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ENERGY POLICIES IN CGE MODELS – THE ROLE OF ENDOGENOUS TECHNICAL CHANGE AND OF GAINS FROM SPECIALIZATION

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OVERVIEW

Computable general equilibrium (CGE) models are used in many countries to estimate the effects of energy policies on industry and the welfare level. The results of the simulations strongly depend on the underlying assumptions on growth and technical change [2]. The aim of this paper is to identify the results of a specific energy policy for two different approaches to model induced technical change. We emphasize the differences between the CITE model (based on endogenous growth dynamics) and an alternative model with homogenous capital and exogenous growth of endowments. The CITE model can be considered as the only existing version of the group of models with endogenous technical change that includes gains from specialization as driver for endogenous growth. These gains are assumed to be present in the benchmark case without political measures as well as in the policy scenarios, which yields consistent technologies with and without an energy policy. These endogenous growth mechanisms yield different results in three dimensions compared to the model with exogenous growth. We therefore show the importance is for policy makers and scientists to fundamentally understand the underlying technological assumptions.

METHODS

The first CGE models were based on the assumptions of exogenous growth and autonomous amelioration of energy efficiency. They ignored interconnections between technological change and policy measures. Changes in energy prices due to political actions only resulted in substitution of other factors for energy, leaving the rate of growth in energy efficiency unchanged. As energy policies have yet an impact on the price of fuels and therefore on the incentives to invest in research and development (R&D), they are strongly linked to technological change. Such policies might cause research efforts to concentrate on the discovery of new production methods or of entirely new products that depend less on energy.

The two models that are compared in this paper are the CITE model and a standard model with homogenous capital and exogenous growth. Both models are top-down models calibrated for the Swiss economy with a decentralized structure. The principal production structures are identical. The main difference is in the inclusion of gains from specialization and therefore of heterogeneous capital in the CITE model. The incentives to accumulate capital generate endogenous growth dynamics. In comparison, in the standard model with homogenous capital, growth is assumed to come from endowments that grow by an exogenously defined rate in each period. This growth comes at no cost ("manna from heaven"). The policy scenario is based on a carbon tax that is based on the carbon intensity of the output of the oil sector and of imported gas. The revenues from the tax are redistributed with a subsidy on R&D that goes to all sectors except the oil sector. The amount each sector gets is optimized during the simulations.

The CITE model builds on the existing literature of CGE models with endogenous growth elements and offers a first attempt to endogenize growth by applying gains from specialization and monopolistic competition as driver for growth. Each sector comprises incentives to invest and therefore to increase the amount of intermediate goods available in

that sector ("expanding variety of products") and thereby sectoral productivity. It builds on empirical evidence of different authors along the centuries. By observing the production in a pin factory, Smith already reported as early as in 1776 that specialization immensely increases the efficiency of the workers and therefore contributes to an augmented output ([7]). The first attempt to include these gains from specialization in economic models was done by [8]. [3] and [5] refined [8]'s approach. The first to combine specialization with production was [4], who assumed that an increasing number of inputs to production would raise output ([1]). [6] followed [4] and assumed that output is an increasing function of intermediate goods.

RESULTS

The comparison of the dynamics of the CITE model to a standard model with exogenous growth shows that the endogenous growth mechanism of the CITE model yield different reactions to a carbon tax. There, capital growth generates gains from specialization and ensures endogenous growth dynamics. These dynamics are influenced by a carbon tax as the incentives to invest change. Investments target at a substitution of energy in the production and result in a higher productivity of the intermediate composite. This, in turn, contributes to a change in the production of final outputs. In the model with exogenous growth, capital accumulation can only contribute to a substitution for energy but not to an increase of productivity. Accordingly, investment incentives are different compared to the CITE model. The dissimilarity of investment incentives are reflected in the reactions of the sectors to a carbon tax. In the CITE model, most industries show a stronger sensitivity to the change in input costs than in the model with homogenous capital. Mainly three differences occur: First, the spread of output of the sectors is larger in the CITE model. Second, the speed in which the industries approach a new balanced growth path is lower in the CITE model. And finally, the effects of the policy on various sectors are different in the two models.

CONCLUSIONS

It can be concluded that the endogenous growth mechanism in the CITE model uncovers dynamics triggered by a carbon tax, which cannot be displayed by a model with homogeneous capital and exogenous growth. These differences are crucial for policy makers when taking results of CGE models into consideration for decisions about policies.

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