to model electricity output. In conventional CGE framework (Shelby et al., 2008; McFarland et al., 2009), electricity output is often aggregated by dispatchable and non-dispatchable technologies by CES function. This kind of CES bundle setting implies the non-dispatchable technologies i.e., wind and soalr will growth with dispatchable technologies—as back up for intermittent renewables energies when electricity demand is raising; however, there is no reason to think the growth of dispatchable technologies depends on non-dispatchable technologies. One possible way to overcome this issue is to introduce a proportion of generation from gas and hydro as fixed-factors and back up to control the growth of wind power (Chen, 2013). Chai et al. (2016) the electricity production is an aggregated sector—which is incapable to reflect the feature of dispatchable and non-dispatchable generation technologies, and the substitution effect among different generation options in response to relative price change. Nevertheless, the renewables' raising penetration and variability in power system, the existing studies (Chen, 2013; Chai et al., 2016) ignore the important role of advanced technologies played in competing with fossil-fuel based power, hydro, and nuclear in grid.

Conclusions

1. The mitigation cost more while the economic-wide reduction effort in terms of CO_2 is carried out rather than based on non-CO_2 greenhouse gases (GHGs). Since Taiwan's research measures abatement cost based on CO_2-only policy, the quantitative constraints focus on one specific gas and is more stringent. While the NDCs are based on GHGs, the CO_2-only policy results in higher carbon price that equilibrates the market; therefore, the abatement cost could be over-estimated (Chai et al., 2017). On the other hand, the endogenously represented GHGs and their high

global warming potential (GWP) allow more feasibility in emissions constraints—result in lower carbon price that modifies the negative impact on economic cost.

2. In general, the abatement cost could be much higher when 2025 non-nuclear homeland policy and energy transition target are undertaken, simultaneously. Taiwan's higher abatement cost comes from phasing out the zero-emit generation option i.e., nuclear; on the other hand, the energy transition path allows coal-fired power contributes a substantial share (50%) in grid which emits more anthropogenic CO_2. Consequently, all these strategic measures together significantly raise the mitigation cost for Taiwan to meet its climate commitment.

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