Linkages Between Agriculture, Trade and Environment in Romania: A Partial Equilibrium Model Analysis

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Abstract

We analyse the impact of trade liberalisation on environment in Romania using a partial equilibrium model of beef trade between Romania and the EU. We follow an existent approach that adjusts a current trade model as to include the effect of agricultural production systems on water quality. The results indicate that the beef trade liberalisation impact on nitrate concentration in groundwater is beneficial in all scenarios considered, even if at different magnitudes.

Keywords: trade and environment linkages; agricultural trade liberalisation; partial equilibrium modelling; Romania; EU enlargement.

1. Introduction

The paper analyses the linkages between environment and agricultural trade in view of the trade and environmental agreements between Romania and European Union (EU) using a partial equilibrium modelling approach.

Before 1990 and for quite a while during the transition period, nowadays with less and less stringency, Romania has been affected by two types of distortions relevant to the subject of this paper, namely, agricultural trade policy distortions and environmental distortions. Trade distortions have consisted in taxing agricultural exports and protecting agricultural import substitutes through import tariffs and quantitative restrictions on imports. Environmental distortions have arisen from the lack of internalisation of the full social value of natural resources due to inadequate institutions and difficulties for implementing and enforcing policies that could off-set such institutional inefficiencies.

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During the transition period, Romania has been in the process of significantly liberalising its trade regimes by gradually reducing export taxation, eliminating import quantitative restrictions and significantly reducing import tariffs. These reforms have been implemented mostly because of pressures and financial support from international organisations in the context of economic liberalisation programs usually mentioned as "structural adjustment" (World Bank, International Monetary Fund) and due to its membership application to the European Union.

The first step towards future EU enlargement involved the negotiation of Europe Agreements (EAs). They form the institutional framework for trade integration between Romania and the EU and govern economic aid and political co-operation between the EU and the applicant countries. The trade provisions of the EAs, called the Interim Agreements (IAs), have been implemented in Romania. The main objectives of these agreements are the creation of bilateral free trade areas for non-agricultural products within a period of ten years, providing also for some liberalisation of agricultural trade, close compatibility of economic laws and practice, and the development of a framework for political dialogue and economic co-operation. The basic liberalisation principles embodied in the EAs are preferential treatment, asymmetric reductions in tariffs and the respect of rules of origin.

These structural adjustment programs and the EU harmonisation process have dealt much less with the environmental distortions and, chronologically, environmental distortions have started to be analysed much after trade liberalisation issues. Tackling environmental distortions require a much more sophisticated and effective government and legal system that has only started to be built as part of the EU integration process and participation in MEAs and promises to continue on the medium and long term.

In Romania, intensive agriculture has negatively affected the fertility and quality of soil, has accelerated its erosion, and has disturbed the ecological equilibrium of the rural landscape. Pressures on the environment from agricultural production decreased during the transition due to lower consumption of inputs (mainly fertilisers and pesticides), contraction of large-scale operations created under the previous regime (livestock complexes) and due to a less intensive agricultural land use structure. At the same time, due to the reduction of government funds for support of irrigation, land amelioration and lack of producers' own funds to finance these activities, soil quality declined. The recent improvements in the environmental situation are the side effects of transition, and, other things constant, they are not sustainable over the longer term as economic pressures on producers decrease, providing more production incentives and enabling increased use of inputs.

Monitoring of air, water, and soil is still inadequate. Moreover, analytical methods are sometimes incompatible; there is a general lack of comprehensive quantitative information about pollution levels. Still, existing information is sufficient enough to identify *hot spots* that most deserve immediate response, although improved monitoring is necessary to formulate the most cost-effective solutions. While toxic emissions and discharges, which are a known risk to health should be dealt with on an immediate basis, a gradual approach should be adopted to enforcing environmental standards. In the coming years, the need to comply with more severe environmental standards and compliance with international conventions would demand the introduction of the state-of-art technologies in Romania for pollution abatement.

Current Romanian policies have started to adopt an approach towards sustainability based on the integration of the environment into sectoral policies and the reshaping of social and economic behaviour through the use of a broader range of instruments and by promoting the principle of shared responsibility. The process of increasing environmental awareness has started and has been linked to the EU pre-accession process and Romania's being part of world conventions on environmental issues. The institutions and legislation in the agri-environmental field have been harmonised gradually according to the current EU framework and the process is to continue in the long term.

Thus, considering the gap between coping with the two different type of distortions, we have the classical second-best problem: in a context of multiple distortions, one cannot a priori determine whether eradicating some of them will be welfare-increasing. Moreover, the elimination of trade distortions has a theoretically ambiguous effect on the environment. If the trade reform has a positive effect on environment, then trade liberalisation is necessarily desirable. If the environment is worse-off, the trade reform is not necessarily detrimental, as the welfare losses from the environmental side are to be weighted against the efficiency gains of bringing domestic prices closer to world prices.

We analyse the impact of trade liberalisation on environment in Romania using a partial equilibrium model of beef trade between Romania and the EU. For this, we adjust a current trade model as to include the effect of agricultural production systems on water quality. The model simulates the effects of policy options on trade flows and environment (groundwater nitrate levels).

The paper is structured as follows: we first present the state of art of the linkages between agricultural trade and environment. Then we describe the partial equilibrium model of bilateral trade in beef between Romania and the EU and discuss the results of simulations.

2. Linkages between agricultural trade and environment

There has been a very strong movement towards increased linkage between international trade and environment in the EU as the distinction between purely domestic and international policy has gradually eroded. This view applies consequently to Romania's trade relationships with the EU and carries an increasing weight.

There are two ways of analysing agricultural trade and environment policy linkages, as they both may impact on each other. On one side, joint production of agricultural and environmental outputs means that agri-environmental policies aimed at internalising domestic externalities may affect quantities produced, trade flows and world prices and may impose burdens on trading partners. As regards to methodological work dealing with the environmental impact on agricultural trade, the environmental policy instruments with potential distorting effects on agricultural trade include *regulatory instruments* (such as product or process restrictions or bans, technical regulations, resource use quotas), *economic instruments* (such as environmental taxes and charges, environmental subsidies, deposit-refund systems) and *voluntary schemes* (such as eco- labelling schemes). As agri-environmental issues have only a recent history in Romania and they have only started to deal with internalising domestic externalities, there is little concern that Romanian environmental policies might burden its trading relations.

On the other side, agricultural trade liberalisation has led to adjustments in production and consumption patterns and these changes may affect the environment. Agricultural production is dependent on the use of natural resources and modern agricultural systems rely on a wide range of industrial outputs such as fertilisers and pesticides that can affect environmental quality. Advocates of liberalisation asserted that environmental quality would improve as a side benefit. For example, some argued that the discipline of the market would cause farmers who formerly received crop subsidies to use less fertiliser, resulting in less water pollution. In contrast, critics of the agricultural trade liberalisation alleged that predominant reliance on market signals would cause environmental degradation. The abandonment of crop and livestock production on farmlands that provided biological and landscape values has been a frequently cited risk. These two opposite views appear to be competing hypotheses, but the outcomes are more complex and not mutually exclusive. There can be diverse environmental effects given the different trading regimes, agricultural systems, natural environments, and environmental management programs across countries.

Ervin (1999) makes a methodical taxonomy of methodologies used to estimate the environmental effects of agricultural trade liberalisation: *partial equilibrium models* (using econometric supply and demand functions for agricultural commodities to estimate changes in inputs, outputs, and prices); *general equilibrium models* (large- scale, static econometric models of the agricultural and non- agricultural sectors that incorporate the horizontal relationships between the sectors and the vertical relationships with input supply and processing, using input and output effects to infer environmental changes); *mathematical programming models* (static models of agricultural production and resource use for major regions or a nation that allocate resources based on satisfying an objective function (e. g., profit maximisation) subject to a set of constraints, such as amounts of land in various classes); *economic- environmental simulation models* (economic models are linked to environmental process models that estimate changes in loadings and ambient environmental conditions). Studies on agricultural trade effects on environment have been targeted at global, national, regional and local levels.

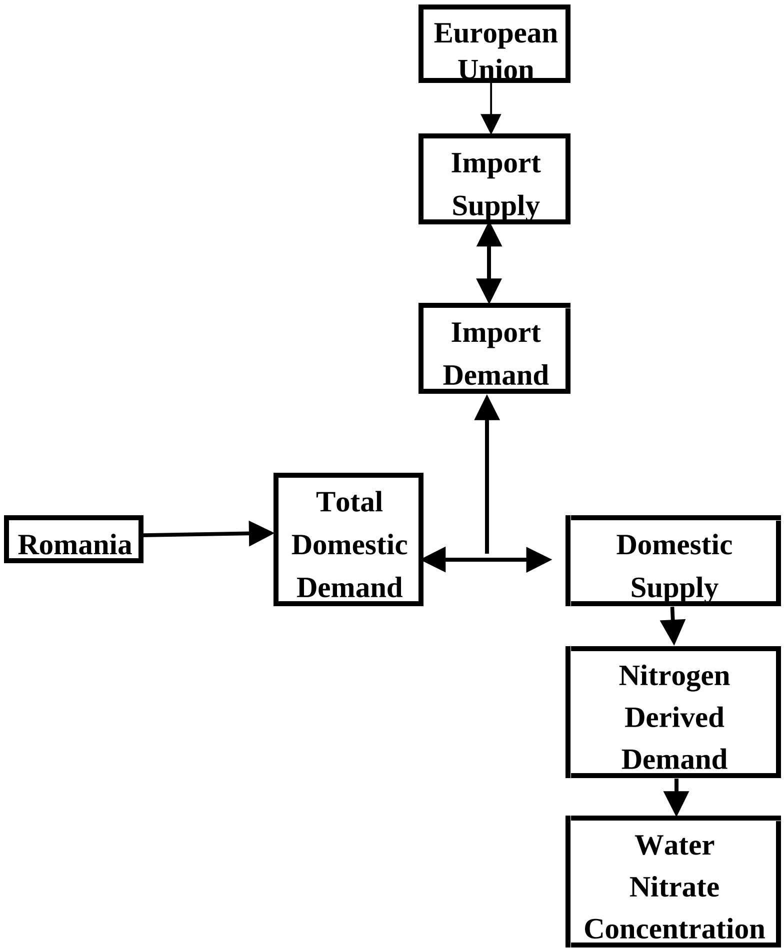
The choice of approach depends on the motivating research questions, the geographical setting, and often on available data. Empirical analyses of the agri-environmental changes that accompany trade liberalisation are restricted to those questions for which there is reliable data. For agriculture, that has meant that most attention has focused on changes in land cultivation, and shifts in fertiliser and pesticide use. However, when it is clear that shifts in production and trading patterns that derive from liberalisation will induce a broader range of environmental effects, additional analysis is necessary.

3. Modelling the impact of agricultural trade liberalisation on environment in Romania in the context of European Union accession process

We analyse the impact of trade liberalisation on environment in Romania using a partial equilibrium model of bilateral trade in beef between Romania and the EU. For this, we use the adjust the model by Saunders et al. (2001) who adjust a current trade model as to include the effect of agricultural production systems on water quality.

The purpose of the model is to simulate the effects of policy options on beef trade flows and on the environment, focusing on the level of nitrate concentration in groundwater. As shown in Figure 1, the model has three components: (1) trade flows from EU to Romania, (2) Romania’s domestic market (supply and demand for the commodity, and input use equations), and (3) equation measuring the impact of input use on nitrate concentration in groundwater.

Figure 1. Romania: Trade and environment model



Romania: Trade and Environment Model

To model the bilateral beef trade EU – Romania, we assume that Romania is a small country as a trading partner for the EU and, therefore the import supply from the EU is perfectly elastic at the import price, such as:

(1) $$P^{EU} = \overline{P}^{EU}(1+t)$$

where t represents the tariff equivalent to any trade policy barrier that increases the export price of EU, $\overline{P}^{EU}$. We will assume that the EU and Romanian products are homogenous, therefore the amount imported corresponds to the quantity that cannot be covered by the domestic supply. If the commodities were not homogeneous, we should have to consider independent demands for the domestic and the imported commodity. Under the assumption of a constant elasticity function form, i.e., Cobb-Douglas type, the aggregate demand, D_{Beef} is given by:

$$D_{Beef} = \beta_0 \cdot p_{Poultry}{}^{\beta_1} \cdot p_{Pork}{}^{\beta_2} \cdot \left(p^{EU}(1+vat)\right)^{\beta_3} \cdot \left(\frac{Gdp}{Pop}\right)^{\beta_4} \cdot Pop \quad (2)$$

where β's are parameters, $P_{poultry}$ and P_{pork} are consumer prices for chicken meat and pork, vat is the value added tax, Gdp is the gross domestic product and Pop is the population. The use of Cobb-Douglas functions is associated to the fact that they allow substitution effects within a simple functional form.

The domestic supply depends on the import price P^{EU} since it is the opportunity cost for purchasing the domestic product, the price of milk P_{Milk} as the product that competes with beef on the farm resources and on the price of inputs, P_{wheat}, P_{cgrain}, $P_{oilseed}$, $P_{oilsead-meal}$, which are represented by the ingredients of the feeding ratio[3] (i.e., wheat, coarse grains, oilseeds and oilseeds meals):

$$Q_{Beef} = \alpha_0 \cdot p_{Milk}{}^{\alpha_1} \cdot p^{EU^{\alpha_2}} \cdot p_{Wheat}{}^{\alpha_3} \cdot p_{CGrain}{}^{\alpha_4} \cdot p_{Oilseed}{}^{\alpha_5} \cdot p_{Oilseed-meal}{}^{\alpha_6} \cdot (1+g_1 \cdot t) \quad (3)$$

where α's are parameters and $g_1 t$ is an exogenous variable representing technological change. The difference between D_{Beef} and Q_{Beef} indicates the amount that is imported (we will assume that the change in stocks is equal to zero).

Following Saunders et al. (2001), to simulate the impact of changing market conditions on production and thus on the environment, the factors affecting nitrogen use and concentrate use are modelled separately.

The derived demand for nitrogen N is assumed homogenous degree one in output and therefore we can write it as follows:

$$N = \gamma_0 \left(\frac{P^{EU}}{P^N}\right)^{\gamma_1} Q_{Beef} \quad (4)$$

where γ_0, and γ_1 are parameters; P^N is the price of nitrogen.

Finally, the equation of the nitrate concentration in water that ties the input demand with the water pollution is built based on the model of Saunders et al. (2001):

$$WNC = \Phi_0 + \Phi_1 \frac{N}{ha} + \Phi_2 \frac{C}{ha} + \Phi_3 \frac{yield}{W} \quad (5)$$

where Φ's are parameters. WNC is the average nitrate concentration in groundwater per year, N/ha is the annual use of nitrogen per hectare, C/ha is the amount of concentrates per hectare per year, 'yield' is the beef production per hectare per year, and W is the annual average drainage per year.

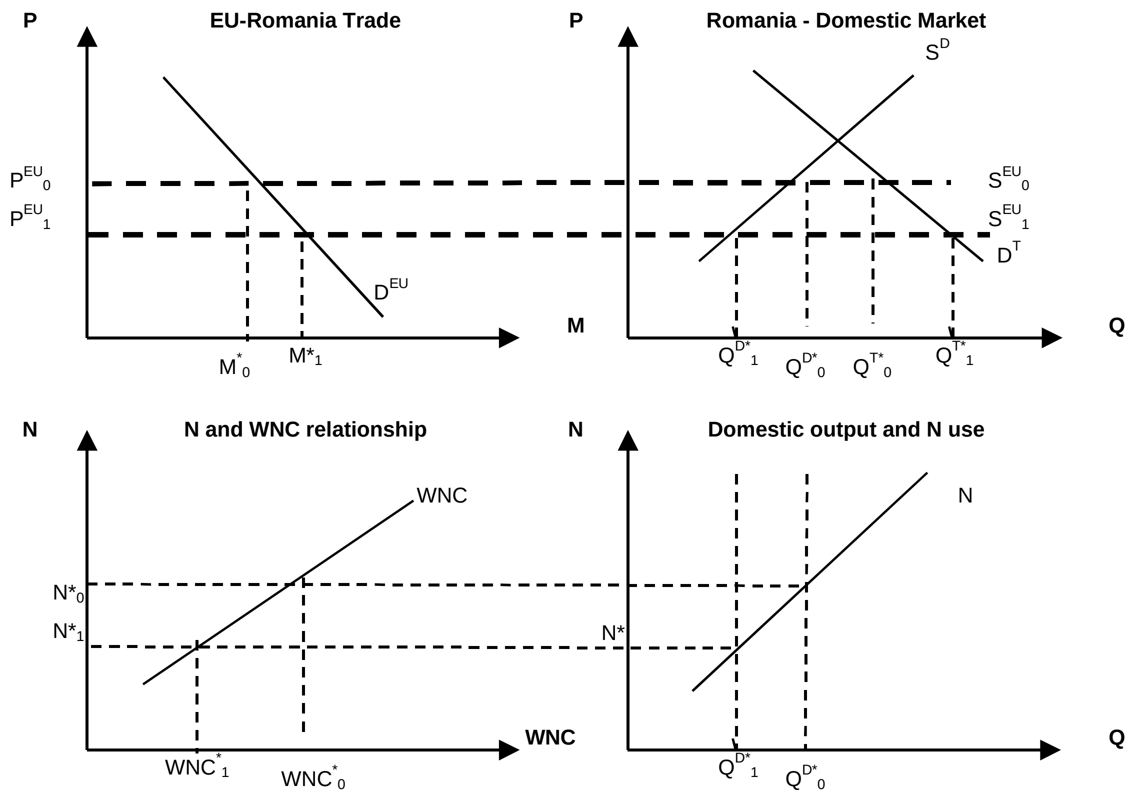
The following figure (Figure 2) illustrates how the model operates. We consider two cases. Case 0 'initial situation' is one where Romania applies a high tariff to beef imports. This

3 A characteristic of the Romanian bovine sector is that there are no differences in the formulation of feeding ratio for dairy cows versus beef cows. In fact, there are no statistical registrations which make the distinction between the two categories of animals (USDA FAS, 2001).

tariff leads to the import price P_0^{EU} in the first two diagrams of Figure 2. At price level P_0^{EU}, Romania produces Q_0^{D*} and imports M_0^*, where the import supply from EU, S^{EU} is assumed perfectly elastic at the import price. This trade pattern produces a nitrate concentration in groundwater equal to WNC_0^*.

In case 1 'trade liberalisation', the tariff applied to the beef imports is eliminated and the import price drops to P_1^{EU}. At this new price, imports increase to the new level M_1^* and the contraction in the domestic production to Q_1^{D*} is reflected in a decrease of the nitrate concentration in groundwater to the level WNC_1^*. Therefore, the figure illustrates the trade-off between domestic protection in the beef sector and groundwater pollution.

Figure 2. EU – Romania Beef Trade and the Nitrate Concentration in Groundwater



EU-Romania Trade and Nitrate Concentration in Groundwater

4. Simulations

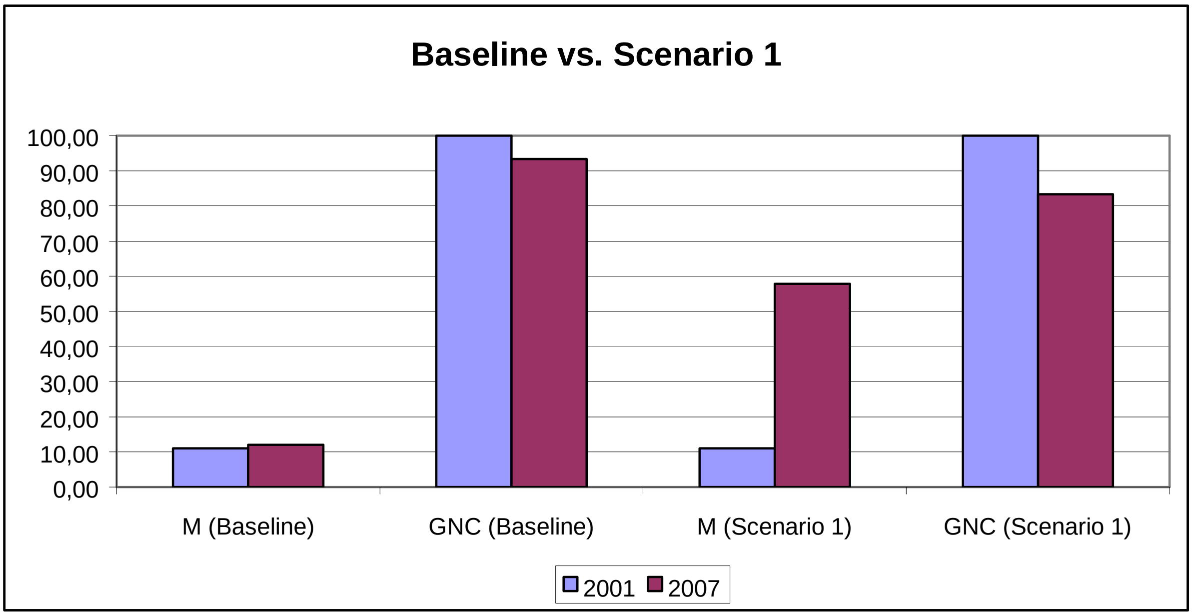
To perform the simulations, we estimated the Romanian demand and supply for beef (the results are presented in the Annex). The data on prices proceed from the Romanian National Commission of Statistics (2001), production data are from USDA's PS&D online database

(2003), exchange rate data are from the National Bank of Romania. The parameters for the nitrogen use and for the equation of the nitrate concentration in groundwater were taken from Saunders et al. (2001).

We simulated the elimination of the tariff applied to the EU imports of beef to Romania and the change in the EU beef export price due to the CAP changes by year 2007 (predicted EU accession year for Romania). These two assumptions produce three possible scenarios, that differ from each other by the magnitude of the change in the EU beef price. This is, while the tariff elimination will reduce the import price of beef to Romania, the change in the EU beef export price within the future CAP will operate in the other direction. Therefore, the final effect of trade liberalisation on environment, in our case the nitrate concentration in groundwater will depend on the combined effect of the two assumptions. Figures 3 to 5 illustrate the results of these simulations.

The baseline for simulations is the case where the tariff remains as it has been after 2001, namely 20 percent (i.e., no full trade liberalisation). The first simulation, 'Scenario 1' considers the case where the Romanian tariff for beef imports is eliminated by 2007. The results are presented in Figure 3. In this scenario, between 2001-2007 there will be an increase in beef imports from the EU to Romania of 46 thousand MT and a decrease in nitrate concentration in groundwater by 17 percent.

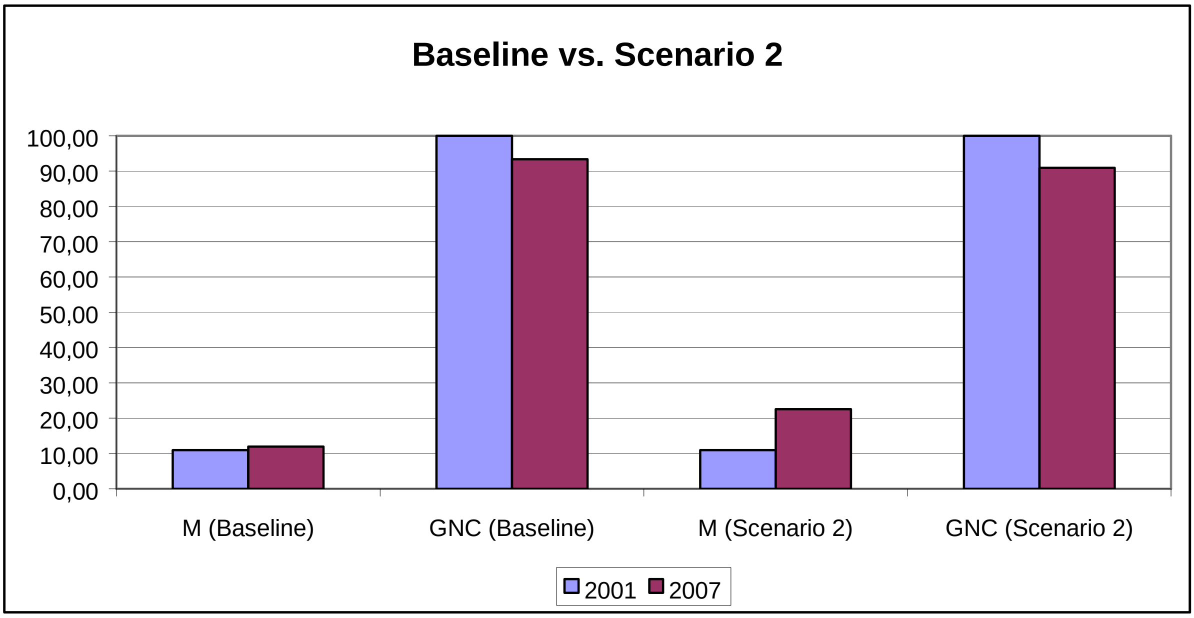
Figure 3. Baseline versus Scenario 1



Note: Imports M are measured in thousand MT.
Nitrate concentration in groundwater is an index using 2001 as base year.

Figure 4 presents the comparison between the baseline and the 'Scenario 2' cases. Scenario 2 illustrates the case where full trade liberalisation between Romania and the EU occurs (tariff is eliminated) combined with an increase of 15 percent in the EU beef export price in the context of the future CAP. We considered an increase of 15 percent as an example to help us analyse the case where the increased EU beef export price does not overcome the reduction of 20 percent in the tariff applied on EU beef imports to Romania in the baseline case. We did not base this assumption on predictions of the existent 'CAP impact assessment' models. Therefore, in 'Scenario 2', the EU beef import price to Romania drops but less than in the 'Scenario 1'. The results of the 'Scenario 2' show an increase in beef imports to Romania of 11 thousand MT and a decrease of the nitrate concentration in groundwater by 9 percent.

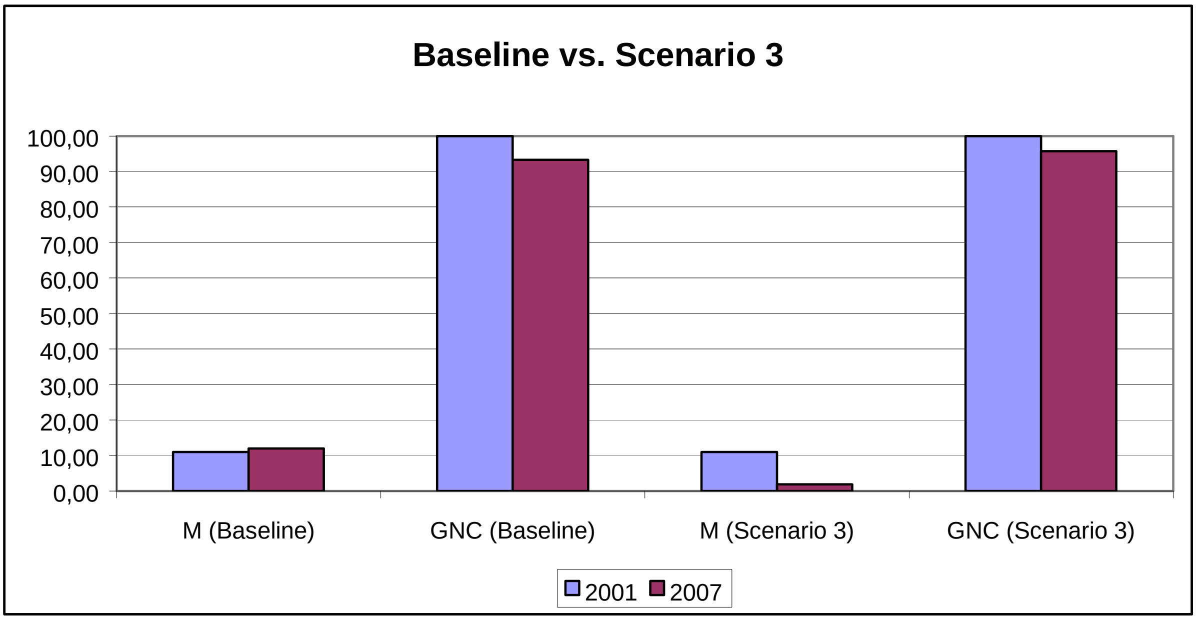
Figure 4. Baseline versus Scenario 2



Note: Imports M are measured in thousand MT.
Nitrate concentration in groundwater is an index using 2001 as base year.

Finally, Figure 5 illustrates the comparison between the baseline and 'Scenario 3' cases. 'Scenario 3' considers the case where full trade liberalisation between Romania and the EU occurs (tariff is eliminated) combined with an increase of 25 percent in the EU beef export price in the context of the future CAP. We considered an increase of 25 percent as an example to help us analyse the case where the increased EU beef export price overcomes the reduction of 20 percent in the tariff applied on EU beef imports to Romania in the baseline case. We did not base this assumption on predictions of the existent 'CAP impact assessment' models. The results of the 'Scenario 3' show an increase in beef imports to Romania of 9 thousand MT and a decrease of the nitrate concentration in groundwater by 4 percent.

Figure 5. Baseline versus Scenario 3



Note: Imports M are measured in thousand MT.
Nitrate concentration in groundwater is an index using 2001 as base year.

The 'Scenario 1' presents the most unfavourable case for the Romanian beef producers and the most favourable case from the environmental quality point of view. As opposite, 'Scenario 3' favours Romanian producers in the detriment of groundwater quality. Still, due to the limitations of our modelling exercise, we cannot predict a clear cut effect of trade liberalisation on the environmental performance of the Romanian beef sector, but only the change in groundwater quality. The model could be improved, for instance by considering the effect of beef trade liberalisation on air quality (emissions of greenhouse gases). Besides, we do not include the effects of possible changes in the agri-environmental policies in Romania, in which case the environmental effects of combined trade liberalisation with an improvement of the agri-environmental policies will be different.

However, the results indicate that the beef trade liberalisation impact on nitrate concentration in groundwater is beneficial in all the three scenarios, even if at different magnitudes.

5. Final remarks

The paper analysed the impact of trade liberalisation on environment in Romania using a partial equilibrium model of beef trade between Romania and the EU. We simulated the elimination of the tariff applied to the EU imports of beef to Romania and the change in the EU beef export price due to the CAP changes by year 2007 (predicted EU accession year for Romania). The final effect of trade liberalisation on environment, in our case the nitrate concentration in groundwater will depend on the combined effect of the two assumptions. The results indicate that the beef trade liberalisation impact on nitrate concentration in groundwater is beneficial in all scenarios considered, even if at different magnitudes. The modelling approach should be developed as to include the effects of possible changes in the agri-environmental policies in Romania, in which case the environmental effects of combined trade liberalisation with an improvement of the agri-environmental policies would be different.

References

Ervin, D. E., 1999. Taking Stock of Methodologies for Estimating The Environmental Effects of Liberalised Agricultural Trade, background paper for the OECD Workshop Methodologies for Environmental Assessment of Trade Liberalisation Agreements, Paris.

McCalla, Alex F., and Revoredo, Cesar L.. "Prospects for Global Food Security: A Critical Appraisal of Past Projections and Predictions," International Food Policy Research Institute. 2020 Vision Discussion Paper 35. October 2001.

National Bank of Romania, 2003, Online database.

Romanian National Commission of Statistics, 2002, Yearbook 2001.

Saunders, C., Moxey, A., and Ronigen, V. O., 2001, Trade and the Environment. Linking a partial equilibrium trade model with production systems and their environmental consequences, Symposium on Trade in Livestock Products ITRAC, Auckland.

USDA's PS&D, 2003, Online database.

Annex

Parameters used in the model:

$$Q_{Beef} = \alpha_0 \cdot p_{Milk}{}^{\alpha_1} \cdot p^{EU}{}^{\alpha_2} \cdot p_{Wheat}{}^{\alpha_3} \cdot p_{CGrain}{}^{\alpha_4} \cdot p_{Oilseed}{}^{\alpha_5} \cdot p_{Oilseed-meal}{}^{\alpha_6} \cdot (1 + g_1 \cdot t)$$

$$D_{Beef} = \beta_0 \cdot p_{Poultry}{}^{\beta_1} \cdot p_{Pork}{}^{\beta_2} \cdot \left(p^{EU}(1 + vat)\right)^{\beta_3} \cdot \left(\frac{Gdp}{Pop}\right)^{\beta_4} \cdot Pop$$

$$T_{Beef} = q_{Beef} - c_{Beef} - \Delta stock_{Beef}$$

$$P_K = \delta_0 \cdot P_{Wheat} + \delta_1 \cdot P_{C-Grain} + \delta_2 \cdot P_{Oilseed} + \delta_3 \cdot P_{Oilseed-meal}$$

$$K_{Beef} = (\gamma_0 \cdot q_{Wheat} + \gamma_1 \cdot q_{CGrain} + \gamma_2 \cdot q_{Oilseed} + \gamma_3 \cdot q_{Oilseed-meal}) \cdot q_{Beef}$$

$$N = \lambda_0 \cdot \left(\frac{P_K}{P_N}\right)^{\lambda_1} \cdot q_{Beef}$$

$$G = \eta_0 + \eta_1 \cdot N + \eta_2 \cdot K_{Beef} + \eta_3 \cdot \frac{q_{Beef}}{D_{Beef}}$$

$$G = 30.8 + 0.028 \cdot FertN_{Milk-A} + 0.0018 \cdot Conc_{Milk-A} + 0.00065 \frac{q_{Milk-A}}{D_{Milk-A}}$$

Parameters

Supply	**α_0**	**α_1**	**α_2**	**α_3**	**α_4**	**α_5**	**α_6**	**g**
	250,37	0,1822	0,623066	-0,326277	-0,094649	-0,356361	-0,34721	0,02
Demand	**β_0**	**β_1**	**β_2**	**β_3**	**β_4**			
	1,13195E-08	1	1,5	-0,67	0,5			
Price of concentrate	**δ_0**	**δ_1**	**δ_2**	**δ_3**				
	0,05	0,84	0,01	0,1				
Concentrate use	**γ_0**	**γ_1**	**γ_2**	**γ_3**				
	0,62	0,66	0,59	0,59				
N use	**λ_0**	**λ_1**						
	3639,9	0,91						
Groundwater nitrate concentrate	**η_0**	**η_1**	**η_2**	**η_3**				
	30,8	0,28	0,0018	0,00065				