Copenhagen meets Doha: greenhouse gas emission reduction and trade liberalization in Norwegian agriculture

David Blandford

The Pennsylvania State University, University Park, PA, U.S.A.

Ivar Gaasland

Institute for Research in Economics and Business Administration,

Bergen, Norway

Erling Vårdal

University of Bergen, Norway

(E-mail: erling.vardal@econ.uib.no)

Contributed paper at the

IATRC Public Trade Policy Research and Analysis Symposium

'Climate Change in World Agriculture: Mitigation, Adaptation, Trade and Food Security'

Universität Hohenheim, Stuttgart, Germany, June 27-29, 2010

Copenhagen meets Doha: greenhouse gas emission reduction and trade liberalization in Norwegian agriculture

Abstract

As a result of substantial government support, Norway is more or less self-sufficient in its main agricultural products. This contributes to both trade distortions and higher greenhouse gas (GHG) emissions. In multinational negotiations separate efforts are being made to liberalize trade (through the World Trade Organization) and to reduce global GHG emissions (through the United Nations). Using a model of Norwegian agriculture, we explore interconnections between trade liberalization and GHG emission reductions. We show that the Doha proposals would involve no major cut in either agricultural production or GHG emissions due to weakness in the disciplines on trade distorting support. We contrast further trade liberalization and the use of a carbon tax to achieve emission reductions. Trade liberalization involves relatively large impacts on agricultural activity. Trade distortions decrease, and, economic welfare increases substantially due to lower production. For a high cost country like Norway, this indicates that the GHG abatement cost is negative in the sector if no value is attributed to agricultural activity beyond the world market price of food. A more targeted policy to reduce GHG emissions is to use a carbon tax. Compared to the trade liberalization case, both production and land use can be kept at a higher level with only a modest decrease in economic welfare. The side-effect is, however, higher trade distortions.

1. Introduction

The imposition of binding global commitments on greenhouse gas (GHG) emissions was on the agenda of the December 2009 climate conference in Copenhagen, held under the auspices of the United Nations (UN). Although it was not possible to reach agreement on firm commitments it is likely that the issue will continue to be on the international political agenda. While agriculture so far has been exempted from most national carbon reduction initiatives, it is reasonable to believe that the sector will be included in the future. At the same time, trade liberalization is being negotiated in the Doha round of the World Trade Organization (WTO). Future climate and trade agreements will in various ways affect the relative profitability of different farming systems, the level of agricultural activity, and the GHG emissions generated by the sector.

Norwegian agriculture is among the most heavily protected in the world (NILF, 2007). The OECD's producer support estimate (PSE) for Norway was 62 per cent in 2008, the highest among the Organization's member countries (OECD, 2009). Norwegian domestic agricultural support is roughly 100 per cent higher than the ceilings proposed in the Doha round negotiations of the WTO (Blandford et al., 2010).

In spite of high support, agriculture accounts for less than one per cent of Norway's GDP. In contrast, GHG emissions from agriculture constitute an estimated 8 per cent of the Norwegian total, and are, consequently, disproportionate to the size of the sector. The emissions are associated with ruminant animals (which are important in Norwegian agriculture), high intensity in the use of fertilizer, and intensive soil tilling (to compensate for climatically related low yields).

The aim of this paper is to explore the interconnections between trade liberalization and GHG emission cuts for Norway. While there exist detailed WTO proposals with respect to trade liberalization that can be used as a point of departure, the Copenhagen conference did not result in a concrete agreement or proposal for emissions. However, prior to the Copenhagen climate conference, Norway proposed a reduction in economy-wide emissions of 30 per cent by 2020 (compared to the 1990 level). In our analysis we assume that agriculture has to reduce its GHG emissions according to this percentage.

To examine the relationship between trade liberalization and emission cuts we use a model of the Norwegian agricultural sector (Jordmod), described in *Section 2*. The model has been adapted as a tool for analyzing climatic and environmental aspects related to food production. Functions and coefficients for GHG emission have been attached to activities and production factors in the model, and GHG policy instruments have been included. The model's representation of the situation in Norwegian agriculture as of the base year of 2003 is presented in *Section 3*. Special focus in that section is on current support measures compared to the proposed Doha commitments and status with respect to GHG emissions from different sources.

In *Section 4* we examine the trade liberalization proposals in the Doha round. We show that disciplines with respect to the use of trade distorting support are weak, such that they would likely involve no major cut in either agricultural production or GHG emissions. Consequently, to reach the assumed 30 per cent cut some additional changes in policy would be required. In *Section 5* two alternative abatement strategies are examined. First we assume that the authorities introduce further, i.e., more effective trade liberalization as a means of reaching the emission target. This is then compared to a more targeted abatement policy involving a tax on GHG emissions. In both cases, the Doha solution serves as a point of departure, and we assume that the authorities have preferences for maintaining a high level of agricultural activity.

2. The model

Main characteristics

Jordmod is a partial equilibrium model of the Norwegian agricultural sector (Mittenzwei and Gaasland, 2008). For given input costs and demand functions, market clearing prices and quantities are computed. Prices of goods produced outside the agricultural sector or abroad are taken as given, and domestic and imported products are assumed to be perfect substitutes. As the model assumes full mobility of labor and capital, it should be interpreted as a long run model.

The model has a supply module that maximizes profit at the farm level for given product prices, subsidy rates and taxes, i.e., optimal model farms are constructed for a given set of relative prices. The module includes functions for production technology (e.g., output and input coefficients per ha or per animal), biological or natural restrictions (e.g., length of grazing season, balance between young and producing animals, respectively, and crop rotation) and cross-compliance restrictions on the farm level (e.g., manure area requirements).

Some production coefficients are constant, i.e., the level of the input (or output) is proportional to the number of hectares or animals at the constructed farm. However, non-linear functions are introduced for three important relations: crop yields increase at a declining rate with the amount of nitrogen applied; milk production per dairy cow is a function of the amount and mixture of coarse fodder and concentrated feed; and economies of scale with respect to use of capital and labour per animal or hectare are incorporated. These non-linear relations imply that both the scale (number of animals and hectares) and mixture of inputs (use of fertiliser and feeding practice in milk production) are functions of given relative prices.

The constructed model farms are integrated into an equilibrium model that includes domestic demand functions (linearly decreasing), given world market prices, subsidies and regulations, trade policies, transportation costs and limitations as to available farmland of different grades. The sum of consumers' and producers' surplus is maximized and the prices and quantities are determined that yield an equilibrium in each market. No restrictions can be violated, and no active model farm or processing plant can be run at a loss.

The model distinguishes between thirty-two production regions, each with varying yields and a limited supply of different grades of land. With few exceptions, the model contains eleven specialised farm types in each region, which are defined by thirty-six production activities (19 for crop production and 17 for animal production). This makes for a total of about 350 model farms for which the optimal amount of inputs and outputs can be found in the supply module.

At the farm level the model has 22 outputs (e.g., wheat, potatoes, cow milk and eggs), 12 intermediate products (e.g., different grades of concentrated feed and roughage, and nitrogen and phosphorus from own animals) and 25 other production factors (e.g., different types of capital, energy, seeds and pesticides).

Domestic demand for final products is divided among five separate demand regions, which have their own demand functions. Each demand region consists of several production regions. If products are transported from one region to another, transport costs are incurred. For imports and exports transport costs are incurred from the port of entry and to the port of shipment respectively. The model is calibrated, partly by using positive mathematical programming (PMP), to the base year of '2003', which is an unweighted average of the years 2002 – 2004.

Implementation of emission functions and coefficients

Functions and coefficients for GHG emissions have been attached to activities and production factors in the model, based on the Intergovernmental Panel Climate Change (IPCC) methodology, adapted to Norwegian conditions and practices. Details, including parameters, data sources and implementation, are given in Gaasland and Glomsrød (2010).

The sources of GHG emission implemented in the model are given in the bottom part of Table 1. For milk cows, emission from enteric fermentation is formulated as a function of the amount and mixture of feed, while for all other animals it is given by an animal specific constant parameter per head. The amount of manure, which leads to emission of methane and nitrous oxide from manure management and nitrous oxide from the use of manure as fertilizer, is modelled as a function of fodder intake for milk cows and as an animal specific constant for other animals. For manure management, the animal specific emission parameters depend on the manure management system. Constant parameters per hectare, which differ between the use of manure and synthetic fertilizer, represent emission of nitrous oxide from the use of fertilizer. Net emission from land use relate to carbon dioxide that is assumed to be released from tilled land (2000 kg per hectare per year) adjusted for the small amount assumed to be sequestered on no-till land (about 100 kg per hectare per year). The 'other' category in Table 1 includes indirect emissions related to deposition of ammonia and leaching and runoff of nitrogen. Carbon dioxide released from the use of fossil fuel in agricultural activity (which amounts to 8 per cent of the agricultural emissions) is not included in the model. Emissions of all substances are translated into carbon dioxide equivalents.

GHG policy instruments can be specified, either in the form of a tax on emission or as a cap. In the latter case, the shadow price attached to the cap can be interpreted as the implicit tax, or the required tax to keep the cap binding. The model allows for several responses to a GHG tax: productions with high emissions (e.g., ruminants) may decline to the benefit of low emission productions (e.g., monogastric animals); the intensity in the use of fertilizer may decrease (i.e., land may substitute for fertilizer); more of the land may be permanently covered with grass and not ploughed (no-till); and the intensity of feeding of milk cows may change.

3. The current situation (base solution)

As a basis for comparison, column 1 in Table 1 gives the model's representation of the impact of Norwegian agricultural policy in the base year (2003). Since the production of various agricultural products, as well as agricultural support, has been relatively stable the last decade, the base year 2003 can be viewed as a representative year.

In spite of climatic disadvantage, production is high and imports are low. Norway is self-sufficient in most of the products listed. For dairy products there is a surplus, with the equivalent of roughly 12 per cent of domestic milk production being disposed of through subsidized exports of cheese. The climate does not permit sufficient production of high-quality grain for bread-making, so roughly half of the wheat used domestically is imported.

The high activity level in Norwegian agriculture is sustained by substantial support. Total support is about NOK 20 billion (1 NOK ≈ 0.125 €). Divided by the amount of farmland, this amounts to NOK 22,000 per ha. About 60 percent of the support is provided from the government budget while the rest is market price support buttressed by import tariffs in the range of 190-430 percent for the main products.

In Table 1 we have translated the Norwegian support into WTO categories. The various types of support are given as a percentage of the commitment in the Doha round. Table 1 shows that Norwegian support by far surpasses the proposed ceilings in the Doha round. The *aggregate measurement of support* (AMS), comprising support not subject to constraint on production, is 99 per cent higher than the proposed commitment. Norway's AMS is composed primarily of market price support, which is measured as the difference between domestic administrative prices and a fixed reference price, multiplied by eligible production. The *blue box*, which includes potentially trade-distorting subsidies that are subject to constraints on production, is 109 per cent above its proposed ceiling. Finally, the *overall trade-distorting support* (OTDS), defined as the total AMS plus *de minimis* and blue box payments, is 92 per cent too high.

With respect to GHG emissions, Table 1 shows that enteric fermentation accounts for more than 1/3 of total agricultural emissions. These are closely related to the number of ruminants (i.e., dairy cows, heifers, beef cows, sheep and goats), which are the basis of the production activity in rural areas. Net emission from agricultural land is the second largest emission category. Intensive soil tilling contributes to the high emission from agricultural land. As can be seen from Table 1, almost 90 per cent of the land is regularly ploughed (tilled), i.e., land with permanent cover is scarce. About 20 per cent of the emissions come from manure management, which is also correlated with the number of animals, inclusive of pigs, poultry and hens. Finally, about 15 per cent of the emissions are associated with the use of fertilizer (both manure and synthetic).

Table 1. Model results

			GHG ABATEMENT STRATEGY		
			Trade liberalization		
	BASE SOLUTION	DOHA SOLUTION	a.	b.	**GHG tax**
(column no.)	(1)	(2)	(3)	(4)	(5)
Production (mill kg)					
Milk	1510	1350	1260	1219	1320
Beef and veal	87	90	57	53	59
Sheep	26	26	24	24	13
Pig	106	106	86	80	93
Poultry	53	53	49	50	59
Eggs	54	54	50	51	61
Food grains	203	159	96	57	161
Coarse grains	961	929	728	688	802
Potatoes	290	290	290	290	351
Total production (index)	*100*	*93*	*82*	*79*	*87*
Support (billion NOK)					
Budget support	11.3	13.9	9.2	8.8	11.5
Market price support	8.6	5.5	6.8	6.3	5.1
GHG tax	0.0	0.0	0.0	0.0	1.1
Total support	*19.9*	*19.4*	*16.0*	*15.1*	*15.5*
Percent of Doha					
AMS	199	56	5	5	66
Blue box	209	100	95	92	57
OTDS	192	69	38	37	59
Economic surplus (billion NOK)	19.0	21.6	25.2	26.5	26.1
Land use (1000 ha)					
Tilled, grain	313.8	288.3	237.8	211.8	280.0
Grassland, roughage	571.2	577.1	431.1	413.1	468.4
Mowed, tilled	440.2	443.7	336.5	326.2	275.0
Mowed, no-till	0.0	0.0	0.0	0.0	24.9
Pasture, tilled	16.8	16.5	13.0	11.6	5.1
Pasture, no-till	114.1	116.9	81.5	75.3	163.5
Total farmland	*885.0*	*865.4*	*668.9*	*624.9*	*748.5*
Intensity in use of fertilizer (N per ha)					
Wheat	155	155	155	155	123
Grassland, mowed and tilled	194	195	190	188	170
GHG emission (CO2 equiv. mill. kg)					
Enteric fermentation	1917	1928	1365	1298	1304
Manure management	1108	1103	868	832	858
Fertilizer, manure	233	232	187	182	164
Fertilizer, syntetic	576	572	418	386	325
Net emmision land use	1530	1485	1166	1092	1101
Other	69	68	51	48	49
Total GHG emissions	*5433*	*5388*	*4056*	*3838*	*3802*

4. Compliance with Doha proposals (Doha solution)

A new round of trade negotiations under the WTO was launched in 2001. One of the major aims of the ongoing Doha Development Round is to reduce agricultural protection and impose greater discipline on domestic agricultural subsidies, particularly those that are most trade distorting. The latest proposal for support reduction commitments was prepared by the previous chair of the WTO agriculture committee, Crawford Falconer (WTO, 2008). In this section we introduce trade liberalization according to the Falconer proposal. We use the model to assess impacts on agricultural activity, welfare, trade distortions and GHG emissions.

As indicated in Section 3, domestic support is divided into the AMS, blue box support and OTDS, which in the base solution are estimated to be 99 per cent, 109 per cent and 92 per cent, respectively, above the proposed ceilings.[1] In addition there is a green box that is exempt from reduction commitments. The green box includes support measures that are minimally production or trade-distorting.

The proposal also includes specific commitments with respect to export subsidies and market access. Products defined as "sensitive", which practically involve all important Norwegian products, are subject to a 23.33 per cent reduction in the ordinary tariff rate, which for Norway yields tariffs above 100 per cent. Concessions in the form of new tariff rate quotas (TRQ) amount to 6.5 – 7 per cent of domestic consumption. Finally, export subsidies are abolished. More details with respect to the implementation of market access are given in Blandford et al. (2010).

On the surface, the proposed changes seem dramatic for Norway, taking into consideration the high level of support under the different categories in the base solution, the

[1] Details with respect to WTO definitions, base rates and reduction commitments are given in Blandford et al., (2010).

required cut in import barriers, and the elimination of export subsidies which cover 12 per cent of milk production. However, it is likely that Norway, like many other countries, will try to reduce the AMS and blue box support in ways that involve no major change in policy. First, Norway has already (in 2005) shifted roughly NOK 3.4 billion from the blue box to the green box with only modest changes in the requirements for receiving such support. Second, the market price component of the AMS has been reduced by abolishing administered prices for selected products while maintaining real market price support through market access restrictions. This provides substantial flexibility to compensate producers through deficiency payments within the AMS ceiling. Column 2 in Table 1, which is based on Blandford et al. (2010), shows that by using such approaches Norway will be able to maintain most of the current activity in agriculture. Consequently, GHG emissions will also be sustained at a high level.

5. GHG abatement strategies

Complying with the proposed Doha commitments involves no significant cut in GHG emissions. The explanation is the inherent weak disciplines in the WTO framework that would allow Norway to maintain most of its current agricultural activity level. Consequently, to reach the assumed 30 per cent cut in GHG emissions, some additional change in policy is required. In the following, two abatement strategies are examined. Section 5.1 assumes that the authorities introduce further, i.e., a more effective trade liberalization measures as a means of reaching the emission target; Section 5.2, on the other hand, involves a more targeted policy using a tax on GHG emissions. In both cases, the Doha solution serves as a point of departure, and we assume that the authorities have preferences for maintaining high agricultural activity.

5.1 Further trade liberalization

In the Doha solution agricultural activity and production was fueled by deficiency payments that were made room for by the elimination of administered prices. In order to cut GHG emissions with trade liberalization, we assume that the Norwegian agricultural authorities abstain from this compensation strategy and, consequently, farmers are confronted by the full effect of the elimination of export subsidies and expanded market access commitments at current subsidy rates.

As the results in column 3 of Table 1 show, agricultural activity is now more seriously affected. Production, as a weighted average, declines by 18 per cent, while land use decreases by 24 per cent. However, GHG emissions are still above the target. Therefore, column 4 provides a solution in which the import tariffs are scaled down proportionally until the target is met, resulting in levels of production and land use that are 21 per cent and 30 per cent, respectively, below current levels.

It is noticeable that land use and GHG emissions are reduced by about the same percentage (30 per cent). The reason is that the abatement strategy used in this simulation, involves no major change in relative prices for production factors, but is merely based on a cut in producer prices. Consequently, substitution between low and high emission activities is more or less ruled out.

Due to lower agricultural activity, and consequently lower support, economic welfare increases substantially (NOK 7.5 billion). For a high cost country like Norway, this indicates that the GHG abatement cost is negative in this sector if no value is attributed to agricultural activity beyond the world market price of food.

5.2 GHG tax

A more targeted policy to reduce GHG emissions involves a tax on such emissions. This strategy lies behind the results reported in column 5 of Table 1. With the policy instruments in the above simulation (column 4) as a point of departure, we introduce a tax equal to NOK 300 per ton of GHG emission. Production and land use are then scaled up until the GHG target is binding.

Compared to the trade liberalization case, we see that both production and land use are kept at a higher level. The additional activity is achieved with only a modest increase in support and a decrease in welfare. Production is now only 13 percent below the current situation, while land use is 16 percent lower. The reduced impact on agricultural activity is due to the substitution that takes place to avoid the GHG tax. First, the output of products that are characterized by high GHG emissions, particularly ruminants, falls by more than the average. Second, at the farm level, the use of nitrogen fertilizer decreases by 10-20 per cent per hectare. In roughage production there is a substantial shift from ploughing to no-till practice. In both cases, more farmland is required for a given level of production, i.e., land intensity increases.

6. Conclusions

As a result of substantial production support, Norway is more or less self-sufficient in its main agricultural products. While agriculture accounts for less than one per cent of GDP, the sector's GHG emissions constitute an estimated 8 per cent of the Norwegian total, and are, consequently, disproportionate to the size of the sector.

Separate efforts are being made to liberalize trade in agricultural products (WTO) and reduce global GHG emissions (UN). Using a model of Norwegian agriculture adapted to climate policy, the aim of this paper has been to explore interconnections between trade liberalization and GHG emission cuts for Norway.

The first conclusion is that the proposed trade liberalization measures in the Doha round involve no major cut in either agricultural production or GHG emissions since the Doha disciplines with respect to the use of trade distorting support are weak. Therefore, to reduce agricultural GHG emissions, some additional change in policy is required. We contrast further trade liberalization (i.e., more effective trade liberalization) to a tax on GHG emissions.

In order to reach a given reduction in GHG emissions, trade liberalization involves relatively large impacts on agricultural activity since this strategy more or less rules out substitution between low and high emission activities. However, trade distortions decrease, and, economic welfare increases substantially due to lower production. For a high cost country like Norway, this indicates that the GHG abatement cost is negative in the sector if no value is attributed to agricultural activity beyond the world market price of food.

A more targeted policy to reduce GHG emissions is to use a tax. Compared to the trade liberalization case, both production and land use can be kept at a higher level with only a modest decrease in economic welfare. The side-effect is, however, higher trade distortions. To avoid the GHG tax, output of products that are characterized by high GHG emissions, particularly ruminants, falls by more than the average, use of nitrogen fertilizer decreases, and there is a substantial shift from ploughing to no-till practice. In both cases, more farmland is required for a given level of production, i.e., land intensity increases.

References

Blandford, D., I. Gaasland, R. Garcia and E. Vårdal (2009), 'How Effective are WTO Disciplines on Domestic Support and Market Access for Agriculture?', Working Paper 03-2009 (Bergen: Department of Economics, University of Bergen).

Gaasland, I. and S. Glomsrød (2010), 'Miljøindikatorer i Jordmod', forthcoming as working paper (Bergen: SNF).

Mittenzwei, K. and I. Gaasland (2008), 'Dokumentasjon av JORDMOD- modellbeskrivelse og analyse', NILF-rapport no. 3 (Oslo: Norwegian Agricultural Economics Research Institute, Oslo.

NILF (2007), *Norwegian Agriculture: Status and trends, 2007* (Oslo: Norwegian Agricultural Economic Research Institute).

OECD (2009), *Agricultural policies in OECD countries: monitoring and evaluation, 2009* (Paris: Organization for Economic Cooperation and Development).

WTO (2008b), 'Revised draft modalities for agriculture', Document no. TN/AG/W/4/Rev.4 (Geneva: World Trade Organization, WTO Secretariat, Committee on Agriculture, Special Session, 6. December).