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ESTIMATION OF THE IMPACT OF GHG TARGET-SETTING ON THE MACROECONOMY AND ITS POLICY IMPLICATIONS

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OVERVIEW

Among recent climate change policy debates, GHG reduction target-setting is one of debatable issues. In fact, the former administration of the Japanese government declared in June 2009 that Japan would reduce GHG emissions by 15 percent from the level in 2005 by 2020. The new administration reversed it in September 2009 and decided to commit itself to reduce emissions by 25 percent from the 1990 level. In these decision-making processes, large-scale energy-economic models played a significant role. However, these models—basically CGE models—are highly complicated and thus, difficult to understand for non-experts. In fact, although there are a lot of parameters that are set *a priori* in these models, the significance remains unclear to policy makers. The purpose of this article is to explore which parameters in CGE models are significant to the estimation of impacts of GHG target-setting on GDP and carbon tax required for achieving the target, and discuss its implications to climate policy making. It is shown that the estimation results are in principle subject to the discretion of model builders.

METHODS

The analysis is based on a static equilibrium model of an economy that utilizes energy resources. It is one of the simplest models as a CGE model. With the model, we can analytically investigate its implications. The treatment of analytical models that represent an economy with energy resources here is based on the work of Maeda (2008).

Consider a one-sector economy that produces final product from capital input, labor input, and fossil energy input. The energy resource is imported from outside of the economy. Except energy resources, the economy is assumed to be closed, that is, there is neither import nor export. The use of fossil energy resource produces carbon emission. Without any technological change, fossil energy use and carbon emission are proportional to each other. The final product is partly consumed and the rest is invested for capital accumulation.

Introduce the following notations:

Q: final consumption good, Y: GDP, K: capital input, L: labor input, E: fossil energy resource input, P_K: rental price, P_L: wage, P_E: price of fossil energy resource, I: investment, s: average saving propensity, δ: depreciation of capital.

Introducing production function F, the economy is described as follows:

$$Q = F(K, L, E),$$

$$Y = Q - P_E E,$$

$$Y = P_K K + P_L L.$$

From the definitions of average saving propensity and depreciation of capital, the following relations hold true:

$$P_K I = sY,$$

$$dK/dt = I - \delta K.$$

RESULTS

Given some assumptions, we have the following claim:

Claim. *When a certain emission reduction target is set by the government, and given that there is no technological change, estimates of both resulting declines in GDP and increases in carbon prices required for the achievement of the target entirely depend on the assumed value of the elasticity of substitution between the composite good of capital and labor and fossil energy resource (*σ*).*

Such dependence of estimated changes in GDP and carbon prices on the value of σ creates a serious problem. Parameters in CGE models are usually set by the procedure called "calibration." For example, all share parameters in production functions in CGE models can be estimated from actual input shares. However, the value of the elasticity of substitution is an exception: it cannot be "calibrated" in any CGE model by principle: to estimate σ, we need to have the slope of demand curve. Since demand curves comprise of data sets of counter-factual equilibria, it is impossible to obtain the curves without assuming that historical data represent such counter-factual equilibria at present time. As a result, σ is always set with modeler's discretion. This means that estimated changes in GDP and carbon prices are entirely determined by modeler's discretion on σ.

In practices in CGE modeling, modelers usually conduct sensitivity analysis on values of the elasticity of substitution. In many cases, it turns out that perturbation of values of the elasticity of substitution creates only minor changes in the equilibrium. Thus, in practices in CGE modeling, it is seldom that modelers have to be careful about influences of values of the elasticity of substitution on computation results. However, as for climate policy making, it is not the case: the estimation of the impacts of emission reduction target-setting is quite different from typical economic analysis.

CONCLUSION

The result obtained here is based on a simplified version of an economy. However, the model structure is essential to all CGE models. Thus, the insight is generally applicable to any CGE analysis: computational models usually contain a lot of ad hoc parameters. The setting of these values is sometimes left to the discretion of model builders. It is fine as long as such discretion does not directly affect calculation results of these models, and it is the typical case in CGE analysis. However, in the case of climate policy, i.e. in the case that macroeconomic impacts of GHG target-setting are estimated, the discretion on the value of the elasticity of substitution between the composite good of capital and labor and fossil energy resource is crucial to the result. It means before policy makers and parties concerned agree on a certain target, they need to reach an agreement on the estimates of the elasticity.

REFERENCES

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