SHALE GAS TRADE AND ENVIRONMENTAL POLICIES: GLOBAL ECONOMIC AND ENVIRONMENTAL ANLYSES IN A HYBRID MODELLING FRAMWWORK

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Overview

A massive expansion in US shale gas production affects markets for a wide range of goods and services at a global scale, generates economic and environmental benefits for the US economy, and improves its relative competitive position in the market. No one has fully analysed the consequences of the US shale gas boom for the global trade of goods and services (including trade of crude oil and gas) and their feedback impacts for the US economy. The shale gas boom will alter the trade between US and its trade partners directly and vary the trade relationships between non-US trade partners as well. This will provide a unique opportunity for the US economy to maximize the economic and environmental gains of the shale gas boom through the trade channel and play a major role in designing a set of trade-environmental policies to reduce its trade deficit, enhance the US relative advantages in the global market, reduce a portion of its budget deficit, and effectively follow emissions reduction policies world-wide.

This paper uses a multidisciplinary modeling framework consisting of a global computational general equilibrium economic model plus an energy model to analyse and quantify the economic and environmental benefits of the US shale gas boom and determine the trade-environmental policies which maximize these benefits. We show that the environmental and economic benefits of the shale gas boom for the US economy are relatively large, but their magnitudes significantly change with the background trade-environmental policies. We determine the impacts of the US trade-environment policies on the distribution of the shale gas boom benefits across the world and within selected countries across economic sectors.

Methodology

The modeling framework consists of a revised version of GTAP-E model constructed and an enhanced version of MARKAL-Macro model. The GTAP-E model, developed at Purdue University (Burniaux and Truong, 2002), is a global computational general equilibrium economic model which is designed to assess the regional economic and environmental impacts of national and multinational energy-economy-environmental-trade policies and development. Alternative versions of this model are used in many economic and environmental analyses (for example see: Kemfert et al., 2006; Hertel et al., 2010; Taheripour et al., 2010; Golub et al. 2012). The model traces production, consumption, and trade of goods and services, categorised in several groups, by region. It considers substitution among energy sources and between capital and energy and takes into account competition for energy and other resources among firms. It also manages allocation of energy between households and firms. We modified and extended this model and its data base to correctly analyse expansion in US shale gas and its consequences for other energy sources and the rest of economic activities. To do so we used a modified version of the MARKAL-Macro model which is a dynamic, perfect-foresight, and energy technology-rich linear programming model widely applied in energy area. In its standard formulation, its objective function is the minimization of the discounted total system cost which is formed by summation of capital, fuel and operating costs for resource, process, infrastructure, conversion and end use technologies. Further details regarding the methodology can be found in (Loulou et al., 2004). Sarica and Tyner (2013) revised the MARKAL model according to new developments in the energy sectors and in particular with respect to recent expansion in the US biofuel production and more importantly in response to the US shale gas boom.

To build the modeling framework and its data base we began with the GTAP data base version 8 (Badri Narayanan et al., 2012) which represents the world economy in 2007. This data base underestimates production and consumption of gas and misallocates consumption of gas among its alternative uses. We fixed these problems using

the published data developed by the IEA. In this process the GTAPAdjust program (Horridge, 2011) is used to maintain the GTAP data base in balance. Then the original GTAP-E model is modified to handle the new data base. In the next step we used a modified version of the MRAKA-Macro model (Sarica and Tyner, 2012) to tune the parameters of the supply side of energy sectors of the GTAP-E model according to the new developments in the US shale gas industry and its expected future expansion. Then several experiments are developed to evaluate the regional economic and environmental impacts of the US shale gas boom under alternative trade-environmental policy configurations. The implemented policies cover a wide range of trade and emissions reduction policies such as restricting the US gas exports through trade barriers, expansion in imports of tar sand oil and gas from Canada, imposing trade barriers on domestic and imported goods according to their induced air emissions, taxes on energy consumption, and finally incentive policies to invest more in gas distribution infrastructure.

Results

The preliminary results show that the expansion in US shale gas enhances the US GDP, improves welfare, reduces trade and budget deficits, and has the potential to affect positively the US capital accumulation capability in long run. The magnitudes of these effects vary with the background trade-environmental policies. We show that in some circumstances expansion in US gas exports operates against the US economy and transfers a portion of expected benefits due to the US shale gas boom to other regions. Our analyses also show relative advantages of the US economy in the world market when more natural gas is available, and the required infrastructure are built to use it. Finally, we discuss areas where economic analyses fail to estimate the costs and benefits of new technologies, accurately.

Conclusions

The US shale gas boom will generate sizeable economic and environmental benefits for the US and other economies across the world. The expected benefits in most cases reamin below 1 percent of US GDP in the long run. However, the magnitudes and regional distribution of the benefits vary with policy options.

References

Burniaux J. and Truong T., 2002. GTAP-E: “An energy-environmental version of the GTAP model,” GTAP technical Paper No. 16, Center for global trade analysis. Purdue University, West Lafayette, IN, USA.

Golub A., Henderson B., Hertel T., Gerber P., Rose S., and Sohngen B., 2012. “Global Climate Policy Impacts on Livestock, Land Use, Livelihoods and Food Security,” Proceedings of the National Academy of Sciences, doi:10.1073.

Horridge M., 2011. “GTAPAdjust: A program to balance or adjust a GTAP database,” Centre of Policy Studies, Monash University, Melbourne, Australia.

Hertel T., Golub A., Jones A., O’Hare M., Plevin J., and Kammen D., 2010. “Global land use and greenhouse gas emissions impacts of U.S. maize ethanol: Estimating market-mediated responses,” BioScience, 60, 223–231.

Kemfert C., Kohlhaas M., Truong T,. and Protsenko A., 2006 “The environmental and economic effects of European emissions trading” Climate Policy, Vol. 6, No. 4, pp .441-455.

Loulou, R., Goldstein, G., Noble, K., 2004. “Documentation for the MARKAL Family of Models”.

-Narayanan B., Aguiar A., and McDougall R., Editors, 2012. “Global Trade, Assistance, and Production: The GTAP 8 Data Base,” Center for Global Trade Analysis, Purdue University.

Sarica, K. and W. E. Tyner, 2013 “Alternative Policy Impacts on US GHG Emissions and Energy Security: A Hybrid Modeling Approach”, *Energy Economics*, forthcoming.

Taheripour F., Hertel T., Tyner W., Beckman J., Birur D., 2010. “Biofuels and their by-products: Global economic and environmental implications,” Biomass and Bioenergy 34, 278–289.