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Global Impacts of the Kyoto Agreement – Comments to Bernstein et al.[1]

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The paper by Bernstein et al. (1999) presents economic impacts of the Kyoto agreement using a dynamic general equilibrium model (MS-MRT model). The model is a multi-sector, multi-region trade model, and simulations are run for the period 2000-2030. The focus of the model is the effects of emission permit trading, and three different regimes are studied. In the first regime, there is no trading, while trading only among Annex 1 countries is allowed in the second regime. Finally, in the third regime, full global trading is allowed. Impacts on such variables as economic welfare, international trade and investments across regions, the spillover effects of carbon emission limits in Annex 1 countries on non-Annex 1 countries, carbon leakage, changes in terms of trade and industry output are studied under the different regimes. The results are well documented, and sensitivity analyses are made to test the robustness of the results.

The paper analyses a very important question, namely the impacts of the Kyoto agreement. This is an important task as it provides useful background information for the forthcoming negotiations, both for the final framing of the Kyoto agreement, and also for the discussions of an agreement after the Kyoto period of 2008-2012. However, one question the reader asks himself when studying a model simulation of the Kyoto agreement is what does this paper tell me that I have not read somewhere else? What is new in this study, and does the model provide some new insight? Unfortunately the authors do not help us very much in answering these questions. They do not refer to similar analyses, or compare their results. Over the last year or

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so, several modellers around the world have made simulations of the Kyoto agreement on their national, regional or global models, and some of these papers will be published in a forthcoming number of the *Energy Journal*. What I think is the main contribution of this study is that the model is both dynamic, and also rich in sectoral and regional specification. Besides this, trade with several goods is modelled. Thus, the model covers several important aspects at the same time, maybe more than other global models, and I therefore think that it makes an important contribution to study the impacts of the Kyoto agreement. In the following, I will not comment so much on the specific results, but focus on subjects that I feel is important, is a bit unclear or maybe not satisfactory studied by the analysis.

One reason to have a dynamic model is the *fossil fuel markets*. The aspects of non-renewable goods require a dynamic model. This is especially important when analysing climate treaties, as about 75 per cent of CO_2 emissions are due to the combustion of fossil fuels. However, fossil fuels are not fully modelled as non-renewable resources as the depletion effects are ignored. This leaves out the question of the rational distribution of production over time. Another important question is strategic type of the markets. As far as I understand, perfect competition is assumed in all markets, also the oil market. But imperfect competition is a characteristic of the oil market. As documented in Berg et al. (1997), whether there is perfect or imperfect competition in the oil market have large impacts on the effects of a climate treaty, for instance the effects on the oil price. With imperfect competition (OPEC as a cartel), the producer price of oil is not much affected the first years after an agreement has come into force, and the carbon leakage may therefore also be minor. The significant leakage in Bernstein et al. in the scenario with no international permit trading may, therefore, partly be explained by perfect competition in the oil market.

Even if the model has a high number of sectors, one important sector is not modelled, namely *forestry*. Land use changes are included in the Kyoto protocol, which makes this sector interesting in an analysis like this. A national CGE model where emissions from the use of timber and carbon accumulation in the forest are taken into account, thus calculating net emissions, is Pohjola (1999). If net emissions are taxed, Pohjola (1999) finds that the carbon tax needed to reduce net emissions by the same amount as emissions from fossil fuels is significantly lower.

International trade is an important aspect of the model. However, the paper could focus more on how international trade can reduce economic costs of a climate treaty, especially when permit trading is not allowed. One example is *electricity trade*. Electricity is produced using a number of production technologies, and the amount of carbon emissions per unit of electricity varies a lot between the technologies. One example is electricity trade in Scandinavia, where electricity in Norway is based on hydropower, while it is mainly based on coal in Denmark. Norway can increase its production of hydropower without increasing CO_2 emissions. If Denmark imports electricity from Norway, Danish emissions will be reduced. Thus, as demonstrated in Hauch (1999), if national emission targets are imposed, Danish emissions can be reduced at a lower cost if electricity is traded compared to a situation with no trade. Electricity trade can actually work as a substitute to permit trading and equalise marginal abatement costs. Natural gas is another good that may help equalising marginal abatement cost via international trade.

The model includes a *backstop technology*, which sets an upper limit on the price of fossil fuels. That the backstop technology is important for future carbon emissions is demonstrated in, e.g., Chakravorty et al. (1997). As far as I understand, the technological change in the backstop technology is exogenous in the model. However, there is a possibility that a carbon treaty speeds up research and development for alternative energy resources, and therefore, reduces the costs of future abatement. This is an important subject, and I hope to take a further look at this issue in the near future.

The paper calculates the *welfare impacts* under alternative trading arrangements. The welfare concept in this analysis does not include environmental impacts. Personally, I do not like to use the word welfare when environmental impacts are not included, as the main reason for reducing emissions is the well being or welfare of people. Environmental impacts can include both primary and secondary benefits. As demonstrated by several CGE models, the secondary benefits from greenhouse gas abatement may actually outweigh the abatement costs, see, e.g., Ekins (1996). One interesting aspect is the feedback from the environment to the economy. A few CGE models have incorporated this. One example is Glomsrød et al. (1998) that studies the

impacts of traffic injuries on labour supply and public health expenditures in a CGE model for Norway. A carbon tax reduces the fossil fuel use and thus the traffic volume, leading to fewer accidents and increased labour supply.

One of the permit trading regimes in the paper is *global permit trading*. However, it is a bit hard to see from the paper how this actually is specified, and also how the emission targets are specified after 2010. It would help the reader if graphs showing carbon emissions were included. How this regime is specified is important. One of the flexible mechanisms in the Kyoto protocol is the Clean Development Mechanism (CDM). This may be interpreted as a kind of global permit emission trading. However, this mechanism may lead to higher global emissions as it gives the non-Annex 1 countries an incentive to delay investments as Annex 1 countries may pay for the investments in a future period. One of the conclusions in the paper is that global permit trading is worse for China and India than no permit trading, which may explain their attitudes towards permit trading. However, this is very dependent on how the emission permits are distributed after the Kyoto period 2008-12, and this should, therefore, be made clearer in the paper. As demonstrated in, e.g., Kverndokk (1993), different permit allocation rules give very different transfers between countries, and allocation rules may be constructed that actually benefit countries like India and China (e.g., a population rule). Therefore, I think a discussion on emission targets after the model period of 2010 is important, and different regional targets could also be analysed.

I have made several comments on how the analysis could be broadened. However, this does not mean that I do not find the paper interesting, or that I think a general equilibrium analysis should include all this aspects. Anyway, I think that the paper may be improved if some of the aspects are mentioned and relevant comparisons are made.

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