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The Effects of EC Environmental Policies on Agricultural Trade and Economic Welfare

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Abstract

There is a growing concern throughout Europe with the environmental effects of intensive farming practices. This new awareness has led to the demand for stricter environmental regulations. The theoretical part of the paper explores the possible effects of environmental regulations. The theoretical part of the paper explores the possible effects of environmental regulations and health standards on competitive advantage, trade and welfare. The empirical part of the paper is based on the SWOPSIM model TEPSIM, which encompasses factors of production, such as pesticides, fertilizer and land. Using this extended SWOPSIM framework the impact of alternative environmental policy scenarios on agricultural trade and economic welfare is simulated.

I. Introduction

There is a growing concern throughout Europe with the environmental effects of intensive farming practices. These impacts include the pollution of ground and surface water with minerals, nitrogen, phosphorous and pesticides. Soil erosion and salinization are an increasing problem. Air pollution due to intensive animal husbandry, manure spreading and crop spraying is a growing nuisance. Farming practices are also blamed for the accelerating rate at which species are disappearing. An important reason for this increasing stress placed by farming on the environment is seen in the intensifica-

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tion and specialization of agricultural production, due in particular to the increasing use of chemical inputs such as nitrogen and pesticides.

This new awareness has led to the demand for environmental regulations, such as input taxes and input quotas as well as health regulations, such as high food standards. Coinciding with these claims is a concern over the potential effects of environmental policies and health regulations on patterns of world agricultural trade. Producers in the EC are worried that due to the introduction of stricter environmental standards they might lose their competitiveness in world markets and demand for the maintenance of the current and the implementation of new protective measures to prevent unfair trade. At the same time producers in other countries are concerned that environmental and health regulations might increasingly be used as international trade barriers.

With these issues in mind, the focus of this study is to analyze the consequences of environmental and health issues for international agricultural trade. The next section explores theoretically the effects of current agricultural policies and trade on the environment as well as the impact of environmental policies on competitive advantage, trade and welfare. Section III provides the empirical part of the paper. To simulate the trade and welfare effects of environmental standards on agricultural trade the multi-output-multi-input world simulation model TEPSIM (Trade and Environmental Policy SIMulation) is utilized. Attention is confined to a comparison of the trade and welfare effects of the implementation of alternative nitrogen quotas in the European Community, leading to a reduction of nitrogen use in the EC of 12.5%, 25%, 37.5% and 50%, respectively. To see how these effects might change in the case of a multilateral implemented environmental policy the paper also analyzes the impact of a scenario in which the two major agricultural trading regions, the EC and U.S., introduce a nitrogen quota of 50%. The conclusions of the paper are summarized in Section IV.

II. Theoretical Considerations

A. Environmental Effects of Agricultural Trade

Countries experience welfare gains if they engage in trade. The prosperity of a nation determines at the same time the consciousness for the value of a functioning environment and the willingness as well as capability to use part of their resources for the improvement of the environment. Thus, the welfare increasing effect of trade has a positive impact on the environment. Trade also facilitates the international distribution and implementation of ecological favorable technologies and helps consumers to make environmentally beneficial choices ⟨GATT [1992]; pp. 19, Anderson [1992]; pp. 25⟩.

The interdepencies between trade and environmental issues, however, are not that clearcut in the case of external effects in the consumption, production or trade of the international traded products. A small country, for example, might deteriorate its environment by the expansion of its import/export activities if the consumption/production of the traded product induces environmental damage. In this case it might be even possible that the negative environmental effects are so large that they outweigh the conventional benefits from open markets, resulting in a net welfare loss for the considered country ⟨GATT [1992], pp. 19⟩. This is the very danger environmentalists in the European Community see in the liberalization of world agricultural trade. A reduction in agricultural trade distortions is feared to have a damaging effect on the environment in developed and developing countries.

There is some evidence that modern agricultural production has negative external effects (see p. 221). Would then a liberalization accentuate or diminish these adverse effects of agricultural production. First it is doubtful that a liberalization of agricultural trade would lead to a deterioration of the environment in the rich countries. The opposite seems to be the case. Many studies suggest that the current agricultural protectionism of the EC and other industrial countries has induced detrimental ecological side effects. By stabilizing and increasing agricultural prices governments in these countries have considerably accelerated the intensification and specialization process in agriculture. Presumable this has led to a loss in soil fertility, a reduction in species and the pollution of drinking water and food with chemical residues ⟨Schmitz [1987], Hartmann and Matthews [1993], Kuch and Reichelderfer [1992]⟩.

Thus a liberalization agricultural trade would not aggravate, but would more likely lead to a reduction of the negative external effects of agricultural production and seems to be an important win-win opportunity for the developed nations. This, however, doesn't mean that a liberalization is capable to solve all environmental problems associated with agricultural production. Rather, the implementation of additional environmental policies will be necessary to achieve an adequate improvement of the air, water and soil quality. These government interventions would have to be introduced as close as possible to the source of divergence to guarantee the sustainability of the natural resources even in the long run.

The environmental effects of trade liberalization are more difficult to predict for the developing countries. Most recent studies suggest that these countries as a group will experience a conventional welfare gain as a results of an agricultural liberalization in the developed world 〈see *e.g.* Anderson and Tyers [1990], Krissoff, Sullivan and Wainio [1990]〉. These positive welfare effects will be reinforced, if the poor countries themselves eliminate their discriminating agricultural policies as well. So far, however, the environmental impact of these reforms have been neglected in most studies, since in the presence of hunger short term food security seems to be more important than long term food security. Empirical studies reveal that an agricultural trade liberalization will lead to an increase in food production in third world countries. Given the low intensity of agricultural production in these countries and the high supply reagibility of chemicals the rise in production will primarily be achieved by increasing the use of inputs, such as fertilizer, pesticides and irrigation systems. Although land is considerably less responsive to farm product price changes than are variable purchased inputs it nonetheless does respond to some extent and might lead to a reduction of natural forests. However, any negative impact of a liberalization on tropical forests is likely to be very small and has to weighted against the positive environmental effects of *e.g.* foregone production in more polluted sectors of developing countries, such as smokestack industries where productive resources would otherwise have been employed 〈Anderson [1992b]〉.

Even if a liberalization would indeed induce negative environmental effects in the developing countries these would be overcompensated by the conventional benefits from open markets if domestic environmental policies are in place. The absence of such policies, however, would not only lead to problems in the trade sector but would result in an inefficient resource use in the whole economy. If that is the case the first best policy is to implement appropriate environmental policies such as targeted taxes or licensing systems. At that point it has to be noted that the demand for environmental quality is a superior good. Thus the welfare enhancing effect of a liberalization policy might help developing countries to afford the implementation or improvement of environmental policies ⟨Runge [1992]; p. 24⟩.

B. Environmental Regulation and Agricultural Trade

The growing awareness of environmental problems associated with agricultural production has led to the consideration and in many cases to the introduction of environmental regulations in developed countries, while such policies are often missing in developing countries. Farmers in nations with more stringent environmental standards fear a reduction in their international competitiveness and demand for special duties on imports of foreign products produced in *environmental dirty ways* to offset the unfair cost advantage from *ecological dumping* ⟨GATT [1992]; p. 28, Whalley [1991]⟩. Here they often find support among environmental groups, who fear that farmers might use their political power for lowering the standards at home if they are not compensated for their loss in competitiveness.

No doubt, countries protecting their soil, water and air by controlling the livestock number which can be kept per hectare,by limiting the time where manure spreading is allowed and/or by introducing taxes or quotas on chemical inputs will experience an increase in their production costs. This will result in a loss of competitiveness of home producers compared to foreign suppliers. International differences in environmental standards could in theory result in a displacement of domestic production by *dirty imports*, an underpricing of exports by unregulated foreign competitors and/or a diversion of new investments to polluter heavens ⟨Charnovitz [1992]; p. 342⟩. Given the immobility of the most important agricultural production factor, land, the latter aspect is of no relevance for the agricultural sector. But even with respect to the first two issues there is little empirical evidence so far on the trade effects of environmental policies in general as well as towards agriculture ⟨Charnovitz [1992]; p. 342, Tobey [1991]; p. 90⟩. One reason might be that the international differences in environmental standards have been too minor in the past to significantly change international trade patterns ⟨Tobey [1990]⟩. Assuming that regulatory differences between high and low standard countries are significant enough in the future to affect trade, one might ask whether such differences present a distortion of comparative advantage and thus should be characterized as unfair?

First, the general argument, that environmental policies lead to a distortion of the comparative advantage of a country is wrong. It is rather that environmental standards are implemented to partly or totally internalize the external effects of agricultural production. Those standards only reduce the existent divergences between private and social costs and thus render possible the correct valuation of the comparative advantage. Before the implementation of the environmental standards the comparative advantage were distorted in favor of the agricultural sector, implying that farm production was protected by a hidden subsidy.

Second, the lack of environmental policies or the existence of less strict environmental standards in third countries is not a sufficient basis for concluding that trade is unfair. Rather, environmental standards have to diverge, if the considered countries deviate in their natural assimilation capacity, in their demand for the assimilation service of the environment and/or in societies' preferences with respect to this public good ⟨Wießner [1991]; pp. 83, Petersmann [1991]; p.203⟩. The factor proportion theorem holds not just for the conventional production factors labor, capital and land but also for the natural resource environment. The establishment of standards serve in this respect as a way to determine the shadow prices for the public good environment. These shadow prices indicate, in analogy to the market prices for private goods, the relative scarcity of the considered resource in a nation. The fact that the population density is much smaller in most developing countries compared to the developed world and given the superior character of the good *environmental quality* leads to the conclusion that environmental standards have to be considerable less stringent in third world countries. Thus the existence of lower environmental standards in these countries is not sufficient to claim that a country is manipulating its environmental policy in order to improve the competitiveness of its producers ⟨GATT [1992]; p. 29⟩. But even if that would be the case it still would not justify the imposition of special duties on imports of goods and services produced in these countries. As long as the environmental problems are strictly domestic there actually exists no difference between the competitive consequences of international differences in environmental standards and deviations in many other policy areas which affect the comparative advantage of a nation as well. The fixing of minimum wages, the extent of government support for science and education and the whole tax policy have a mayor influence on the competitiveness of a country. As it is absurd to compensate farmers for possible comparative disadvantages in these or other policy areas, there exists no justification for trade sanctions in the case of stricter environmental standards.

C. Health Regulation and Agricultural Trade

International differences in food quality standards are another central point in the current discussion on agricultural trade. If products can be sold in countries with less strict health regulations while their distribution is not allowed in countries with higher standards this would imply a non-tariff trade barrier. The EC ban on all beef imports from the USA containing hormones may be a good example reflecting this issue ⟨Runge and Nolan [1990]; p. 3⟩. Producers in countries with less stringent environmental standards therefore fear that new trade barriers being erected against their imports, which might not always be scientifically justified. Although the policies may hold for home producers as well as for foreign producers they nevertheless often place a higher burden on the latter. If for example a foreign producer exports only a small fraction of her/his production into countries with stricter health regulations he/she is confronted with considerable diseconomies of scale. The developing countries are likely to be hidden most by such measures since they often lack the necessary human capital and resources to fulfill the required standards. Thus high quality standards obviously can serve as a very effective non-trade barrier.

A harmonization of international food quality and safety standards is one solution to settle these trade conflicts. The execution of such a strategy is however almost impossible due to the different economic, social and political situation in each country. For example, even in the case of the EC an agreement upon a set of uniform food quality standards has proven difficult and is no longer considered a realistic objective of the EC 1992 process ⟨Sheldon and Von Witzke [1991]; p. 212⟩. An alternative and more realistic approach is the ***mutual recognition*** by fixing a minimum food quality standard at the same time. This strategy seems in fact to be adopted by the EC. But even this proposition has led to considerable opposition. Critics of this proposal argue that a mutual recognition of quality standards would induce far reaching distortions in international competitiveness, putting an unjustified burden on countries with high standards. They claim that firms in these countries will pursue two strategies: First, new investments will be diverted to countries with lax or non-existent regulatory regimes, while second, firms in countries with high standards will lobby their governments to reduce those standards. Both strategies would lead in the medium and long run to a debasement of quality and safety. This horror scenario has generated coalitions between interest groups in the agricultural and food sector and consumer groups lobbying together for the international harmonization of food standards ⟨Sheldon and Von Witzke [1991]; p. 213⟩.

The concern that a mutual recognition policy would reduce the quality and safety of food products seems, however, unfounded. If consumers have transparency with respect to quality differences high and low quality products will remain in the market. The demand for quality is a luxury good and therefore has a very high income elasticity. Especially rich consumers are willing and capable to pay higher prices for high quality products. Since average income between different countries deviates considerable, while there also exist important income differences within each country a policy of mutual recognition would induce extensive intra-industry trade flows. Developing/developed countries would export lower/higher quality products, which would be purchased by poorer/richer consumers in the developed/developing countries. These trade activities offer the opportunity of taking advantage of economies of scale, thereby leading to welfare gains in all countries. Beyond this, a strategy of mutual recognition induces additional welfare gains since it doesn't pay any longer to use higher and complicated food standards as a means of protection from international competition. Thus there is no longer any incentive for unproductive rent-seeking activities and international competition is freed from unnecessary regulations. Due to the superior character of quality, these welfare gains will lead to an increase in the average food quality level in developing and developed countries.

III. Empirical Analysis

A. Model and Data Used

Simulations with a quantitative model can be helpful in gaining a better understanding of the consequences of alternative environmental policy approaches on competitiveness and economic welfare. Although section II. A suggests that a liberalization of agricultural trade is generally likely to be consistent with improvements in conventional welfare as well as environmental quality, the execution of this policy seems to find little political support. Moreover there seems to be a tendency to maintain the current agricultural price support policy and to additionally implement more stringent environmental regulations. Thus, the empirical part of the paper will deal with these kind of policies. First, however the SWOPSIM model TEPSIM created for this purpose will be described.

The SWOPSIM (Static World Policy Simulation Model) modeling framework has been developed at the USDA by Roningen and others as a software package which can be used to build various types of national or regional models linked by trade. SWOPSIM models are based on constant elasticity functional forms for agricultural output supplies and consumer demands. They are static, nonspatial, multi-product and multi-region partial equilibrium models which can be solved to determine changes from the base year due to endogenous shocks such as changes in demand, supply or policy. The economic structure of SWOPSIM is now widely known and will not be described further here. The interested reader is referred to Roningen, Sullivan and Dixit [1991] and the references therein.

Standard SWOPSIM models have 22 output commodities although output-input relationships between commodities can be incorporated, as is the case between livestock products and feed grains. This is done by specifying that feed grain demand is not only a function of its own price and cross price driven substitution between the feed grain and alternative input products but is also dependent on the quantity of meat and milk produced, where the elasticities are the quantity share of the feed grain fed to meat and dairy animals ⟨Roningen, Sullivan and Dixit [1991]; p. 19⟩.

An alternative approach to incorporate inputs in a SWOPSIM model is simply to treat them as another commodity in which case only price terms appear in the demand for inputs function ⟨Liapis [1990]⟩. The latter approach was adopted in the TEPSIM model created for all other inputs but feed.

TEPSIM includes five inputs apart from feed input for the EC and the US region. These are nitrogen, other fertilizer, pesticides as well as arable land and pasture land. Chemicals are incorporated into the model with an infinitely elastic supply elasticity. Thus supply is assumed always to equal demand at a constant price while the demand for these inputs is a function of crop and livestock producer prices as well as of its own price and the consumer prices of other inputs. Land is treated as a non-traded input with an own price supply elasticity of 0.2. Changes in the demand for land are thus reflected in its rental value. Another change from the standard SWOPSIM commodity set is the omission of derived dairy and oilseed products. This was done because the SWOPSIM modeling framework is not sophisticated enough to create the correct equations for yet another layer of inputs (processed products – products – feed inputs – other inputs). The TEPSIM model thus consists of 20 commodities and three regions, the US, the EC and the Rest of the World.

Most data, price elasticities and protection rates were taken from the 1989 database of the USDA ⟨Sullivan, Roningen, Leetmaa and Gray [1992]⟩. To complete the model additional data is, however, required for the demand and prices of the newly integrated inputs. Those were obtained from different sources ⟨Commission of the European Community [1992], Fao [1990a and 1990b], Barse [1990], USDA [1992]⟩.

To complete the elasticity matrix values are required for the EC and US own price elasticities for chemicals and land as well as the cross price elasticities of demand and supply with other commodities. While a wide range of values for the own price elasticity of nitrogen demand have been defended in the literature ⟨Burrell [1989] and the references therein⟩ only few estimates of the same parameter for other fertilizer, pesticides and land as well as for the supply response of individual commodity outputs to changes in land and chemical input prices have been published ⟨*e.g.* Anker and Schmitz [1987], Ball [1988], Boyle and O'Neill [1990], Glass and McKillop

[1989], Michalek [1988]⟩. In this paper the own price elasticity of demand was set equal to –0.4 for all inputs in the EC and the US. The cross supply elasticities of agricultural products with respect to the price of chemical inputs (land) was set in the range of 0 to –0.1 (0 to –0.05) in the EC. These elasticities were slightly adjusted in the Untied States model taking into consideration the different intensity of agricultural production in these two regions. The cross price elasticities of land and nitrogen demand with respect to changes in individual commodity prices have been calculated imposing symmetry conditions ⟨Liapis [1990]⟩.

B. Policy Options and Results

Six different policy options are considered in this study. In the first four scenarios a unilateral implementation of a nitrogen quota in the EC is simulated, which leads to a reduction in nitrogen use in European agriculture of 12.5%, 25%, 37.5% and 50%, respectively (additionally the policy of a 75% and 95% reduction in nitrogen use has been simulated. These, however, are very extreme policy options, which are not analysed in detail in this paper). In these scenarios it is assumed that EC price remain constant for all CAP[1] commodities as long as the stabilized and supported EC price are higher than the adjusted world market prices. The effects of a 50% nitrogen quota in the EC combined with a compensation policy is analyzed in the fifth simulation run. In this scenario farmers are partly compensated for the enforced limitation of nitrogen use by a 5% increase in producer prices for livestock products and a 20% increase in the producer price for crops. The final policy options considered in this paper consists of a bilateral implemented nitrogen quota in the EC and the US, the two major agricultural trading regions.

The relative change in production, which results from the different TEP-SIM runs are reported in table 1. Table 1 reveals that a reduction in nitrogen use in EC agriculture will lead to a decline in supply for all products but

1 Common Agricultural Policy; Given the deficiency payment system on the oilseed markets, consumer prices of these products will change with world market price changes. Since the model doesn't consider any policy intervention on the markets for cotton and tobacco world market price changes for these products are fully transmitted into the EC.

Table 1
EC Supply Changes Due to a Reduction in Nitrogen Use in Agriculture (in %)

Commodity or Commodity Group	Reduction of Current Nitrogen Use					
	12.5% in the EC	25% in the EC	37.5% in the EC	50% in the EC	50% and Compensation[3] in the EC	50% in the EC and in the U.S.A
Beef	–0.84	–1.79	–2.91	–4.27	–2.28	–4.47
Pork	–0.39	–0.85	–1.38	–2.02	1.51	–3.01
Mutton & Lamb	–0.48	–1.04	–1.69	–2.49	–0.11	–2.66
Poultry Meat	–0.04	–0.09	–0.14	–0.20	3.46	–1.15
Poultry Egg	–0.09	–0.18	–0.30	–0.42	3.07	–2.14
Dairy Fluid Milk	0	0	0	0	0	0
Wheat	–3.54	–7.47	–11.91	–17.05	–15.31	–15.14
Corn	–2.84	–6.02	–9.64	–13.89	–12.48	–14.80
Other Coarse Grains[1]	–2.85	–6.04	–9.68	–13.94	–11.42	–15.07
Rice	–3.53	–7.45	–11.87	–17.01	–15.10	–17.36
Soybeans	–3.56	–7.52	–11.99	–17.16	–15.30	–17.51
Other Oilseeds[2]	–3.56	–7.52	–11.99	–17.16	–13.11	–18.14
Cotton	–3.62	–7.65	–12.20	–17.47	–16.32	–16.11
Sugar	–2.83	–5.99	–9.60	–13.82	–11.75	–14.19
Tobacco	–3.27	–6.93	–11.10	–15.98	–14.97	–14.04

Note: 1. Barley, millet, mixed grains, oats, rye and sorghum
2. Copra, cottonseeds, flaxseed, palm kernels, peanuts, rapeseed, safflower, and sesame seed
3. Compensation Policy in the EC consists of a 5% increase in the producer for livestock products and a 20% increase in the producer price for crops.

Source: Authors' calculations utilizing the TEPSIM model described in the text.

milk. Due to the EC milk quota a realistic reduction of nitrogen use leads to no supply effects on this market, since the shadow price for milk lies far below the EC market price. In the case of a very strict quota on nitrogen use the marginal cost curve might, however, move up so far that the quota-equivalent price reaches the market price. In this case the milk supply would start to decrease and the milk quota policy would be no longer binding. The relative change in supply very much depends on the level of nitrogen restriction and is, as expected, most significant in the case of a 50% quota policy. It is interesting to observe that the decline in production is not linear as the restriction on nitrogen use becomes tighter but that it is of an exponential nature. Table 1 also shows that the change in crop production is not very sensitive with respect to the additional introduction of a nitrogen quota in the United States. This is due to the fact that for most crops the EC producer prices will not change although additional implementation of an input restriction in the US will induce considerable world market price increases. Only in the case of wheat the world market price rises above the supported CAP price, leading to an increase of the producer price on this market. Since no policy intervention is assumed on the markets for tobacco and cotton these world market price changes are fully transmitted into the EC market, thereby mitigating the production decline due to the input quota on these commodities. The opposite holds for livestock products. Higher consumer prices for oilseeds and wheat reinforce the reduction in production on these markets. Thus the supply changes on these markets are much more sensitive with respect to the additional implementation of a quota policy in the United States. If producers are compensated by an increase in agricultural product prices the change in production is not as pronounced. In the case of non-ruminant meat and poultry egg supply will even increase compared to the reference scenario. The price increase on these markets obviously overcompensates the disincentive effect due to the implementation of the nitrogen tax (see Table 1). Reducing nitrogen use in EC agriculture has not only a considerable effect on output markets but leads also to a sharp (moderate) decrease (increase) in the demand for other chemical inputs (land) of about 2% to 23% (0.3% to 2%) depending on the considered policy scenario.

With the decrease in agricultural production, net exports are discouraged

Table 2

EC Net Exports of Agricultural Products Due to Different Levels of Nitrogen Use (in 1000 Mt)

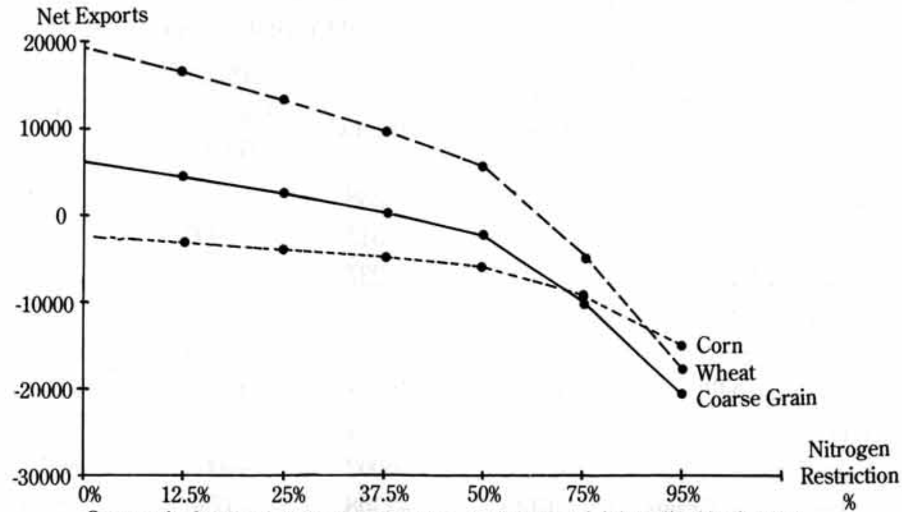
Commodity or Commodity Group	Reduction of Current Nitrogen Use				
	0%	12.5%	25%	37.5%	50%
Beef	574	508	433	344	238
Pork	791	737	674	601	513
Mutton & Lamb	–199	–204	–211	–218	–227
Poultry Meat	354	351	349	345	341
Poultry Egg	69	64	59	53	47
Dairy Fluid Milk	10578	10578	10578	10578	10578
Wheat	19274	16425	13263	9694	5564
Corn	–2450	–3180	–3994	–4920	–6002
Other Coarse Grains[1]	6145	4410	2472	267	–2308
Rice	–268	–317	–371	–433	–504
Soybeans	–13045	–13049	–13053	–13057	–13060
Other Oilseeds[2]	–2383	–2660	–2968	–3316	–3718
Cotton	–965	–975	–987	–1000	–1015
Sugar	2605	2171	1686	1133	484
Tobacco	-292	–302	–313	–326	–341

Note: 1. Barley, millet, mixed grains, oats, rye and sorghum
2. Copra, cottonseeds, flaxseed, palm kernels, peanuts, rapeseed, safflower, and sesame seed

Source: Authors' calculations utilizing the TEPSIM model described in the text.

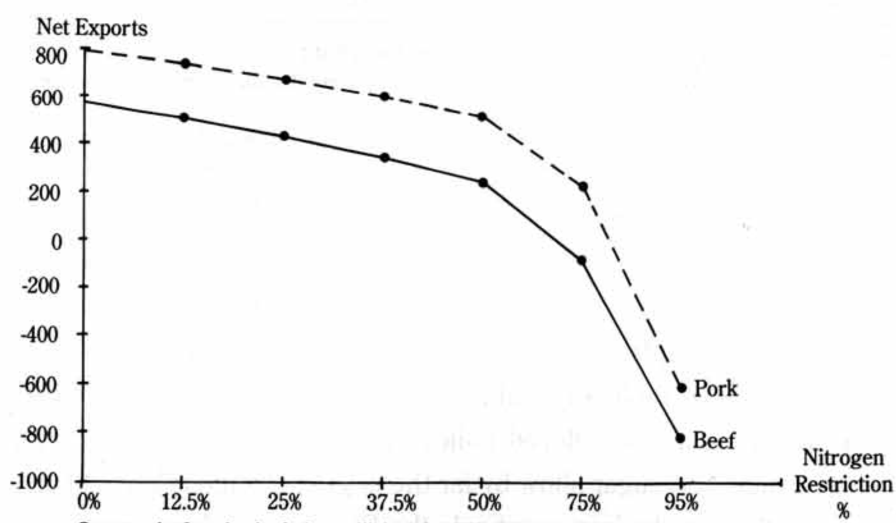
in almost all scenarios (see Table 2 and 3). Only in the case of a 50% nitrogen quota supported by a compensation policy EC net exports would increase for pork, poultry meat and poultry egg, since the supply increases for these products while demand remains constant. Table 2 and Figures 1 and 2 reveal that there exists no linear relationship between the reduction in nitrogen use and the decline in net exports. Rather, the decrease in net exports is of an exponential nature. In general the results show that the EC would change from a net exporter to a net importer for most products. This holds especially if a 75% or 95% nitrogen quota would be implemented in the European Community. Thus the loss of comparative advantage of EC agriculture aggravates with every additional percentage reduction in nitrogen use. This observation is reaffirmed with respect to the change in the impor-

Figure 1
Impact of a Reduction in Nitrogen Use on EC Net Exports of Agricultural Grain Products



Source: Authors' calculation utilizing the TEPSIM model described in the text.

Figure 2
Impact of a Reduction in Nitrogen Use on EC Net Exports of Agricultural Livestock Products



Source: Authors' calculation utilizing the TEPSIM model described in the text.

Table 3
EC Net Exports of Agricultural Products Due to Different Levels of Nitrogen Use (in 1000 Mt)

Commodity or Commodity Group	Reduction of Current Nitrogen Use			
	0% in the EC	50% in the EC	50% and Comp.[3] in the EC	50% in the EC and in the U.S.A
Beef	574	238	394	222
Pork	791	513	999	375
Mutton & Lamb	–199	–227	–200	–229
Poultry Meat	354	341	571	282
Poultry Egg	69	47	228	–43
Dairy Fluid Milk	10578	10578	10578	10578
Wheat	19274	5564	6397	7874
Corn	–2450	–6002	–6098	–6639
Other Coarse Grains[1]	6145	–2308	–1740	–3989
Rice	–268	–504	–477	–515
Soybeans	–13045	–13060	–13345	–11888
Other Oilseeds[2]	–2383	–3718	–3518	–3620
Cotton	–965	–1015	–1012	–991
Sugar	2605	484	803	428
Tobacco	–292	–341	–338	–323

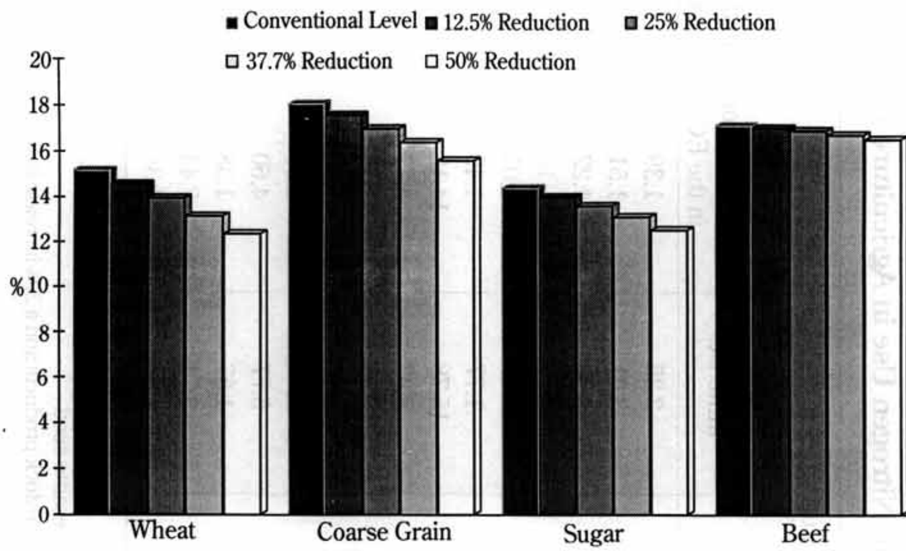
Note: 1. Barley, millet, mixed grains, oats, rye and sorghum
2. Copra, cottonseeds, flaxseed, palm kernels, peanuts, rapeseed, safflower, and sesame seed
3. Compensation Policy in the EC consists of a 5% increase in the producer prices for livestock products and a 20% increase in the producer price for crops.

Source: Authors' calculations utilizing the TEPSIM model described in the text.

tance of the EC in world agriculture. Figure 3 suggests that EC production is increasingly displaced by agricultural production in third countries.

The results in Table 4 reveal that world market prices would increase for all products in all considered policy options. The prices for wheat, other coarse grains and sugar show by far the largest change relative to 1989 base prices, reflecting the important role the EC plays on these commodity markets (see also Figure 3). Table 4 also shows that the rise in world market prices more than doubles on almost all product markets if a nitrogen quota

Figure 3
EC Share of World Production Due to Different Levels of Nitrogen Use in the EC



Source: Authors' calculation utilizing the TEPSIM model described in the text.

of 50% is implemented in both major trading regions, the U.S.A. and the EC, compared to a scenario where this policy is only introduced in the European Community. The unilateral introduction of a nitrogen quota induces an increase in supply and a decrease in demand on almost all agricultural product markets in the United States and the Rest of the World, leading to an improvement of the trade balance and inducing in some cases even a trade reversal. In addition the rise in world market prices for all commodities leads to a considerable increase in the demand for nitrogen and other chemical inputs in the US, while the demand for arable and pasture land experiences only a small increase due to the low supply elasticity of this input.

For all six policy runs the conventional welfare effects for the three regions, the EC, the US and the Rest of the World as well as for the world as a total are calculated. At this point it has to be noted that conventional welfare includes only the change in real income. The benefits due to the possible improvement of the environment (*e.g.* reduction in pollution of ground and surface water with nitrogen, phosphorous and pesticides) resulting from the introduction of a nitrogen quota are not considered in this analysis.

Table 4

World Market Price Changes Due to a Reduction in Nitrogen Use in Agriculture (in %)

Commodity or Commodity Group	Reduction of Current Nitrogen Use					
	12.5% in the EC	25% in the EC	37.5% in the EC	50% inthe EC	50% and Compensation[3] in the EC	50% in the EC and in the U.S.A
Beef	0.47	1.00	1.61	2.35	1.39	5.83
Pork	0.61	1.29	2.08	3.01	1.51	8.06
Mutton & Lamb	0.46	0.98	1.59	2.30	1.22	4.95
Poultry Meat	0.53	1.12	1.80	2.59	1.10	7.88
Poultry Egg	0.51	1.08	1.73	2.49	1.05	6.99
Dairy Fluid Milk	0.37	0.77	1.23	1.77	1.49	7.73
Wheat	3.13	6.70	10.84	15.78	14.12	31.67
Corn	1.63	3.46	5.58	8.07	6.77	29.02
Other Coarse Grains[1]	2.59	5.53	8.93	12.99	11.18	30.47
Rice	0.31	0.64	1.03	1.47	1.30	3.68
Soybeans	0.59	1.25	2.00	2.88	2.38	18.24
Other Oilseeds[2]	1.17	2.49	4.00	5.77	4.60	13.95
Cotton	0.33	0.69	1.10	1.57	1.38	7.81
Sugar	1.77	3.76	6.04	8.74	7.44	13.26
Tobacco	0.94	2.00	3.22	4.65	4.34	12.00

Note: 1. Barley, millet, mixed grains, oats, rye and sorghum

2. Copra, cottonseeds, flaxseed, palm kernels, peanuts, rapeseed, safflower, and sesame seed

3. Compensation Policy in the EC consists of a 5% increase in the producer prices for livestock products and a 20% increase in the producer price for crops.

Source: Authors' calculations utilizing the TEPSIM model described in the text.

The method used for the measurement of the conventional welfare change is the sequential approach based on the Hicksian compensated curves. This approach of the new welfare economics is an exact welfare measure in the case of multiple-price changes, market interdependencies and market distortions. Using this extended framework of applied welfare economics, the efficiency effects consist of the following three components ⟨Just, Hueth and Schmitz [1982]; pp. 338-341, Hartmann [1991]⟩. First, the benefits to consumers can be measured by an approximation of the Hicksian equivalent variation,[2] while second, the welfare effects to producers are equal to the changes in producer surplus. In addition to these total private welfare effects of a policy induced multiple price change, one has to consider the change in the government budget.

The distributional and efficiency effects of all policy simulations are summarized in Table 5. If the EC introduces a nitrogen quota, EC producers and consumers have to bear welfare losses while on the other hand land owners are beneficiaries of such a policy run and government revenues will increase. The latter, however, doesn't hold if producers in the EC are compensated by an increase in their prices. In this case government revenue will decrease by more than 11 billion US dollars, since the EC has to pay higher export restitutions and/or production subsidies. The net welfare change in the EC would be positive in the case of a 12.5% reduction in nitrogen. Interesting enough this welfare gain would even increase if nitrogen restriction becomes tighter. It reaches its peak by a quota of 23%. The welfare effects will turn to be negative if the quota policy exceeds 39% (see Figure 4).[3] The results also reveals that an increase in protection would be a very inefficient way to compensate farmers for the negative cost effects of an enforced reduction in nitrogen use, leading to an increase in the costs of

2 For the method to approximate the equivalent variation see Hartmann [1991].

3 If the EC would decide to reduce nitrogen use by implementing a tax instead of a quota the efficiency effects would remain the same. However, the producer loss would increase considerable while the government revenues would rise by the same amount. To accomplish for example a 12.5% reduction in nitrogen use the EC would have to implement a tax on nitrogen consumption of 43% of base nitrogen prices. This would result in an additional burden on producers of 2.1 billion US dollars and an increase in government revenues by the same amount.

Table 5

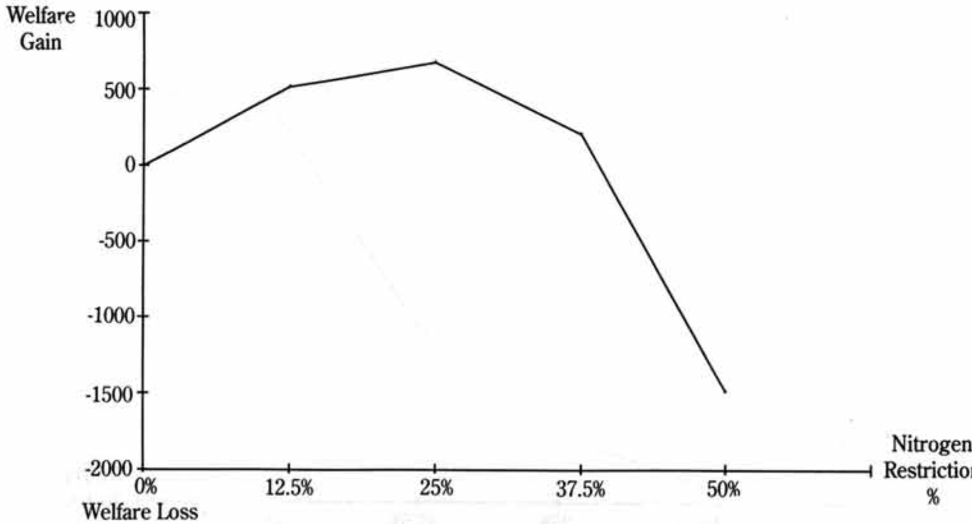
Welfare Change Due to a Reduction in Nitrogen Use in EC and/or US Agriculture (in Mil. US Dollars)

Countries/Regions Scenarios	Change in Producer Welfare	Equivalent Variation	Change in Government Revenue	Change in Land Owner Revenue	Change in Net Welfare
European Community					
12.5% in the EC	–1182	–51	714	1035	516
25% in the EC	–2981	–107	1456	2308	677
37.5% in the EC	–5781	–172	2230	3931	209
50% in the EC	–10382	–247	3037	6107	–1486
50% in the EC & the US	–10774	–1120	3397	6311	–2185
50% in the EC & Comp[1]	–1136	–216	–11114	8455	–4012
United States					
12.5% in the EC	801	–548	–40	42	255
25% in the EC	1714	–1165	–85	89	554
37.5% in the EC	2776	–1871	–136	143	912
50% in the EC	4049	–2705	–196	206	1355
50% in the EC & the US	664	–7590	682	6045	–199
50% in the EC & Comp[1]	3019	–1848	–166	165	1169
Rest of the World					
12.5% in the EC	3808	–4695	–120	0	–1007
25% in the EC	8129	–10008	–255	0	–2134
37.5% in the EC	13135	–16143	–411	0	–3419
50% in the EC	19105	–23431	–595	0	–4920
50% in the EC & the US	48284	–56142	–1585	0	–9443
50% in the EC & Comp[1]	15032	–18910	–429	0	–4307
World Total					
12.5% in the EC	3427	–5294	554	1077	–236
25% in the EC	6862	–11280	1116	2397	–903
37.5% in the EC	10130	–18186	1683	4074	–2298
50% in the EC	12772	–26383	2246	6313	–5051
50% in the EC & the US	38174	–64852	2494	12356	–11827
50% in the EC & Comp[1]	16915	–20974	–11709	8620	–7150

Note: 1. Compensation Policy in the EC consists of a 5% increase in the producer prices for livestock products and a 20% increase in the producer price for crops.

Source: Authors' calculations utilizing the TEPSIM model described in the text.

Figure 4
Conventional Welfare Effects in the EC Due to a Reduction of Nitrogen Use in the EC



Source: Authors' calculation utilizing the TEPSIM model described in the text.

the environmental policy of almost 200%. Table 5 also reports the distributional and efficiency effects in third countries. In accordance with the EC, land owners in third countries experience a welfare gain and consumers have to bear welfare losses in all considered policy scenarios. Producers in the US and the rest of the world will be beneficiaries from the unilateral implementation of a nitrogen quota in the EC while government revenue will decline in both regions. If, however, the United States introduces as well a nitrogen quota government revenues will increase. In this policy scenario the US would have to bear net welfare losses. In all other simulations the net welfare change is positive for the US but negative for the Rest of the World, reflecting the different net trade position of the two regions.[4] Most important, the implementation of a nitrogen quota in the EC and/or the United States leads to a loss in world welfare. The examination of Table 5 and Figure 5 also reveals that the loss in conventional welfare rises exponentially in the EC and the world as a whole as the restriction on nitrogen use becomes tighter.

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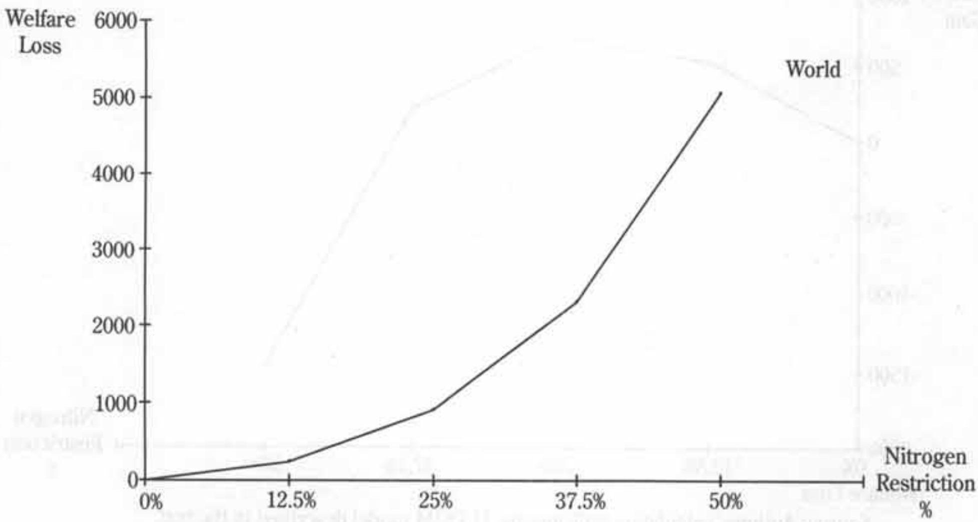
4 The US (Rest of the World) is a net exporter (importer) on most considered product markets in the base situation.

Figure 5
Conventional Welfare Loss in the World Due to a Reduction of Nitrogen Use in the EC



Source: Authors' calculation utilizing the TEPSIM model described in the text.

IV. Conclusions

With the intensification and specialization of agricultural production conflicts between agricultural and environmental goals are increasing. This has led to the demand for a stronger integration of agricultural and environmental goals in agricultural policy. The theoretical part of the paper focuses on the possible effects of environmental regulations and health standards on agricultural trade. It is shown that in most cases different environmental and food safety standards lead neither to a distortion of comparative advantage nor can they be characterized as unfair. Rather, standards have to diverge between countries due to the varying social, political, economic and natural circumstances.

The empirical part of the paper is based on the SWOPSIM model TEPSIM created for this study. It is shown that the introduction of a nitrogen quota in the EC will indeed induce a reduction in comparative advantage of European agriculture. The results also reveal that an implementation of a moderate quota on nitrogen use can lead to an improvement in conventional net social welfare in the EC. This is due to the fact, that the environmental policy is implemented on already distorted markets. The quota on the input market thus partly compensates for the price support on the output market. These gains might, however, be an overestimation of the real conventional welfare effects of a nitrogen quota, since additional unproductive *rent-seeking* activities, due to the implementation of a new political intervention as well as unwanted side effects are not considered in the empirical analysis. Even neglecting latter aspects a quota policy will induce a negative conventional welfare change if the enforced reduction in nitrogen use increases. These losses will rise exponential as the restriction becomes tighter. The paper also reveals that the world as a whole would have to bear considerable welfare losses due to the implementation of a nitrogen quota in the European Community. These losses would rise more steeply as the reduction becomes greater.

The conventional welfare losses discussed so far would be partly offset by the benefits due to an improvement in environmental quality, resulting from the implementation of a nitrogen quota. While, however, the costs associated with reducing nitrogen consumption will rise exponentially as the restriction becomes tighter, the additional benefits received in terms of reduced environmental damage are likely to decline with every percentage increase in the reduction of nitrogen use ⟨Senauer⟩. Thus, by setting standards too high or by pursuing an inefficient environmental policy governments might waste scarce resources. This will work in the medium and long run against the environment, since economic growth will be reduced and thus the ability and willingness to pay for environmental improvements.

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