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Assessing the Environmental Impact of Liberalising Agricultural Trade – With Special Reference to EU-Mercosur

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Abstract

A bi-lateral trade agreement between the EU and the South American trading bloc known as Mercosur has been under consideration since 1995, with periodic hiatuses in negotiations since their inception. During the past twelve years there have been concurrent multilateral negotiations taking place under the WTO Doha Development Agenda. This work examines the potential production, trade and environmental outcomes for the EU and Mercosur that could arise under each of the trade negotiations using the Lincoln Trade and Environment Model, a multi-commodity and multi-country partial equilibrium model focused on projecting changes in international markets for agricultural products, and the greenhouse gas and nitrate implications from the outputs of these markets. The Scenarios presented include trade liberalisation, both global and EU/Mercosur specific, those which have been proposed under the Doha Development Agenda ranging around the 2008 Revised Draft Modalities document, and the 2004 and 2006 EU bi-lateral trade offer to Mercosur.

Keywords : *International Trade, Partial Equilibrium Modelling DDA, EU, Mercosur, Environmental Impact*

JEL code Q17, Q18, Q56

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Introduction

This paper draws on the results of a larger study examining the implications of the potential effects on global trade in agricultural and food products of two recent sets of international trade negotiations and on their environmental implications (Revell et al, 2013). The first is the Doha Development Agenda (DDA), an as yet only partially resolved negotiation within the World Trade Organisation (WTO). The second is the re-launch of an initiative to improve bi-lateral trade relations between the European Union (EU) and the Mercosur regional trading bloc of Latin American Countries, Mercosur, of which the full members are Brazil, Argentina, Uruguay and Paraguay. The study focussed specifically on the EU and Mercosur impacts

Although both trade policy negotiations address multi-sectoral trade issues, the emphasis of this study is on the implications of any settlements specifically on the agriculture and food sectors, and how this may impact on the environment in the EU (27) and Mercosur. The study uses a global multi-country, multi-commodity agricultural trade and environment model, the Lincoln Trade and Environment Model (LTEM), developed at Lincoln University, New Zealand (Cagatay et al, 2003), to explore different scenarios under sets of assumptions about the potential out-turns of the Doha and Mercosur negotiations. Whilst some of the positions that have been tabled are known, neither the DDA nor EU-Mercosur negotiations have been concluded, and hence one outcome of the project is to inform negotiators as to the possible environmental consequences of specific trade liberalisation measures on a product and country basis in order that they may be factored in to any final decisions regarding agreement. The primary environmental foci are the potential impacts of trade policy changes on greenhouse gas (GHG) emissions and on groundwater quality.

EU (27) and Mercosur Agriculture and Trade

This section presents the output and trade of the EU (27) and Mercosur in the wider global context and looks in more detail at EU-Mercosur trade links in the Base Year 2008 used to projec the counter-factual baseline in the LTEM. Data were obtained from the OECD FAO Outlook statistical database, although as its Mercosur country coverage excludes Paraguay, Paraguay data was obtained from the FAO FAOSTAT database. Given the relatively small share of most commodity outputs from Paraguay, this will not significantly affect the general conclusions.

Table 1 shows that the EU was a major world producer[2] of all products except rice, oilseeds and sheepmeat, and accounted for more than one fifth of world production of wheat, butter, cheese, milk powders. The Mercosur region accounted for over 20 percent of world oilseeds and protein meals production, almost 20 percent of world beef, and some 14 percent of poultrymeat and 18 percent of world sugar.

Table 2 shows the shares of the EU (27) and Mercosur in world agricultural commodity export trade by volume. It also shows EU imports from Mercosur as a proportion of total world trade by commodity, and the EU's global import share. Mercosur countries had large world export market shares in coarse grains (maize, sorghum), oilseeds and protein meals (oil meals), beef and poultry meat and sugar, with Mercosur exports for the latter four commodities accounting for at least one third of world exports of each. The EU had relatively large shares of world exports only for dairy products, pigmeat and wheat. As an importing region, the EU took over 40 percent of all world oil meal imports, a significant proportion of global trade in oilseeds and oils, and over a quarter of global sheepmeat imports. EU imports from Mercosur countries in oilseeds, oil/protein meals and poultrymeat account for large proportions of EU global imports.

[2] Arbitrarily here defined as >10 percent of world production.

Table 1: Relative importance of EU (27) and Mercosur in World Agricultural Production 2008

Commodity		Production m tonnes[a]			As % World	
		World	EU-27	Mercosur[d]	EU (27)	Mercosur
CEREALS	Wheat	685.4	150.4	15.8	22.0%	2.3%
	Coarse grains	1126.6	163.4	81.4	14.5%	7.2%
	Rice	459.6	2.7	9.9	0.6%	2.2%
OILSEEDS	Oilseeds	379.8	27.2	95.1	7.2%	25.0%
	Protein meals	227.1	25.0	51.5	11.0%	22.7%
	Vegetable oils	132.5	13.6	13.0	10.3%	9.8%
MEATS	Beef and veal (cwe [b])	65.5	8.1	12.7	12.4%	19.5%
	Pigmeat (cwe)	104.3	22.7	3.3	21.7%	3.2%
	Poultry meat (rtc [c])	93.1	11.6	12.9	12.4%	13.9%
	Sheepmeat (cwe)	12.9	0.9	0.2	7.4%	1.3%
DAIRY	Fresh dairy products	418.0	47.6	13.0	11.4%	3.1%
	Butter (prod. wt)	9.6	2.1	0.2	22.2%	1.6%
	Cheese (prod. wt)	19.5	8.7	1.1	44.7%	5.8%
	Skim milk powder (prod. wt)	3.3	0.9	0.2	26.1%	5.1%
	Wholemilk powder (prod. wt)	4.3	0.9	0.8	20.6%	19.0%
SUGAR	Sugar (raw equivalent)	150.9	15.6	26.8	10.3%	17.8%

[a] m tonnes million tonnes ; [b] Carcass weight equivalent ; [c] Ready to cook weight [d] excluding Paraguay
Source OECD FAO Agricultural Outlook Trade database.

Table 2: Relative importance by volume of Mercosur and EU (27) in World Agricultural Trade 2008

Commodity		Global Exports as % of Global Production	Share of World Exports		EU (27) Imports by source as % World Trade	
			Mercosur	EU (27)	From Mercosur	From World
CEREALS	Wheat	20.4%	2.9%	18.1%	0.0%	5.5%
	Coarse grains	10.1%	15.5%	7.5%	4.2%	7.2%
	Rice	6.3%	6.2%	0.5%	0.6%	5.4%
OILSEEDS	Oilseeds	22.7%	34.4%	0.7%	10.6%	18.1%
	Protein meals	29.0%	56.6%	1.1%	34.8%	41.9%
	Vegetable oils	43.0%	12.5%	1.6%	2.5%	16.3%
MEATS	Beef & veal cwe [a]	13.7%	33.6%	2.4%	4.2%	4.9%
	Pigmeat (cwe)	6.9%	7.5%	26.3%	0.0%	0.7%
	Poultry meat (rtc [b])	11.2%	35.2%	8.8%	7.2%	8.2%
	Sheepmeat (cwe)	9.7%	2.2%	0.7%	1.1%	24.9%
DAIRY	Fresh dairy prods	8.3%	4.3%	18.7%	0.0%	8.0%
	Butter (pw[c])	10.3%	3.8%	27.7%	0.0%	4.4%
	Cheese (pw)	38.8%	2.2%	14.2%	0.0%	0.6%
	Skim milk powder(pw)	47.5%	12.5%	23.3%	0.0%	0.0%
SUGAR	Wholemilk powder(pw)	8.3%	48.3%	2.7%	2.3%	7.9%

Source OECD FAO Agricultural Outlook Trade Database
[a] carcase weight equivalent; [b] ready to cook weight; [c] product weight

The relative importance of Mercosur in EU (27) imports of agricultural commodities in value terms and the distribution of those imports from amongst individual Mercosur countries is shown in more detail in Appendix A. EU grain imports excluding rice were valued at €1.6 billion, with Mercosur countries accounting for over 48 percent of EU total grain imports, one-third of its barley imports and three quarters of its maize imports. Brazil and Argentina dominated EU imports of maize and barley respectively. Over half of EU imports of oilseeds and beans came from Mercosur, valued at €3.6 billion, with the Mercosur export share dominated by Brazil. Nearly 90 percent of total EU oil meal imports valued at €7.4 billion originated from Mercosur, predominantly from Brazil. Brazil also accounted for virtually all EU imports of sugar from Mercosur, although Mercosur only supplied some 18 percent of EU sugar imports. Of the €28.5 billion EU imports of crop products in Table 2, €13.3 billion or 47 percent originated from Mercosur.

Mercosur was the dominant import source for the EU (27) for beef, and veal accounting for over 83 percent of the total imported product. Virtually all (97 percent) of poultrymeat exports into the EU from Mercosur originated from Brazil, and comprised around 63 percent of EU total poultrymeat imports. Animal health restrictions, the absence of any TRQs and high tariffs effectively have excluded Mercosur countries exporting pigmeat to the EU. The Mercosur dairy sector is still small and uncompetitive in the context of dairy exporting, predominantly meeting growing domestic demand.

DDA and EU-Mercosur trade negotiations

The commencement of the Mercosur negotiations was almost contemporaneous with the opening of the Doha Development Agenda WTO Round of negotiations in 2001. These have made slow progress, with the last set of publically available DDA principles and proposals effectively enshrined in the Revised Draft Modalities (RDM) for Agriculture of December 2008 (WTO 2008a, 2008b). The Revised Draft Modalities arrived at single numbers rather than ranges for cutting tariffs including in-quota tariffs for selecting Sensitive and Special Products and for domestic support. It also contained revised provisions on tariff simplification and criteria by which Sensitive Products can be selected through creating new tariff quotas. In the context of this study, we focus only on the direct trade-related policy measures affecting market access through quotas and in-and out of quota tariff rates, and not on those directed at domestic market support.

A tiered formula was accepted for agricultural tariff cuts, also distinguishing between Developed and Developing countries. All tariffs and duties are in tariff equivalent *ad valorem* form. Bound tariffs are placed in bands according to their levels, and cuts imposed with higher tariff bands incurring greater tariff percentage reductions (Appendix B).

Negotiations between the Mercosur and EU began in April 2000 within the EU-Mercosur Bi-Regional negotiations committee. The talks aimed at a conclusion of an interregional Association Agreement by October 2004 (Jank et al., 2004b), with an overall aim to move towards free trade between the two regions (SIA EU 2007, Burrell et al 2011). EU offers were made during May 2004 and counter proposals from Mercosur were received, but not published (USDA 2004). Talks stalled during the autumn of 2004, however, as the EU offer remained unacceptable to Mercosur, and the EU found Mercosur offers relating to non-agricultural market access (NAMA) also unacceptable. Although discussions resumed in 2010, there has been little progress and no further trade concessions offered, with negotiations focusing only on 'normative' areas – principles forming the basis of market openings (Agra Europe 2013).

The EU Mercosur 2004 offer identified three Annex groups of products. Annex One products including durum and high quality wheat, flour, barley, wheat gluten, malt, eggs and some wines were to be fully liberalised within 10 years. Annex Two products were to have a 50 percent

reduction in import tariffs over 10 years, and included *inter alia* olive oil, sugar cane molasses, preserved fruits and some juices. Annex Three refers to Sensitive Products, containing also most of the commodities which are the focus of this study. It was expected (USDA 2004) that these products would have TRQs with tariff reductions phased in to the equivalent of 50 percent of the bound in-quota duties for the extant tariff quotas. Subsequently it became clear that the EU would zero tariff rate any Annex Three in-quota Mercosur exports. The quota increases for many of the Sensitive Products were to be two-phased, the second phase contemporaneous with the start of the implementation of a DDA agreement (EC 2004). The EU offer also created a number of new TRQ products with zero in-quota tariffs for rice, wheat, maize and sorghum, pigmeat, milk powder (SMP and WMP), butter, cheese and bio-ethanol.

Literature review of recent impact studies of trade liberalisation

Many of the studies of the potential impact of the Doha Round have focussed on evaluating the effects of the 2008 Doha RDM proposals on agriculture and non-agricultural markets (WTO 2008a; WTO 2008b). Some have analysed in depth the details of the RDM package (Martin and Mattoo, 2008). Others have assessed the impact on access and on effective tariff rates by country, such as Laborde and Martin (2008) and Blandford et al (2008) for the USA, or Jean et al (2008) for the EU, or for developing countries (Laborde et al, 2010).

A study by Nassar et al (2008) examined the implications of the Draft Modalities for Brazil only. This is relevant to this study as it simulated the potential effects on Brazilian exports to the EU for Sensitive Products and was based on GTAP-AGR model demand and supply elasticities, in order to obtain an import demand elasticity estimate, together with assumptions about market access. It should be noted however, that this was very much a partial analysis excluding any DDA effects on Brazil in a multi-country country trading context. The authors concluded that for beef, poultrymeat and sugar, TRQ expansion would at best internalise over-quota trade, as there would be no meaningful reduction in EU import prices, which would effectively require a reduction in over-quota tariffs. It adds further emphasis to the argument that a reduction in in-quota tariffs will simply increase quota rents. If a reduction in the in-quota tariff is also associated with an increase in the tariff quota which only redistributes some over quota to within quota trade, then trade will increase only by the change in quota, with enhanced scope for rent seeking on the additional quota. Under such circumstances, it does not suggest that there would be much stimulus to production expansion, more so were this to be the case in a bi-lateral agreement.

A review of some earlier quantitative modelling studies is presented in Burrell et al (2011), although clearly the pre-2008 studies do not have the advantage of assumptions based on what is now known about the RDM proposals. Hence it may be difficult to relate their conclusions regarding DDA impacts on the EU and Mercosur to the present state of negotiations. Furthermore many of these earlier studies were based on computable general equilibrium models (CGE), and hence may either incorporate agricultural commodities at a fairly aggregate level or treat agriculture as a whole within a multi-sectoral economy.

Decreux and Fontagné (2011) used the MIRAGE model based on GTAP-8 data for 2004, in which agricultural commodities were relatively disaggregated, though some were also classified as light industry (e.g. meat). They explored a range of scenarios, the central one of which postulated RDM based tariff reductions for agricultural tariffs, restrictions on the proportions of Sensitive Products with amelioration or cuts to in-tariff concessions of one-third of the RDM–defined reduction. Assumptions relating the Swiss Formula option tariff reductions are applied to NAMA goods and services, and some trade facilitation measures were introduced. Welfare gains for Mercosur countries ranged from 0.23 percent for Argentina to 0.03 percent for Brazil, but only 0.06 percent

for the EU. Within their agriculture sectors there were positive changes in the long run value of agricultural exports, but whilst value added by agriculture in Mercosur as a whole increased by between 1 to over 4 percent and in each member country, in the EU, it fell by 0.7 percent. In contrast, their study revealed a drop in value added for all agricultural commodities in the EU.

The study by Burrell et al (2011) not only examined the potential effects of a bi-lateral agreement on the EU and Mercosur, but also explored the impact of the DDA alone (and also with a linkage of both DDA and EU-Mercosur proposals). The DDA part of the study was based on a CGE GLOBE[3] model, and contained 23 product categories across the whole of each country/region's economy. Products included were rice, wheat, other cereals (coarse grains including maize and sorghum), oilseeds, raw sugars. Meat was however aggregated over beef, sheep, goat and horsemeat, and a second meat product category pork and poultrymeat. Dairy products were aggregated, as were oils and fats. A "no policy change" scenario was constructed - that served the same counterfactual function as the Base scenario in the LTEM modelling. Two scenarios were explored in the study: DDA applying the RDM provisions but excluding Sensitive Products (equivalent to DDA Formula scenario in LTEM modelling, and DDA agreement including abatement of tariff cuts for Sensitive Products which is the closest comparator to the LTEM DDA Flex scenario[4]. However, the critical variable in such modelling in inferring environmental impacts is production, and the Burrell study only published production outcome data for its DDA Formula scenario, in which EU, aggregate output fell by just over 1 percent, with the products most affected by a DDA agreement being rice (almost -11 percent), red meats (-4 percent) and sugar (-12 percent). Conversely, the value of aggregate production in Mercosur would increase by 2.4 percent, with wheat and other cereals increasing by around 2 percent, pork and poultrymeat (3 percent), sugar (over 4 percent) and beef and other red meats (7.5 percent). The model clearly indicates that in terms of bi-lateral trade[5], the inclusion of provision for Sensitive Products will diminish EU imports from Mercosur. Given the greater likelihood of any DDA settlement being closer to the DDA Flex scenario, then the greatest impact on EU net imports would be most significant for rice and wheat, all meats and sugar.

Contemporaneous with the proposals being advanced between the EU and Mercosur in 2004, were two studies (Jank et al , 2004a and 2004b) which examined the underlying factors of the offers and the potential outcomes of the negotiations. There have been several studies which have followed publication of the initial EU offer to Mercosur in EC 2004, SICE 2004, USDA 2004 and 2005), although there has been less clarity about the precise nature of the Mercosur offer to the EU. The latter has therefore generally been modelled in more recent studies as complete liberalisation of EU tariffs on imports from Mercosur (SIA EC 2007, Boyer and Schuschny 2008, Weissleder et al 2008, Piketty et al 2009), or by zero in-quota tariffs and fixed duties with tariff quota increases in excess of those made in the EU offer of 2004 but no change to out of quota tariff rates. Other studies consider scenarios which effectively apply DDA–defined concessions only to a bilateral EU-Mercosur context, either with the DDA Formula tariff escalation applied to EU import tariffs, or modified to allow for Sensitive Products (Piketty et al 2009; Burrell et al 2011). There are therefore a plethora of possible scenarios that have been examined in the bilateral EU–Mercosur agreement context.

Three of the studies cited above took a CGE approach to analysing the potential effects of an EU-Mercosur agreement, namely those of the Trade Sustainability Impact Analysis (SIA EC 2007), Boyer and Schuschny (2008), and Burrell et al (2011).

[3] A social accounting –based model calibrated with data from GTAP database. See also Burrell et al p18 for a complete explanation of the model structure.

[4] See Scenario Specifications p11 for further details.

[5] The authors interpreted the bi-lateral trade changes as net trade changes as the GLOBE modelling did not quantify all other multi-lateral trade changes.

The SIA EC study utilised the Copenhagen Economics Trade Model (CETM), which incorporates agricultural products at a high level of aggregation into 4 product groups viz. grains, crops (including sugar cane, fruits, vegetables and oilseeds); animal products (effectively live animals and milk) and processed foods (meats, vegetable oils, dairy products, sugar), but did not aggregate Mercosur, and the EU was represented as EU (15) and EU (10). Its broad conclusions relating to the liberalisation scenario[6] were that Mercosur grain production would rise between 8.6 percent in Uruguay, by 15 percent in Brazil, and fall by 1.5 to 4.4 percent in the EU (15) and EU 10 respectively. Crop production changes in Argentina (+1.7 percent) and Brazil (+0.4 percent) were relatively modest in Paraguay fell by almost 8 percent. EU changes were less than 0.5 percent, up in the EU (15) and down in EU (10). The model however revealed significant increases in Brazilian and Paraguayan animal product outputs by 32 percent and 37 percent respectively, and a decline in EU (15) animal product output of over 3 percent. These changes were amplified in the changes in processed foods outputs of almost 47 percent in Brazil, 73 percent in Paraguay and 17 percent in Uruguay. EU 15 output of processed foods fell by over 5 percent, and almost 3 percent in EU (10). The large increases projected in Mercosur countries' processed food outputs was reflected in even larger changes to their exports to the EU –over 330 percent for Brazil, 600 percent for Paraguay, with lesser but not insignificant increase of over 40 percent from Argentina and 131 percent from Uruguay. Notwithstanding the need for some reality check on the magnitude of such changes generated from within the model, it is interesting to note the declines in Mercosur countries' grains and crops exports to the EU.

The Burrell et al (2008) GLOBE model examined two EU-Mercosur scenarios in the absence of any Doha Agreement. Scenario 1 was the EU offer with zero tariffs on all non TRQ products, and zero in-quota tariffs on all TRQ products, plus expanded quotas as specified in Appendix Table D.4. Scenario 2 was a Mercosur offer/demand which contained significant increases in tariff quota allocations[7]. The EU offer would lead to a reduction in the aggregate value of EU agricultural production of 0.1 percent, and a rise in Mercosur output of 1.6 percent.

However, although all major products in the EU were predicted to experience declines in output under Scenario 1, with the exception of vegetable oils and fats, these were all below 0.5 percent. The magnitude of the Mercosur production increases were all less than 2 percent. In this scenario, EU imports of wheat would almost double, those of rice and vegetable oils increase by around 12 percent, beef and sheepmeat by 8 percent and pork and poultry by just under 6 percent. Under Scenario 2, which effectively only increased quotas relative to Scenario 1, EU output fell by 0.2 percent whilst Mercosur output increased by 1.4 percent. From an EU perspective, there was a further decline in production of other cereals, but little change for other products compared with Scenario 1. In the Mercosur zone, production of the meats rose more sharply than for other commodities, and also for wheat and other cereals. These were correspondingly reflected in greater increases in EU imports of rice, cereals and meat from Mercosur. Nevertheless, the general conclusion drawn from the results of this study are that the rises in Mercosur production would be relatively modest, with perhaps come rebalancing between growth in output of other cereals relative to oilseeds, particularly in Scenario 2, where the expansions of wheat and also meat production are more marked. Conversely, EU production appears to be almost negligibly adversely impacted in both scenarios.

Two other studies are worthy of brief mention (Piketty et al, 2009, Weissleder et al 2008), both used the Common Agricultural Policy Regional Impact (CAPRI) partial equilibrium models, and

[6] Referred to in the study as a"perfect competition" scenario

7 Additional 250,000 tonnes for poultry, 300,000 tonnes for beef, 200,000 tonnes of raw cane sugar 150,000 tonnes for rice, 1 million tonnes for wheat, 3.5 million tonnes for rice, 20,000 tonnes of pork, 115,000 tonnes of milk powder, butter and cheese.

are precursor's to a later study by Burrell et al (2011). Both examine outcomes of bi-lateral trade agreements between the EU and Mercosur, including variations of the EU-Mercosur 2004 offer and full liberalisation.

The Lincoln Trade and Environment Model (LTEM)

The LTEM is a partial equilibrium model of international trade in the agricultural sector, with exogenous links to other industries, factor markets, and the macro-economy. It is a multi-country, multi-commodity model with a high degree of commodity disaggregation: the dairy market is divided into five traded products and the oilseed complex is represented by three commodities. The model quantifies price and quantity impacts on production, consumption, and trade, and allows calculation of revenue and welfare impacts. It links through to the environment via production functions and then through to environmental consequences. Currently, the model links through to groundwater nitrates, greenhouse gas emissions and energy.

The LTEM is a synthetic model since the parameters are adopted from the literature. The symmetry condition holds for the supply and demand elasticities, therefore own- and cross-price elasticities are consistent. The model is used to quantify the price, supply, demand and net trade effects of various policy changes, either domestic or those relating directly to international trade regulation. It is used to derive the medium- to long-term equilibrium policy impact in a comparative static fashion from a given base year. The policy parameters and/or variables and non-agricultural exogenous variables are listed in Appendix C. Twenty two commodities are included, although results for only 19 which are most relevant to this study are shown in Appendix C and in the subsequent presentation of the model simulation results

The dairy sector is modelled as five commodities: butter, cheese, liquid milk, whole milk powder and skim milk powder. Raw milk is defined as the farm gate product and is then allocated between the five dairy markets depending upon their relative prices, subject to physical constraints. The red-meat sector is disaggregated into beef and veal, sheepmeat and pigmeat, and the poultry sector (poultrymeat and eggs) is also modelled explicitly. There are eight crop products viz. wheat, maize, sugar, other grains, rice, oilseeds, oil meals and oils. A final general characteristic of the LTEM is that although each commodity is normally treated as homogenous, there is the possibility of representing it in two different forms should this be desirable. This can permit, for example, the modelling of quality-differentiated products, such as two types of wheat or two types of butter. Hence product quality differentiation is linked to production methods, and given that such data are available, is thus capable of endogenising consumer preferences for products linked to specific production methods/systems, and those specific production methods themselves to GHG emissions outputs. The ability to represent a commodity as two separate variables can also provide a means by which preferential trade links may be represented, or where a product can be traded both within and out of quota.

In addition to 18 original regions or countries in the model, Paraguay and Uruguay were both added in order to complete the current full membership of the Mercosur group of countries. The LTEM countries included in the model are shown in Appendix C.

The LTEM works by solving for the commodity based world market clearing price in each country on the domestic quantities and prices which may or may not be under the effect of policy changes. Excess domestic supply or demand in each country spills over onto the world market to determine world prices. The world market-clearing price is determined at the level that equilibrates the total excess demand and supply of each commodity in the world market. In general, there are six behavioural equations and one economic identity for each commodity in each country in the LTEM

framework. Hence there are seven endogenous variables in the structural-form of the equation set for a commodity under each country[8]. There are four exogenously determined variables, but the number of exogenous variables in the structural-form equation set for a commodity varies, based on the cross-price, cross-commodity relationships. The behavioural equations are domestic supply, demand, stocks, domestic producer and consumer price functions and a trade price equation. The economic identity is the net trade equation which is equal to excess supply or demand in the domestic economy. For some products the number of behavioural equations may change, as the total demand is disaggregated into food, feed, processing industry demand, and are determined endogenously. The solution of the model is an iterative process of constrained non-linear optimization. Full descriptions of the LTEM model specification are given in Cagatay et al (2003), and Saunders and Kaye-Blake (2010).

The direct LTEM outputs presented in this study are of producer revenues/returns, volumes or quantities of production, international traded prices, trade balance/net trade [9] and apparent consumption (production minus net trade by commodity) for all relevant countries. It should however be made clear at this point, that for any country, the model only evaluates its aggregate net trade for a commodity, i.e. the sum of imports and exports, from and to all other countries. It does not therefore enable us to examine the impact of specific trade measures on bilateral trade between countries and/or regions.

In order to simulate the impact of changing market conditions on production and thus the environment, the factors affecting greenhouse gas emissions have been specified separately, and for the purpose of this study, emissions from beef and dairy cattle and sheep are taken into account. The principal determinants of gas from this source are livestock numbers, feed intake and type per head (Lassey et al., 1997).

As the LTEM is not a bi-lateral trade model and uses a world-market-price clearing mechanism to simulate international trade, it is not possible for a given commodity to model tariffs for bi-lateral trade that are separate from tariffs applied generally. The model assumes all traded goods within a commodity to be homogenous, with each commodity group having an average tariff for each importing country. Hence, in order to simulate the effects of different tariff and quota levels between Mercosur and the EU, each relevant commodity has been divided into two sub-commodities: the first, that of Mercosur origin, can be traded into the EU at a given tariff rate; the second is defined as that which can be traded world-wide. No preference for either sub-commodity is assumed other than supply and price and the two are assumed to be perfect substitutes. Mercosur can produce both or either of the sub-commodities, Mercosur or non-Mercosur. In consumption all countries can consume either or both sub-commodities. FAO trade data (FAO 2010-2013) were used to split each country's consumption into consumption of Mercosur and non-Mercosur commodities.

Production and demand are thus assumed to be segregated into M and non-M products (effectively 32 LTEM products in EU-Mercosur trade were modelled). The M and non-M products were assumed to be substitutes in production and consumption and identical supply, demand, stock and price functions were used for M and non-M varieties (similar to the approach used in Nielsen et al. 2000; Barkley 2002)[10].

[8] The LTEM model contains over 4,000 equations, with each country having between some 200-300 equations, depending on its primary sector.

[9] Net trade<0 implies that a country is an importer of a particular commodity and >0, an exporter

[10] M-commodities in the model are only traded to the EU (although there can be a slight overflow into the 'rest of the world'), and are thus bound to excess demand in the EU. However as M-countries do not solely produce M-commodities, but also non-M, they can also export into the rest of the world. Hence, for example, if in a particular

Where quotas exist in a scenario, a constraint is placed on the maximum incoming trade allowed by a country. These constraints would normally apply to the aggregated imports from all countries. However, when modelling divisions of origin-specific variants of commodities, these constraints can be used to model trade restrictions between multiple partners. In this case the method was used to restrict Mercosur exports to the EU under the relevant scenarios. Similarly this split in origin specific commodities was used to model different tariff rates for M commodities and non-M commodities.

Modeling Environmental Impacts in the LTEM

GHG emissions from agriculture

Agricultural activities contribute directly to emissions of greenhouse gases through a variety of different processes. The IPCC (1996) identified a range of greenhouse gas (GHG) emitting activities, in addition to those from traditional cultivation practices such as savannah burning, and those relating to forest clearance, neither of which are considered in the modelling framework of LTEM. The GHG emitting activities included in the model are from enteric fermentation in domestic livestock, manure management, rice cultivation, and from cultivation of agricultural soils.

Methane (CH_4) is produced in herbivores as a by-product of enteric fermentation. Both ruminants (e.g., cattle, sheep) and some non-ruminants (e.g., pigs, horses) produce CH_4, although ruminants are the major source. The amount of CH_4 that is released depends on the type, age, and weight of the animal, together with the types and volumes of their feed. CH_4 is also produced from the decomposition of animal manure under anaerobic conditions. These often occur where large numbers of animals are managed intensively such as on dairy farms, beef feedlots, and in indoor pig and poultry units), where manure is typically stored in large piles or in slurry lagoons for subsequent spreading on the land. Finally, anaerobic decomposition of organic material in flooded rice fields produces CH_4, which escapes to the atmosphere.

Three types of nitrous oxide (N_2O) from agricultural soils can be distinguished: direct soils emissions, direct soil emissions of N_2O from animal production (usually included in the manure management category) and indirect emissions. Increases in the amount of nitrogen added to the soil generally result in higher N_2O emissions (Bouwman, 1990). Direct soil emissions can occur from nitrogen input to soils through synthetic fertilisers, nitrogen from animal waste, biological nitrogen fixation, reutilised nitrogen from crop residues and sewage sludge application. Furthermore, soil cultivation can increase mineralisation of soil organic matter and N_2O emissions. Direct soil emissions of N_2O from animal production include those induced by grazing animals. Indirect N_2O emissions take place after nitrogen is lost from the field as NOx, NH_3 or after leaching runoff.

The IPCC Emission factors are thus important in determining the total greenhouse gas emissions from agriculture in each country, and its Guidelines (IPCC 1996, IPCC 2006) produced default emission factors for the different sources of gases and for a maximum of eight regions of the world

scenario solution, 45 percent of Argentinian wheat is M-wheat and 55 per cent non-M wheat, then 45 per cent is exported to the EU and 55 per cent goes into the normal trade pool for every other country. The production in M countries is not fixed, so production can shift between M-commodities and non-M-commodities depending on the price for each. Similarly in consumption, the EU consumes both standard non-M commodities and M-commodities, with the quantities of each *inter alia* determined by price relativities.

(North America, Western Europe, Eastern Europe, Oceania, Latin America, Asia, Africa and Middle East, and the Indian Subcontinent).

Animal numbers are of critical importance in determining the CH_4 and N_2O emissions for each country. Two major sources are used for the livestock data: the FAO agricultural statistics database and the OECD Agricultural Outlook database (OECD FAO 2010-13).

The calculation of coefficients for CH_4 and N_2O production from livestock systems was based on the IPCC methodology for GHG inventories. Default emission factors provided by the IPCC were used for the calculation of coefficients in most countries (IPCC 1996). All of the various emissions sources associated with livestock agriculture are summarized into single equation, Equation (7) with coefficients specified by (Clough and Sherlock, (2001). In Equation (7), GHG is specified as a function of applied N and number of animals (NA), and CH_4 and N_2O emissions from these sources are multiplied by their respective CO_2 weightings:

$$\mathrm{GHG} = 23.(\alpha NA) + 296.(\beta N, \gamma NA). \qquad (7)$$

The domestic supply functions include the price of N fertilizer and number of animals, as well as the producer and consumer commodity prices, in order to analyse the supply effect of changes in N usage on production and number of animals.

Groundwater nitrates

Where soil water-holding capacity is exceeded as a result of rainfall and or irrigation, nitrogen leaching and runoff is likely to occur. Nitrogen in the soil may be derived from the application of synthetic fertiliser, the breaking down of crop residues and mineralisation of organic nitrogen within soil organic matter. The IPCC 2006 Guidelines for National GHG Inventories (IPCC 2006) contains estimates of leaching factors. Where precipitation is greater than evapotranspiration a leaching factor of 0.3 is used (range is 0.1 to 0.8 and is dependent on soil physical properties) but where evapotranspiration is greater than precipitation the default factor is zero. LTEM uses a value of 0.3 and 0.267 for Mercosur and the EU, respectively. The quantity of nitrogen fertiliser applied and the crop yields were derived from the International Fertiliser Association (IFA) statistical database of worldwide fertilizer consumption and data from the LTEM.

Trade modelling

The LTEM uses two main database components in order to model different trade scenario outcomes. The first is a database of elasticities governing the international and domestic interactions within and between product markets and their responses to changes in tariff and quota levels. The second is a large database of historic price, trade, production, consumption and geographic data for all countries and commodities mapped in the model, used to establish the basis of projected trends.

The first of these two components, the supply and demand elasticities, were predominantly those from the pre-existing 2004 LTEM model. However, for the Mercosur countries, supply and demand elasticities were taken from the more recent CAPRI model (CAP at el 2006; Brescia and Lema, 2007). The database of core data was completely updated. The baseline year 2008 was selected as this was the most recent year with consistent and reliable data available at the start of this project[11]. The majority of these data were obtained from the OECD Agricultural Outlook for

[11] Commenced in 2010

2010-2019. The FAOSTAT database provided a secondary source supplementing the OECD source. Average national tariff rates for international trade in agricultural commodities were not available from the OECD or the FAO sources. These were provided by personal communication from Will Martin, and are consistent with those discussed in Laborde and Martin (2008), Martin and Matoo (2008) and Laborde et al (2010).

EU WTO tariff quotas, tariff rates and specific duties and bound out-of quota tariffs and duties were sourced from those published in the Official Journal of the European Community (OJ 2007). Trade-weighted average applied out of quota tariff equivalent rates were derived by the authors from COMSTAT 8 digit trade data relating to all relevant products from Mercosur and non-Mercosur countries[12]. All EU taxes (ad valorem tariffs and specific duties) on imports were converted to ad valorem tariff rate equivalents.

All scenario outputs from the modelling are shown relative to a counterfactual scenario referred to as the Base scenario. This is the projection in the LTEM of a 'business as usual' scenario, based on the exogenous variables which include underlying projections of supply, demand and growth (related to population and GDP growth). Whereas under the various modelled scenarios, quota levels and tariffs are changed according to the relevant assumptions, the Base scenario projects out to 2020 from data in the baseline year 2008 without any such policy change assumptions. Indeed the changes in production and net trade between the baseline and Base scenario are quite large, reflecting the underlying exogenous facto- driven trends that are assumed to continue over the 18 year period to 2020.

Scenario specifications

A range of potential scenarios in the study were explored relating to the DDA negotiations including a scenario on free trade, albeit that we view such an outcome as unlikely. This scenario shows an indication of the magnitude of impact if both existing TRQs and all out of quota tariffs and duties were to be removed in a global context. It thus provides a further comparator for the more modest trade concession scenarios explored in relation to both the DDA and EU Mercosur negotiations. All scenario assumptions for tariff reductions by the EU (27) for imports from Mercosur and non Mercosur countries are set out below in Appendix Table D.3, which shows the in quota and out of quota applied rates in tariff rate equivalents for the Base scenario for all countries in the model, and the percentage reductions in quota and out of quota tariffs in each of the DDA and also EU-Mercosur bilateral agreement scenarios.

Two scenarios are explored in relation to the DDA Draft Modalities proposals. The first is referred to as "***DDA Formula"***, in which the tariff escalation schedule in Appendix Table D.3 is applied to final bound out of quota tariffs in all countries in the model. There are no cuts assumed to in-quota tariffs or quota levels, nor any assumptions made about the effects of market access proposals which also form part of the terms in the Draft Modalities. The second DDA scenario explored is one which recognises the Special/Sensitive Products provision, in which the tariff escalation schedule can be abated according to the provisions explained earlier. We refer to this scenario as "***DDA Flex***". The percentage reductions applied to average out of quota tariff rates are thus less than under DDA flex for Sensitive Products.

In the absence of any available documentation regarding the exact level of additional quotas over and above those offered by the EU in 2004, we have opted to examine what the impact of full liberalisation in agricultural trade (zero quotas and tariffs) between EU (27) and Mercosur countries would be applied bi-laterally, with no changes to existing TRQ and out of quota tariffs

[12] The assistance of L Colby, Meat Market Analyst in deriving the applied tariff rates is gratefully acknowledged.

for non-Mercosur countries. The scenario is referred to as "***EU Merc Lib***" in subsequent discussions. Although we do not believe this is a likely outcome of the resumption in EU-Mercosur negotiations in 2013, it should generate a "worst case" outcome for EU producers against which the direction and magnitude on EU and Mercosur production arising from more substantial bi-lateral increases in tariff quotas and lowering of out-of quota tariff rates can be gauged, compared with the EU Mercosur offer of 2004.

This scenario is based on a variation of the original EU Mercosur 2004 offer as outlined earlier. We assume that the EU will cut in-quota tariff rates to zero, as emerged in discussions post 2004 rather than by 50 percent. However, we assume that irrespective of any DDA outcome, the EU will have effectively shown its hand in being prepared to increase quotas beyond those of the 2004 offer, and so include within the scenario, total quota increases which include both phases indicated in Appendix Table D.4.

Given that the objective of this study is to gain insights from trade-agreement driven changes on the EU and Mercosur agricultural sectors and its consequent environmental impact, the focus of the discussion about the scenario results will focus largely on the production changes which are projected relative to the Base scenario. Whilst there are many other economic dimensions of interest that could be explored in analysing the effects of DDA and EU Mercosur trade agreements, they are *per se* of more peripheral relevance and importance to the principal objectives of the study, albeit fundamental to generating those environmental impacts.

Results

Comparative impact of the DDA and EU-Mercosur scenarios on the EU (27)

Table 3 shows that DDA full liberalisation is predicted reduce the aggregate value of output i.e. volume of output measured at constant/Base prices by almost 9 percent in the EU (27). The DDA Formula scenario would result in a fall in output by volume of over 5 percent relative to Base, and the DDA Flex scenario reduces the impact through lesser tariff reduction concessions on Sensitive Products to an aggregate reduction in output of 4.7 percent. These contrast markedly with the relatively minor reductions in output which result for the EU Mercosur bilateral scenarios, with EU Merc Lib as might be anticipated, has a marginally greater impact on aggregate EU (27) output than the EU Merc scenario. Under the two more plausible DDA scenarios, output of cereals falls by some 3.6 percent under Formula variant, and over 2 percent under the DDA Flex. Cereal output also falls under both EU Mercosur scenarios but only by 0.5 percent. The effects on oilseeds and oil meals of both the DDA and EU Merc scenarios are small. Sugar production would decline by more than 3 percent under a DDA settlement, but virtually no change under EU Merc. Overall, crop product output is projected to fall by 2-3 percent in the DDA scenarios and by only 0.5 percent under the bi-lateral trade scenarios.

The pattern of relatively minor adjustments in EU production under both the EU Mercosur scenarios compared with those of the DDA is repeated in the livestock sector. Both the DDA Flex and Formula scenarios show aggregate livestock production to decline by 7 percent relative to Base, but only by 0.3 percent under EU Merc Lib, and not at all under EU Merc. This clearly shows that reductions in non-quota tariffs would have a stronger impact on livestock product production in the EU than in quota tariff reductions or increased quotas. It also suggests that the changes in EU Mercosur trade arising through bilateral concessions, even to the extent of full liberalisation, for most commodities do not exert a strong effect on either EU or Mercosur prices in a multi-country trading context.

Table 3: EU (27) and Mercosur Scenario Changes in Production Volumes

	Commodity	Base	DDA Lib	DDA Formula	DDA Flex	EU Merc Lib	EU Merc
		tonnes	Percentage change on base				
EU (27)	Cereals	344,390	-9.9	-3.6	-2.2	-0.6	-0.6
	Oilseeds, Meals, Oil	74,708	1.8	0.0	0.4	0.1	0.0
	Sugar	11,706	-13.7	-5.8	-3.3	0.1	-0.1
	Crop products	***430,804***	***-7.9***	***-3.0***	***-1.8***	***-0.5***	***-0.5***
	Beef and Sheep	7,940	-19.8	-7.7	-4.2	-0.4	-0.1
	Pigs, Poultry , Eggs	42,762	-0.8	-1.9	-3.2	-0.4	-0.0
	Dairy Products	59,653	-16.2	-10.7	-10.1	-0.2	-0.1
	Livestock Products	***110,355***	***-10.5***	***-7.1***	***-7.0***	***-0.3***	***-0.0***
	All Agriculture[(1)]	**330,736**	**-8.9**	**-5.4**	**-4.7**	**-0.4**	**-0.2**
MERCOSUR	Cereals	130,772	2.6	0.4	0.5	0.8	-0.2
	Oilseeds, Meals Oil	219,832	-1.7	-0.6	-0.1	-0.3	0.0
	Sugar	51,611	9.3	5.1	2.3	-0.6	-0.4
	Crop products	***402,216***	***1.1***	***0.5***	***0.4***	***0.0***	***-0.1***
	Beef and Sheep	14,931	5.6	1.1	0.6	2.3	-0.0
	Pigs, Poultry , Eggs	22,925	-6.6	-0.7	-0.4	-3.5	0.0
	Dairy Products	20,986	1.3	0.9	0.7	-0.1	-0.0
	Livestock Products	***58,842***	***-0.7***	***0.3***	***0.2***	***-0.8***	***-0.0***
	All Agriculture[(1)]	**180,854**	**2.2**	**1.2**	**0.7**	**-0.0**	**-0.1**

[(1)] Volume changes measured at Base Prices;

Table 4 reveals that when price adjustments under the scenarios are taken into account, the decline in total EU (27) agricultural output by value is greater than the fall in volume measure of output, particularly in the DDA Formula scenario. The impact on producer revenues under the EU Merc scenarios is not significantly different than on production volumes. Under the two DDA scenarios, aggregate output value falls by between 5-8 percent, with that of crop products falling by some 4-8 percent, and livestock products by 7-9 percent. The value of beef output falls by 10-18 percent, and that of poultry, pigs and eggs by 8-10 percent. The value of sugar output also drops by between 12-19 percent. Consumption at the aggregate level in volume terms is predicted to increase across all scenarios, particularly for sugar, beef (even under the EU Merc Lib scenario), and for pigmeat and poultrymeat. This is reflected however by a deterioration in the EU net trade position for most commodities.

Table 4: EU (27) and Mercosur Changes in Value of Output at Scenario Prices

	Commodity	Base	DDA Lib	DDA Formula	DDA Flex	EU Merc Lib	EU Merc
		$mn	% change relative to Base				
EU (27)	Cereals	76,906	-18.6	-9.6	-5.1	-0.8	-1.1
	Oilseeds, Meals Oil	31,138	-0.8	-3.0	0.1	0.5	0.0
	Sugar	5,894	-42.7	-19.2	-11.8	0.7	-0.2
	Crop products	***113,939***	***-15.0***	***-8.3***	***-4.0***	***-0.3***	***-0.7***
	Beef and Sheep	36,958	-43.7	-18.1	-10.3	-0.6	-0.2
	Pigs, Poultry , Eggs	71,799	-11.8	-8.0	-10.4	-0.5	-0.1
	Dairy Products	81,582	-11.0	-5.8	-2.1	-0.3	-0.3
	Livestock Products	***190,339***	***-17.7***	***-9.0***	***-6.8***	***-0.4***	***-0.2***
	All Agriculture[(1)]	**330,736**	**-14.6**	**-7.8**	**-5.2**	**-0.4**	**-0.4**
MERCOSUR	Cereals	24,212	7.9	1.3	1.2	5.3	-0.4
	Oilseeds, Meals Oil	48,031	-1.1	-1.0	-0.0	1.7	0.1
	Sugar	36,339	14.2	7.9	3.5	-0.6	-0.6
	Crop products	***108,582***	**6.0**	**2.5**	**1.4**	**1.7**	**-0.3**
	Beef and Sheep	32,167	13.9	2.2	1.2	6.2	-0.1
	Pigs, Poultry , Eggs	25,754	-8.6	-0.5	0.0	-4.5	-0.0
	Dairy Products	13,454	8.3	3.8	3.0	1.9	-0.0
	Livestock Products	***71,375***	**4.7**	**1.5**	**1.1**	**1.5**	**-0.0**
	All Agriculture[(1)]	**180,854**	**5.5**	**2.1**	**1.3**	**1.6**	**-0.2**

(1) Measured at Scenario Prices,

We can conclude that the EU (27) agricultural sector would experience strong reductions in income arising from DDA scenarios in which non-quota tariffs are reduced, although consumers would benefit to the extent of an increase in the aggregate volume of consumption at lower prices. It is also worth noting that the reduction in EU net trade is not offset by an equivalent increase in that of Mercosur, suggesting that under the DDA scenarios, other countries will also meet the excess demand. As we have already remarked earlier in this report, the *a priori* effects of reducing TQ rates and raising quota thresholds would not be expected to have a strong impact on trade or production, except to increase the share of imports to the recipients of the additional quotas and increase their opportunity for quota rents. The effect of removing tariffs and quotas in a bilateral concessionary trade scheme also appears to have limited impact on the EU production, although there is an impact on apparent consumption and hence a deterioration in net trade under EU Merc Lib, albeit without any great decline in EU prices to stimulate the increased demand.

Comparative impact of the DDA and EU-Mercosur scenarios on Mercosur

The predicted response of Mercosur to the DDA and EU Mercosur scenarios is also shown in Tables 3 and 4. Aggregate production volumes are projected to rise by 1.2 percent under DDA Formula and 0.7 percent under DDA Flex. Crop outputs of cereals (especially other grains and to a lesser extent wheat) and sugar both rise, but that of oilseeds and oil meals falls. This is consistent with the results of Weissleder and Piketty mentioned earlier. The overall increases in production of crops oilseeds and sugar was projected to insignificant at 0.4-0.5 percent above Base. Livestock product output on aggregate was also predicted to rise, but only by 0.2-0.3 percent, less than the growth in crop products. There is modest growth in beef output of between 0.4-0.5 percent and of dairy output 0.7-0.9 percent, but falls in outputs of the intensive meat products, pigmeat and

poultrymeat. The impact of the EU Merc scenario is quite restrictive, and has negligible impact on production in Mercosur.

Most Mercosur products were predicted to experience price rises under the DDA Flex, DDA Formula and EU Merc Lib except for oil meals and poultrymeat. Mercosur price increases are generally in the range of 2 to 5 percent, with the exception of processed dairy products. This together with increased physical output means that producer returns in Mercosur rise by between 1.3 to 2.1 percent under the DDA scenarios and by 1.6 percent under EU Merc Lib. It is clear from these results that the scenarios incorporating greater non-quota tariff reductions (DDA Formula and EU Merc Lib) also stimulate greater output of beef and dairy products in Mercosur. In Brazil, Paraguay and Uruguay beef output was projected to rise by about 2.5 percent in the bilateral liberalisation scenario, and an increase in rice production of over 5 percent in Brazil. The EU Merc Lib scenario is characterised by increases in net trade (exports) of oilseeds and oil meals, beef, pig and poultrymeat, maize, and rice. Under the DDA scenarios, the sugar trade balance rises, as do those of maize, beef, pigmeat, poultry and dairy products.

The LTEM results from this study are similar to those from the CAPRI partial equilibrium modelling of DDA and EU Mercosur bilateral scenarios on EU (27) and Mercosur production and trade Burrell et al (2011). The two modelling approaches are similar, although the primary objectives are different. The LTEM production projections under the DDA and EU Mercosur scenarios are similar to those in the CAPRI study. Furthermore, many of the changes in production emerging from both models are very small and frequently of an order of magnitude of less than half of one percent.

Potential environmental impacts of the trade policy scenarios

This section considers the environmental impacts that may arise from liberalisation of agricultural trade between the EU-27 and Mercosur countries. The analysis that follows is based on the LTEM modelling work which simulates three variables with direct impact or relationship to the environment: production levels for various crop and animal products; the associated emission of greenhouse gases implicit in their production, and nitrogen (other than nitrous oxide) lost from cropping and livestock systems. Although five trade scenarios were considered in the modelling, we here will focus largely on the potential environmental impacts of the DDA Formula, DDA Flex and the two EU Mercosur scenarios.

Table 5 summarises the effect of the trade scenarios on GHG emissions, which unsurprisingly largely mirror the projected changes in crop and animal production. The LTEM Base estimates for EU (27) GHG emissions from agriculture are 301 million tonnes of CO_2 equivalent. This is lower than the Eurostat estimate (EU 2012), but comparable to the CAPRI based estimates (Leip 2010). Given the differences in baseline construction and modelling approaches to GHG estimation, we would argue that the LTEM estimate is sufficiently robust a basis for estimating the proportional changes in livestock and crop production.

EU emissions are projected to fall by over 7 percent under the DDA Flex and Formula scenarios, driven by the reductions in livestock emissions of almost 9 percent. Emissions decline by negligible amounts in the two EU Mercosur scenarios. Mercosur emissions rise by between 0.6 to 1 percent under the DDA scenarios, but by 1.8 percent under the EU Merc Lib scenario, reflecting the increase in ruminant production, particularly in Brazil and Paraguay.

GHGs are a global issue and the point of emission is less important than the actual amount. All the trade scenarios suggest a small reduction in overall aggregate net emissions of the EU (27) and Mercosur which is of greater importance than the transfer of burden from the EU (27) to Mercosur.

Table 5: Greenhouse Gas Emission Changes (m tonnes CO2 equivalent)

		Base	DDA Lib	DDA Flex	DDA Formula	EU Merc Lib	EU Merc
		Mt CO2e	% change relative to base				
EU (27)	*Total Crops*	*72.60*	*-6.29*	*-2.82*	*-1.43*	*-0.09*	*-0.14*
	Total Livestock	*228.52*	*-14.14*	*-8.99*	*-8.81*	*-0.35*	*-0.29*
	TOTAL CROPS AND ANIMALS	**301.12**	**-12.25**	**-7.50**	**-7.03**	**-0.29**	**-0.26**
Argentina	*Total Crops*	*6.09*	*2.36*	*0.67*	*0.61*	*0.83*	*-0.20*
	Total Livestock	*79.55*	*4.19*	*0.33*	*0.39*	*1.34*	*-0.08*
	TOTAL CROPS AND ANIMALS	**85.64**	**4.06**	**0.36**	**0.41**	**1.30**	**-0.08**
Brazil	*Total Crops*	*22.13*	*5.89*	*1.71*	*1.36*	*-0.22*	*-0.15*
	Total Livestock	*317.27*	*5.34*	*1.27*	*0.60*	*2.03*	*-0.01*
	TOTAL CROPS AND ANIMALS	**339.40**	**5.37**	**1.29**	**0.65**	**1.89**	**-0.02**
Paraguay	*Total Crops*	*0.55*	*4.68*	*0.45*	*0.75*	*0.93*	*-0.16*
	Total Livestock	*16.07*	*-3.21*	*0.85*	*0.48*	*2.08*	*0.04*
	TOTAL CROPS AND ANIMALS	**16.62**	**-2.95**	**0.83**	**0.49**	**2.04**	**0.04**
Uruguay	*Total Crops*	*0.32*	*3.81*	*0.92*	*0.58*	*1.12*	*0.08*
	Total Livestock	*28.23*	*2.90*	*0.81*	*0.52*	*1.52*	*0.04*
	TOTAL CROPS AND ANIMALS	**28.55**	**2.91**	**0.81**	**0.52**	**1.52**	**0.04**
Total Mercosur	*Total Crops*	*29.09*	*5.10*	*1.46*	*1.18*	*0.04*	*-0.16*
	Total Livestock	*441.12*	*4.66*	*1.05*	*0.55*	*1.88*	*-0.02*
	TOTAL CROPS AND ANIMALS	**470.21**	**4.69**	**1.08**	**0.59**	**1.76**	**-0.03**
EU and Mercosur	*Total Crops*	***101.69***	***-3.03***	***-1.60***	***-0.68***	***-0.06***	***-0.14***
	Total Livestock	***669.64***	***-1.76***	***-2.37***	***-2.64***	***1.12***	***-0.11***
	TOTAL CROPS AND ANIMALS	**771.33**	**-1.92**	**-2.27**	**-2.38**	**0.96**	**-0.12**

Table 6 presents the LTEM estimates for changes in nitrogen leachate, The DDA scenarios in particular reductions in nitrogen losses in the EU (27) of around 6 percent, compared with less than 0.3 percent in both EU Mercosur scenarios. In Mercosur, there are small increases in emissions under the DDA scenarios associated with both crop and livestock production increases. However, under both DDA and EU Mercosur scenarios, increases in nitrogen emissions for Mercosur barely exceed 1 percent, and are clearly offset by falls in EU (27) emissions.. Only when trade between the EU and Mercosur is completely liberalised might there be a net increase in aggregate EU Mercosur nitrogen emissions.

Leachate amounts and therefore any reductions in nitrogen losses should be treated with some caution since they are based on a simple 'one value fits all' approach within the LTEM. However, at this level of aggregate modeling analysis, it was felt that this was the most pragmatic and practical approach to take. Actual leaching of nitrogen, as nitrate, is dependent on the balance between water applied (precipitation plus irrigation) and evapotranspiration, and the subsequent interaction between any surplus and soil physical properties. Both water applied and evapotranspiration vary enormously geo-spatially and temporally, so accurate measurement of leaching losses are very difficult to undertake. Estimates are therefore based on the use of a single

value leaching factor and it is important to remember that up to eight-fold variation is possible. It is thus likely that the different scenario outcomes in Table 6 (except perhaps the DDA Lib scenario for the EU (27)) are likely to be non-significant in statistical terms.

Table 6: Nitrogen Leachate and Excreted by Region/Country (m tonnes N2O)

		Base	DDA Lib	DDA Flex	DDA Formula	EUMerc Lib	EUMerc
		m tonnes	% change relative to base				
EU-27	*Total Crops*	*3.19*	*-7.93*	*-1.77*	*-3.17*	*-0.09*	*-0.12*
	Total Livestock	*7.57*	*-11.85*	*-7.57*	*-7.62*	*-0.38*	*-0.30*
	TOTAL CROPS AND ANIMALS	**10.76**	**-10.69**	**-5.85**	**-6.30**	**-0.30**	**-0.25**
Argentina	*Total Crops*	*0.63*	*0.79*	*0.24*	*0.29*	*0.39*	*0.01*
	Total Livestock	*2.66*	*4.04*	*0.39*	*0.33*	*1.28*	*-0.07*
	TOTAL CROPS AND ANIMALS	**3.29**	**3.42**	**0.36**	**0.32**	**1.11**	**-0.06**
Brazil	*Total Crops*	1.70	4.43	1.11	1.26	-0.05	-0.19
	Total Livestock	11.05	4.53	0.54	1.13	1.67	-0.01
	TOTAL CROPS AND ANIMALS	**12.75**	**4.52**	**0.62**	**1.15**	**1.44**	**-0.04**
Paraguay	*Total Crops*	*0.06*	*3.54*	*0.50*	*0.28*	*1.18*	*-0.13*
	Total Livestock	*0.54*	*-2.94*	*0.49*	*0.85*	*2.00*	*0.04*
	TOTAL CROPS AND ANIMALS	**0.60**	**-2.28**	**0.49**	**0.80**	**1.92**	**0.03**
Uruguay	*Total Crops*	*0.03*	*3.24*	*0.46*	*0.88*	*3.04*	*0.06*
	Total Livestock	*1.28*	*3.66*	*0.44*	*0.66*	*1.22*	*0.05*
	TOTAL CROPS AND ANIMALS	**1.32**	**3.65**	**0.44**	**0.67**	**1.27**	**0.05**
Total Mercosur	*Total Crops*	*2.43*	*3.44*	*0.86*	*0.98*	*0.14*	*-0.13*
	Total Livestock	*15.53*	*4.12*	*0.50*	*0.95*	*1.58*	*-0.01*
	TOTAL CROPS AND ANIMALS	**17.95**	**4.03**	**0.55**	**0.95**	**1.38**	**-0.03**
EU (27) And Mercosur	*Total Crops*	*5.62*	*-3.02*	*-0.63*	*-1.38*	*0.01*	*-0.13*
	Total Livestock	*23.10*	*-1.12*	*-2.14*	*-1.86*	*0.93*	*-0.11*
	TOTAL CROPS AND ANIMALS	**28.72**	**-1.49**	**-1.85**	**-1.77**	**0.75**	**-0.11**

Conclusions and discussion

All the trade scenarios suggest that livestock production in the EU(27) will decline, with the biggest impact on ruminants, dairy, beef and sheep. It is worth remarking that in the unlikely event of full liberalisation in the DDA, the scale of decline in ruminant production would undoubtedly have a positive effect on GHG emissions and other nitrogen losses, but also may have serious adverse effects on land management, conservation and biodiversity. Land abandonment may occur with the greatest impact occurring in the least favoured, and economically poor, areas of the EU (27).

The direct environmental consequence of the three DDA scenarios on agriculture in the EU-27 is straightforward: a reduction in GHG emissions and losses of nitrogen. In principle one of the biggest benefits of a reduction in production in the EU-27 would be less use of synthesised nitrogen fertilizer. This would reduce emissions of GHG emissions and other nitrogen losses and lessen the burdens of global warming and eutrophication. However, as described above, it may be difficult to see reductions occurring if other agricultural opportunities exist outside the parameters of the modelling framework.

The impact of the different trade scenarios on production within the Mercosur countries is also fairly consistent. In a majority of the scenario/commodity combinations, the result of liberalisation is an increase in production although oilseeds, pigs, poultry and eggs show a decline. The overall effect is to increase greenhouse gas emissions and other nitrogen losses.

A comparison between the EU-27 and Mercosur countries using the DDA scenarios and focused on GHG emissions would seem to imply that the consequences of liberalisation would be an overall drop in emissions. The same is true of other nitrogen losses. However, closer inspection shows that the three DDA scenarios also result in a drop in the combined production of both trading blocs; this may partially explain the reduction in GHG emissions and nitrogen losses. A fuller environmental analysis would need to consider the influence of the other trading nations and the environmental impact associated with their production systems before any firm conclusions could be reached.

The wider indirect environmental costs of liberalisation are probably of greater importance than the direct impacts. The potential to increase the environmental burden within Europe still exists, but its potential to cause damage at a global scale is minimal. The same is not true within some of the Mercosur countries. Brazil, especially, has globally important areas of tropical forests and savannah, as does Paraguay, which has outstanding and sometimes unknown, reserves of biodiversity. Any trade policy changes which might potentially add to the threats to those resources should be evaluated carefully before any decisions on implementation are taken, as despite new measures to protect the Amazonian forests, deforestation is still happening, with consequent increase in GHG emissions through land use change which follows.

It is worth examining the livestock sectors in more detail to explore the consequences of the trade scenarios on individual commodities. Given that EU net imports rise by more than an increase in net exports from Mercosur, there may well be indirect environmental impacts of rises in CO_2 emissions from greater transport of commodities to the EU; also, increased N_2O emissions from the use of crop-based feedstock materials in the USA and increased water consumption in the semi-arid areas of the USA and Australia. This analysis may be a worst case scenario but the trend is true across all the trade scenarios. More detailed work would be required to examine if the direct reductions in environmental impact are greater than the indirect impacts within the wider global economy in the LTEM.

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Appendix A. Relative importance of Mercosur in EU (27) Imports in 2010

Crop Products and Derivatives	From All Countries	From Mercosur	% EU (27) from Mercosur	Argentina	Brazil	Paraguay	Uruguay
	€mn	**€mn**		**% of Mercosur to EU (27)**			
CEREALS							
Wheat, Meslin	1,788.9	5.0		68.9%	1.0%	13.4%	16.7%
Barley	117.8	42.1	35.7%	99.8%			
Maize	2,021.8	1,581.7	78.2%	46.6%	50.0%	3.4%	
Total Cereals excl Rice	***3,928.4***	***1,628.7***	***41.5%***	***48.1%***	***48.5%***	***3.3%***	
RICE	***964.2***	***74.3***	***7.7%***	***7.9%***	***22.3%***	***0.0%***	***69.8%***
VEGETABLE OILSEEDS, MEALS, OILS AND FATS							
Soya beans	5,157.5	3,556.5	69.0%	3.0%	85.8%	9.1%	2.2%
Rapeseed	915.2	1.8	0.2%	100.0%	0.0%	0.0%	0.0%
Linseed	221.9	2.7	1.2%	100.0%	0.0%	0.0%	0.0%
Sunflower	302.3	43.6	14.4%	50.0%	0.0%	0.0%	50.0%
Other	358.0	10.9	3.0%	15.7%	40.6%	43.8%	0.0%
Total Oilseeds and Beans	***6,954.8***	***3,615.5***	***52.0%***	***3.7%***	***84.5%***	***9.1%***	***2.7%***
Soybean oil	882.3	763.3	86.5%	46.7%	53.1%		
Olive oil	383.5	69.4	18.1%	63.4%	36.6%		
Palm oil	3,234.2	1.8			84.7%		15.3%
Cotton seed , safflower and sunflower oil	1,007.5	384.0	38.1%	95.5%		3.6%	
Rapeseed Oil	364.7	7.2	2.0%	64.5%		35.5%	
Linseed, and other oils, veg fats	365.3	21.3	5.8%	26.0%	69.5%	4.1%	
Total Oils	***7,447.8***	***1,247.4***	***16.7%***	***62.3%***	***36.2%***	***1.5%***	***0.0%***
Total Oil meals	***7,366.4***	***6506.5***	***88.3%***	***18.2%***	***81.8%***	***0.0%***	***0.0%***
SUGAR							
Raw cane or beet sugar	1,436.7	263.3	18.3%	2.3%	93.1%	4.6%	
Other sugars, lactose, fructose etc.	156.1	0.6	0.4%	62.0%	38.0%		
Molasses	275.9	3.0	1.1%		48.7%	51.3%	
Total Sugar	***1,868.7***	***266.9***	***14.3%***	***2.4%***	***92.5%***	***5.1%***	
FLOUR	**13.9**	**0.2**	**1.7%**	**64.6%**	**15.3%**	**3.0%**	**17.2%**

Animal Products	From All Countries	From Mercosur	% EU (27) from Mercosur	Argentina	Brazil	Paraguay	Uruguay
	€mn	**€mn**		**% of Mercosur to EU (27)**			
BEEF AND VEAL							
Fresh or Chilled Boneless	879.3	703.4	80.0%	65.3%	12.5%		22.0%
Frozen Boneless	363.3	314.8	86.6%	17.5%	40.3%		42.1%
Processed Beef	218.8	213.6	97.6%	11.1%	86.6%		2.3%
Corned Beef	113.4	113.1	99.7%	16.2%	79.8%		4.0%
Total Beef	***1,643.0***	***1,369.7***	***83.4%***	***40.7%***	***36.8%***		***22.4%***
SHEEPMEAT							
Frozen Boneless	131.4	24.4	18.6%	19.8%			80.2%
Frozen carcasses/half ccses	21.7	5.7	26.5%	100.0%			0.0%
Total Sheepmeat	***997.9***	***34.2***	***3.4%***	***41.7%***	***0.0%***	***0.0%***	***58.3%***
POULTRYMEAT							
Cooked Chicken	735.6	411.4	55.9%	0.6%	99.4%		
Salted Chicken	430.5	254.6	59.1%		99.5%		
Frozen Boneless Chicken	289.4	225.6	77.9%	6.9%	93.1%		
Processed Turkey meat	265.7	216.6	81.5%		100.0%		
Processed Chicken	93.2	55.3	59.4%		100.0%		
Total Poultrymeat	***2,013.7***	***1,279.2***	***63.5%***	***3.0%***	***97.0%***	***0.0%***	***0.0%***
PIGMEAT	***125.6***	***0.0***	***0.0%***				
DAIRY PRODUCTS	***639.8***	***0.0***	***0.0%***				

Appendix B. WTO Tariff Escalation Schedule under Revised Draft Modalities

	Developed Countries		**Developing Countries**	
Tariff Band	**Range (%)**	**Cut (%)**	**Range (%)**	**Cut (%)**
A	0 -<20	50	0 - <30	33.3
B	20 - <50	57	30 - <80	38
C	50 - <75	64	80 - 130	42.7
D	>75	70	>130	46.7
Average cut	Minimum	54	Maximum	36

Appendix C The LTEM Model

Key variables in the LTEM

- **International Trade Policy Variables:-**
  - Import tariffs
  - Trade quotas
  - In-quota tariffs
  - Out-quota tariffs
  - Export subsidies
  - Exogenous variables
- **Exogenous variables**
  - Gross domestic product
  - Country price indexes
  - Population
  - Exchange rates

Main commodities in LTEM

- Wheat
- Maize
- Other grains
- Rice
- Sugar (refined)
- Oilseeds
- Oilseed meals
- Oils
- Beef and Veal
- Pig meat
- Sheep meat
- Poultry meat
- Eggs
- Raw milk
- Liquid/fresh milk
- Butter
- Cheese
- Whole milk powder
- Skim milk powder

Country and region composition of LTEM

- EU (27)
- Argentina
- Brazil
- Paraguay
- Uruguay
- Switzerland
- Norway
- Turkey
- Russian Federation
- USA
- Canada
- Mexico
- Australia
- New Zealand
- Japan
- Korea
- China
- South Africa
- India
- Rest of World

APPENDIX D LTEM Scenario Modelling Assumptions

EU TRQs in baseline 2008 and counterfactual 2020 Base Scenario

Table D.1 shows the baseline tariffs in 2008 for key products in the study which the scenarios on trade concessions address. The bound rates on the Tariff quotas show the fixed ad valorem tariff, and the applied rate is the ad valorem tariff plus any specific import duties denominated in € /tonne converted to an ad valorem equivalent. Hence if the bound tariff is zero and the applied in quota tariff is positive, the latter will represent the ad valorem equivalent of the fixed duty. The levels of non-quota applied tariffs were substantially higher than all in-quota tariffs and on average around double the applied in-quota rates, and for barley, rice, sugar and poultrymeat there would appear to be some binding tariff overhang in relation to the ad valorem bound tariff rates[13].

Table D.1: EU (27) WTO Tariffs, Average Tariff Equivalent Applied Rates in 2008

PRODUCT	WTO Bound TQ RATES		NON QUOTA
	Bound Tariff %	Applied [a] %	Applied %
WHEAT	0%	3.7%	29.4%
BARLEY	8%	7.4%	42.9%
MAIZE	0%	25.6%	48.2%
RICE	15%	0.0%	48.1%
VEG OILS			7.4% [b]
SUGAR	0-24%	1.8%	60.6%
BEEF	20%	20.0%	48.0%
SHEEPMEAT	0%	0.0%	55.9%
PIGMEAT	0%	14.3%	29.3%
POULTRYMEAT	0-15.4%	10.1%	27.6%
DAIRY	0%	23.0%	42.9%

[a] Applied rates include bound tariff rate and specific duties and are trade-weighted tariff rate equivalents; [b] Between 0-12.8%; Source COMSTAT and authors' own calculations

The EU quota fill situation in the 2008 baseline relative to both imports from Mercosur and the rest of the world is illustrated in appendix. Imports of fresh and chilled beef[14] from Mercosur were almost 10,000 tonnes under quota, and Mercosur filled 85 percent of the frozen unallocated beef quota. Mercosur exported almost 74,000 tonnes of frozen beef to the EU (27), around 85 percent of the EU's total frozen beef imports. Over both fresh chilled and frozen categories, EU beef imports relative to quota allocations were about 41,000 tonnes under quota. Non quota fresh and chilled product from Mercosur was over two thirds of the 56,000 tonnes imported from all sources. With no changes to applied out-of quota tariffs, an additional TRQ of 100,000 tonnes allocated to Mercosur might well encompass what would otherwise be out-of quota imports. given that the EU imported 144,000 tonnes of beef from Mercosur of which only 45,000 tonnes were specifically allocated to Mercosur. Whether all the additional quota could be taken up would also depend on how the additional quota were allocated between High Quality/Hilton, other fresh and chilled, frozen and manufacturing qualities, and furthermore, whether the additional quota could be filled in practice would depend on if it was allocated pro rata to each Mercosur country specifically, and/or if it could be redistributed within Mercosur depending on the production circumstances in each country.

[13] This would apply in practice however on specific tariff lines.
[14] Specifically High Quality Beef

For poultrymeat, the additional quota would seem unlikely *a priori* to make a significant difference to EU (27) imports from Mercosur given the substantial total over-quota fill of 220,000 tonnes. It would however, permit opportunity for greater rent capture by Mercosur exporters. The additional quota for wheat does not appear to afford greater export opportunities in reality for Mercosur because there is a large country-non-specific-global quota for which it appeared to be unable to compete at what are low in-quota applied tariff rate. For maize, imports from Mercosur substantially exceed the EU's global unallocated quota of 2.7 million tonnes, and hence the additional quota proposed by the EU is most likely to include some of the existing exported volume, with quota rent potential increased. New TRQs for pork, milk powders, butter and cheese are relatively small, but exports from the Mercosur to the EU (27) for these products are either zero or small, and hence the additional quotas seem unlikely to disturb markets from either the Mercosur or EU perspectives.

Table D.2: EU (27) TRQs, Quota Fill 2008 and proposed additional Mercosur Tariff Quotas

	Mercosur	Non-specific	All Countries	Additional TRQ
BEEF	**tonnes product weight**			
TRQ Fresh-Chilled	45,3009 [a]	1,300	65,250	***100,000***
Quota Imports	35,433		49,269	
Over Quota Fill	***-9,867***		***-15,981***	
Other Imports	38,423		56,081	
TRQ Frozen		107,703	107,703	
Imports	70,581		82,929	
Over Quota Fill			**-24,774**	
SHEEPMEAT				
TRQ Fr., Chilled, Fzn.	*28,800*	*200*	*283,715*	
Imports	*12,213*		*273,472*	
POULTRY				
TRQ Fr., Chilled, Fzn.	11,232	17,619	33,951	**75,000**
Imports	158,572		186,667	
Over Quota Fill	***147,340***		***152,716***	
TRQ Salted	170,807	828	264,245	
Imports	195,464		204,019	
Over Quota Fill	***24657***			
TRQ Processed	171,777	23,039	354,849	
Imports	220,511		428,506	
Over Quota Fill	**48,734**		**73,657**	
TRQ All Poultry	353,816	41,486	653,045	
Imports	574,547		864,000	
Over Quota Fill	***220,731***		***210,955***	
WHEAT				
TRQ		2,721,600	3,332,453	
Imports	13,269		5,525,529	**200,000**
Over Quota Fill			**2,193,076**	
MAIZE				
TRQ		2,742,074	2,742,074	
Imports	8,147,280		9,681,488	**700,000**
Quota Fill			**6,939,414**	
RICE				
TRQ		122,945	124,145	
Imports	174,017		1,640,437	**40,000**
Quota Fill			**1,516,292**	
SUGAR RAW				
TRQ	334,054	86,876	1,735,555	
Imports	997,287		3,925,000	
Quota Fill	**663,233**		**2,189,445**	
PORK	0			**11,000**
MILK POWDER	16			**13,000**
BUTTER	0			**4,000**
CHEESE	0			**20,000**

[a] Includes an additional quota given to Brazil in 2009. Source UN COMSTAT and EC(2004)

Table D.3: EU (27) Tariff rate assumptions under the DDA and EU-Mercosur Trade Scenarios[15]

	Trade Weighted Tariff Rate Equivalents % [(a)]		In Quota Tariff rates % reductions		Average Out of Quota Trade-Weighted Tariff Rates % reductions									
	BASE 2008 All Countries		Non Mercosur	Mercosur	Mercosur Countries					Non Mercosur Countries				
Commodity	Average Applied WTO in-Quota Rates	Out of Quota Applied Rates	DDA Scenarios	EU Merc Scenarios	DDA Lib	DDA Formula	DDA Flex	EU Merc Lib	EU Merc	DDA Lib	DDA Formula	DDA Flex	EU Merc Lib	EU Merc
Beef	20	50	-50	-100	-100	-68	-44	-100	0	-100	-68	-44	0	0
Pigmeat	14	29	-50	-100	-100	-31	-31	-100	0	-100	-31	-31	0	0
Sheepmeat	0	56	0	0	-100	-20	-20	-100	0	-100	-20	-20	0	0
Poultry	10	27	-50	-100	-100	-33	-19	-100	0	-100	-33	-19	0	0
Milk Powder	20	32	-50	-100	-100	-38	-31	-100	0	-100	-38	-31	0	0
Butter & Cheese	38	85	-58	-100	-100	-51	-33	-100	0	-100	-51	-33	0	0
Eggs	9	16	-44	-100	-100	0	0	-100	0	-100	0	0	0	0
Wheat	4	22	-50	-100	-100	-23	0	-100	0	-100	-23	0	0	0
Other Grains	8	43	-50	-100	-100	-37	-26	-100	0	-100	-37	-26	0	0
Maize	0	43	0	0	-100	0	0	-100	0	-100	0	0	0	0
Rice	0	48	0	0	-100	-69	-29	-100	0	-100	-69	-29	0	0
Soybeans	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil & Oilseed Meals	0	1	0	0	-100	0	0	-100	0	-100	0	0	0	0
Sugar	0	80	0	0	-100	-54	-13	-100	0	-100	-54	-13	0	0

[a] Applied rates include specific duties and are trade weighted tariff rate equivalents

[15] Average applied rates and tariff reductions for the EU under the DDA Flex and Formula scenarios and also for other countries in the model, were provided by L Martin (personal communication) and can be provided on request.

Table D.4: EU 2004 Additional Quota Offer to Mercosur: Sensitive Products

Products (tonnes)	Start of EU-Mercosur	Start of DDA	Total Quota Increase
Existing TRQ Products			
High Quality Beef	50,000	50,000	100,000
Poultry Products	45,000	30,000	75,000
Garlic	6,000	4,000	10,000
New TRQ Products			
Maize and Sorghum	400,000	300,000	700,000
Low Quality Wheat	120,000	80,000	200,000
Rice	26,000	14,000	40,000
Cheese	10,000	10,000	20,000
Butter	2,000	2,000	4,000
Milk and Milk Powders	6,500	6,500	13,000
Pigmeat products	6,000	5,000	11,000
Bio-ethanol	600,000	400,000	1,000,000

Source: SICE (2004)