Deployment of new clean technologies in developing countries in a CGE framework: fostering investments in clean and renewable energy

Carlo Orecchia[a,b], Ramiro Parrado[a,b]

[a] *Fondazione Eni Enrico Mattei (FEEM), Isola di San Giorgio Maggiore 8, 30124 Venice, Italy*
[b] *Euro-Mediterranean Center on Climate Change (CMCC), Isola di San Giorgio Maggiore 8, 30124 Venice, Italy*

Abstract

Technological advancements are one of the major drivers of economic growth. Diffusion of new technologies provide the initial impulse for new and alternative production processes that will constitute additional engines for development. In addition, with adequate incentives these new technologies could grow in size and become an important sector within an economy. This is the case of clean and renewable energies which are growing fast not only in the developed world, but also on developing countries. Modeling these kind of processes have proven to be quite a challenge, in particular in a general equilibrium framework. Furthermore, given that computable general equilibrium (CGE) models use data from social accounting matrices (SAM) providing information for the calibration year, it is very difficult to introduce a new sector or technology in SAM where initially it was incipient. This paper describes a methodology to integrate new sectors in a recursive dynamic CGE by modifying the initial SAM and including a new type of investment which cumulates in time allowing the new sector to become mature and take part in the future economy development.

Keywords: CGE, Technical change, Adaptation

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1. Introduction

In all CGE models, the base year is of fundamental importance. Broadly speaking, we can think of it as a snapshot of the economic activity carried out in a particular year; this snapshot, or better said, the economic data behind it, is then used to solve the model and make projections or future scenarios. Thus, the future development of sectors that are not present (i.e. zero economic value) in the base year might be very challenging. To overcome such limitation, we introduced into the ICES model a new form of capital endowment representing a stock of investments in new clean or renewable technologies. These new technological capital can cumulate in time and could be exogenously shocked as well to simulate an additional effort to develop a new sector in the dynamic recursive CGE. The new primary factor is modeled as a "sluggish" endowment, it is not mobile across sectors and it is sector-specific. This allows us to target investments to selected sectors (e.g. solar or wind energy for example) and trigger the adoption of new technologies even in countries where such technologies do not exist yet. Thus, this new endowment is a sort of "auxiliary capital" used to foster the development of such sectors until the reach a mature stage. The investment is modeled as an exogenous variable which in each period increases the stock of the technological capital. This new capital endowment is then combined with the "traditional" output using a CES function. Therefore, the new final output at the top nest is made of the standard output (which, as in the original formulation combines all other primary factors with intermediate inputs) and the new form of capital. Through the CES function elasticity it could be also possible to calibrate investments in order to achieve a certain level of output of a particular sector. As a matter of fact, certain types of technologies require long term investments. Finally we run a policy exercise simulating a mitigation scenario with these additional clean energy technologies and compare them with a simulation where there are no such new technologies.

2. Methodology and model improvements

3. Policy experiment

4. Results

5. Conclusions

References

[1] Avetisyan, M., A. Golub, T. Hertel and S. Rose. (2010), "Why a Global Carbon Policy could have a dramatic impact on the pattern of worldwide livestock productio". Draft manuscript, Center for Global Trade Analysis. Purdue University, West Lafayette, IN.

[2] Böhringer C., Rutherford T. and Tol R., (2009), "The EU 20/20/20 targets: an Overview of the EMF22". Energy Economics 31, 268-273.

[3] Böhringer, C., Fisher, C. and K.E. Rosendahl (2010), "The global effects of subglobal climate policies, Resources for the Future". Discussion Paper 10-48.

[4] Bosello, F., Buchner, B., Crimi J., Giupponi C., Piovesan F. and Povellato A. (2005), "Cost efficiency and effectiveness of GHG mitigation policies and measures in the agro-forestry sector: a survey of the economic literature. MEACAP WP2 D6. Feem, Milan, Italy.

[5] Bosello, F., Campagnolo, L., Eboli, F., Parrado, R. and Portale, E. (2011), "Extending Energy Portfolio with Clean Technologies in the ICES Model". 14th Annual Conference on Global Economic Analysis, Venice, 16–18 June. $https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID = 3632$

[6] Bosello, F., Campagnolo L., Carraro C., Eboli F., Parrado R., Portale E. (2013a), "Macroeconomic Impacts of the EU 30% GHG Mitigation Target". Feem NOTE DI LAVORO, 2013.028. Milan, Italy.

[7] Bosello, F., Orecchia C., Parrado R. (2013b), "The additional contribution of non-CO_2 mitigation in climate policy costs and efforts in Europe". Proceedings of the Gtap 16th Annual Conference on Global Economic Analysis. ISSN 2160-2115 (online).

[8] Burniaux, J.-M., Truong, T.P., (2002), "GTAP-E - an energy-environmental version of the GTAP mode"l. GTAP Technical Papers, No. 16. Center for Global Trade Analysis, Purdue University, West Lafayette, Indiana, USA 47907-1145.

[9] Calzadilla, A., Rehdanz, K., Tol, R. (2008), "The Economic Impact of More Sustainable Water Use in Agriculture: A CGE Analysis". Research Unit Sustainability and Global Change, FNU-169. Hamburg University.

[10] Capros, P., Mantzos, L., Parousos, L., Tasios, N., Klaassen, G., Van Ierland, T., (2011), "Analysis of the EU policy package on climate change and renewables". Energy Policy 39 (3), 1476-1485.

[11] De Cian, E., Sferra, F. and Tavoni M., (2013),"The Influence of Economic Growth, Population, and Fossil Fuel Scarcity on Energy Investments". FEEM Working Paper No. 59.2013. Available at SSRN: http://ssrn.com/abstract=2284045 or http://dx.doi.org/10.2139/ssrn.2284045

[12] De Cara, S., Houzé, M., Jayet, P.-A., (2005), "Methane and nitrous oxide emissions from agriculture in the EU: a spatial assessment of sources and abatement costs". Environmental and Resource Economics 32 (4), 551-583.

[13] De Cara, Jayet, P.-A., (2011), "Marginal abatement costs of greenhouse gas emissions from European agriculture, cost effectiveness, and the EU non-ETS burden sharing agreement". Ecological Economics 70 (2011), 1680-1690.

[14] Deke, O., Hooss, K. G., Kasten, C., Klepper, G., Springer, K. (2002) "Economic Impact of Climate Change: Simulations with a Regionalized Climate-Economy Model". Kiel Institute of World Economics, Kiel, 1065.

[15] Eboli, F., Parrado, R. and R. Roson (2009),"Climate Change Feedback on Economic Growth: Explorations with a Dynamic General Equilibrium Model". FEEM Note di Lavoro 2009.043.

[16] European Commission, (2008) 20 20 by 2020:" Europe's climate change opportunity. Communication COM(2008) 30 final". Commission of the European Communities, Brussels, Belgium.

[17] European Union, (2009), "Decision on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020". Decision of the European Parliament and the Council of the European Union 406/2009/EC, Official Journal of the European Union, Brussels, Belgium, L140, pp. 136-138.

[18] Golub, Alla., Thomas Hertel, Huey-Lin Lee, Steven Rose, Brent Sohngen (2009), "The opportunity cost of land use and the global potential for greenhouse gas mitigation in agriculture and forestry". Resource and Energy Economics 31 pp 299-319.

[19] Golub, Alla., B. Henderson, T. Hertel, S. Rose, M. Avetisyan, B. Sohngen (2010), "Effects of GHG Mitigation Policies on Livestock Sectors". GTAP Working Paper No.62.

[20] Golub A A, Henderson B B, Hertel T W, Gerber P J, Rose S K and Sohngen B (2012),"Global climate policy impacts on livestock, land use, livelihoods, and food security". Proc. Natl Acad. Sci. at press (doi:10.1073/pnas.1108772109).

[21] Höglund-Isaksson, L., Winiwarter, W., Wagner, F., Klimont, Z., Amann, M., (2010), "Potentials and costs for mitigation of non-CO_2 greenhouse gas emissions in the European Union until 2030". Results. Report to the European Commission, DG Climate Action Contract No. 537 07.030700/2009/545854/SER/C5. International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria.

[22] Hediger, W., (2006), "Modeling GHG emissions and carbon sequestration in Swiss agriculture: an integrated economic approach. Greenhouse Gases and Animal Agriculture: An Update". Proceedings of the 2nd International Conference on Greenhouse Gases and Animal Agriculture (Zurich, Switzerland): International Congress Series, 1293, pp. 86-95.

[23] Hertel T.W., Lee H., Rose S., Sohngen B., Hertel T.W.,Rose S.,Tol R. (2008), "Modeling Land-use Related Greenhouse Gas Sources and Sinks and their Mitigation Potential" in "Economic Analysis of Land Use in Global Climate Change Policy". Routledge, Chapter 6.

[24] IPCC. 2001. "Climate Change 2001: The Scientific Basis, Intergovernmental Panel on Climate Change". Edited by J.T. Houghton, Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, C.A. Johnson, and K. Maskell. Cambridge, UK: Cambridge University Press.

[25] Narayanan, G.B. and T.L. Walmsley, Eds. (2008), "Global Trade, Assistance, and Production: The GTAP 7 Data Base". Center for Global Trade Analysis, Purdue University.

[26] Povellato A., Bosello F. and Giupponi C. (2007) , "Cost-effectiveness of GHG mitigation measures in the european agro-forestry sector: a literature survey". Environmental Science & Policy 10 (5), 474-490.

[27] Reilly, J.,Prinn, R., Harnisch, J., Fitzmaurice, J., Jacoby, H., Kicklighter, D.W., Melillo, J.M., Stone, P., Sokolov, A., and Ng, C. (1999). "Multi-gas assessment of the Kyoto Protocol". Nature, 401, 549-555.

[28] Rose, S.K., Avetisyan, M., and Hertel, T. W (2010),"Development of the Preliminary Version 7 Non-CO_2 GHG Emissions Dataset". GTAP Research Memorandum No. 17.

[29] Rose SK, et al. (2012), "Land-based mitigation in climate stabilization". Energy Econ 34: 365-380

[30] Weyant JP, de la Chesnaye FC, Blanford GJ. (2006), "Overview of EMF-21: Multigas Mitigation and Climate Policy". The Energy Journal Special Issue on Multi-Greenhouse Gas Mitigation and Climate Policy: 1–32

Appendix