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Food miles: Starving the poor?

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Abstract

Food miles measure the distance food travels to reach consumers' plates. Although substituting local food for imported produce will not necessarily reduce greenhouse gas (GHG) emissions, the food miles movement is widely supported by consumers and import-competing producers. We investigate the economic implications of food miles-induced preference changes in Europe using an economy-wide model. We observe large welfare losses for several Sub-Saharan African nations. We conclude that food miles campaigns will increase global inequality without necessarily improving environmental outcomes.

Key words: food miles, non-tariff barriers, trade protection

JEL codes: F18, D58

1. INTRODUCTION

Sir Nicholas Stern's review of the economics of climate change (Stern, 2006) predicted a bleak future for the global economy if the world fails to cut back emissions of greenhouse gases (GHGs). Against this backdrop, former UK cabinet minister Stephen Byers asserted that flying one kilogram of kiwifruit from New Zealand to Europe generates five kilograms of carbon dioxide. Additionally, in May 2008, celebrity chef Gordon Ramsay stated that restaurants serving out-of-season produce should be fined. The distance food is transported from producers to consumers and the associated environmental damage due to GHG emissions is known as food miles. This concept has received increasing consumer awareness and media attention in Europe and North America.

As food miles ignores GHG emissions associated with food production, it is widely accepted by politicians and scientists that distance travelled is not a good indicator of environmental sustainability. Nevertheless, the simplicity of the concept and advertising campaigns urging consumers to substitute domestic food for imported food raises the possibility of a change in consumer preferences in favour of local produce. We examine the economic consequences of a shift in preferences in the UK, France and Germany (countries where the food miles movement has gained the most momentum) towards food transported shorter distances. Our simulations consider several different relationships between preferences and distance. In all specifications, we find that welfare losses relative to GDP are largest for Sub-Saharan African nations and New Zealand. For some distance-preference shift relationships, welfare losses in some parts of Sub-Saharan Africa are significantly larger than elsewhere. This is because, despite being geographically closer to Europe than several developed countries, African nations such as Malawi export large amounts of agro-food products (relative to GDP) to Europe. These results indicate that some of the world's poorest nations may suffer the most from European food miles campaigns. To our knowledge, the economic implications of the food miles movement have not been investigated elsewhere.

This paper has five further sections. The next section provides an overview of the food miles movement. Section 3 outlines our modelling framework. Section 4 describes the data and details our sources. Section 5 presents our simulation results. The final section concludes.

2. FOOD MILES

The phrase 'food miles' was first coined by British academic Professor Tim Lang in the mid-1990s (Paxton, 1994). Lang describes food miles as the distance that groceries travel to reach consumers' plates. The calculation may include kilometres travelled as food is shipped from farms to processors, from processors to storage depots, from storage depots to vendors, and from vendors to consumers. The clear inference is that the further food has to travel, the worse it is for the environment.

Towards the end of the 1990s, food miles became more widely used, as a variety of economic agents embraced its simplicity when seeking to raise environmental concerns. By 2003-04, news articles on food miles were appearing in UK media on a daily basis. The message in these media articles was unambiguous: one easy way consumers can reduce their carbon footprint (broadly defined as the amount of GHG emissions and associated environmental impact due to their consumption) is to reduce the amount of food in their diets that has travelled long distances. For example, these articles asked: why buy lamb imported 11,000 miles from New Zealand when a perfectly good substitute can be sourced from Wales? Why buy tomatoes freighted to the UK from Spain when similar fruit can be bought from British farms? And why buy Australian wine when you can find something similar from a source closer to home such as France or Italy?

There are several drivers behind the rise in popularity of food miles in the UK and other parts of Northern Europe. These include commercial advertising, food security and lobbying by environmental groups. Farming associations and producers have been the most active promoters of food miles campaigns. For example, the Farmers' Weekly website launched a concerted advertising campaign with the slogan 'Local food is miles better' in 2006. Additionally, a print advertisement by a UK dairy producer showed a picture of a rusting freight ship belching smoke (portraying the pollution caused by transporting butter from New Zealand) alongside a picture of a sun-drenched, thatched traditional farmer's cottage (representing the way that butter is made in the UK).

The concept of 'flower miles', largely aimed at African flora, highlights another important aspect of the food miles debate. Developing countries are often heavily reliant on exports of primary products, and many are located far away from their key export markets. A reduction in purchases of items from developing countries due to food miles concerns could have a significant detrimental effect on agricultural exports from these countries. Kenya has responded to food miles movements with the 'Grown under the sun' campaign, highlighting that Kenyan horticulture uses relatively few energy-intensive inputs compared to European producers (see http://grownunderthesun.com).

Despite the attention received by food miles, reducing purchases of imported food will not necessarily reduce GHG emissions. First, an assessment of the environmental consequences of consuming food from different countries should evaluate GHG emissions during the product's lifecycle, including sowing, growing, harvesting, packaging, storage, transportation and consumption. Second, by considering only distance travelled, food miles do not take into account the GHG efficiency of alternative transport modes. The energy used, and emissions generated, per tonne-kilometre of freight depends on whether food is moved using aeroplanes, ships, trains, heavy goods vehicles, light goods vehicles or household cars. For example, carbon emissions from long haul air freight are over 100 times larger than those from sea freight (Department for Environmental, Food and Rural Affairs, DEFRA, 2001 & 2005; and Mason *et al*, 2002).

Several studies highlight that food miles are an inadequate measure of environmental sustainability. For example, DEFRA (2005, p.v) notes that it can be more sustainable (in energy terms) to import tomatoes from Spain than to produce them in heated greenhouses in the UK. Saunders *et al.* (2006) estimate that, after taking into account transport to the UK, the energy associated with consuming dairy products, lamb, apples and onions from New Zealand is lower than that associated with equivalents from alternative sources. Schlich and Fleissner (2003, p.6) conclude that, when energy use in the production phase is taken into account, New Zealand lamb has lower energy inputs than lamb produced in Germany. Williams (2006) estimates that carbon emissions associated with importing Kenyan roses into the UK are almost six times lower than for roses imported from the Netherlands (where roses are artificially heated), even after accounting for emissions associated with air-freight.

Other research has confirmed that the majority of environmental costs associated with food transportation are generated from domestic rather than international freight. DEFRA (2005) reports that domestic freight accounts for 82 per cent of vehicle kilometres associated with transporting food consumed in the UK. Pretty *et al*. (2005) compare external environmental costs (increased carbon emissions from fossil fuel consumption) of sea and air freight with the total cost (monetary plus environmental costs) for consumption of a representative food basket in the UK. Sea, internal water and air transport account for a ‘trivial’ proportion (0.0002 per cent) of total food costs, and just 0.003 per cent of total food externalities. On the other hand, on-farm externalities, domestic road transport and household shopping trips account for nearly two-thirds of total food externalities. Similarly, a standard British shopping trip of 6.4 kilometres in a large family car to collect 20 kilograms of food uses 25.6 megajoules of energy, the same amount of energy used to transport 20 kilograms of food over 8,500 kilometres by sea (Heyes and Smith, 2008).

The key conclusion in the food miles literature is that reducing the distance that food has to travel does not necessarily reduce its environmental impact, once the emissions generated across the entire production cycle are considered. Indeed, in some circumstances buying locally may increase (and not decrease) global GHG emissions.

Assessing GHG emissions over a product's life cycle is difficult for consumers. If they are to make informed choices, they need to know the GHG footprint of all of the products available to them, and then weigh up environmental costs against other factors such as price, freshness, quality and seasonality. Some UK retailers (Tesco's in particular) have already started to investigate options for 'carbon labelling' that would present this information. They have quickly realised that this is a massive undertaking that requires a considerable amount of scientific research (Adam, 2007). DEFRA, The Carbon Trust and The British Standards Institute have collaborated to develop a Publicly Available Specification (essentially a common, voluntary standard) for measuring the GHG footprint of goods and services. This may, in time, be a basis for widespread retailer carbon labelling.

Despite methodological problems, surveys and media reports from the UK suggest that consumers are increasingly aware of the potential environmental impacts of food purchases, and are looking to purchase more locally-grown food. For example, a UK communications agency found that around 56 per cent of UK consumers are aware of the phrase 'food miles' (Fishburn Hedges, 2007). Furthermore, a survey by a UK online bank indicated that 40 per cent of UK consumers are prepared to pay 10 per cent more for environmentally-friendly goods (those that are organic, recycled or energy efficient). In the same survey, around 71 per cent of people reported that they aimed to reduce their personal carbon footprint by buying more UK-grown fruit and vegetables (Anon., 2008). Furthermore, sales of locally produced food at Waitrose supermarket rose by 58 per cent in 2007-08 (Waitrose, 2008), and 40 per cent at Tesco (Hawkes, 2008).

Although the food miles movement has gained the most momentum in the UK, there is growing awareness of this concept elsewhere. The European Commission (2008) found that 21 per cent of European consumers have bought locally-produced products or groceries in the past for environmental reasons. This figure was higher than the EU average in the UK (30 per cent) and Germany (29 per cent). In the same survey (p. 14), 75 per cent of consumers reported that are prepared to pay a “little bit more” (undefined) for environmentally-friendly products. This figure was higher than the European average in the UK, France and Germany. Our numerical analysis focuses on the economic impacts of food miles-induced preference changes in these nations.

3. MODELLING FRAMEWORK

Despite the finding that the environmental impacts from reducing the distance that food has to travel are often negligible, and even negative, the food miles concept does appear to be changing consumers’ preferences. We analyse the economic impacts of this preference shift using a global, economy-wide model. Our chosen model, ‘GTAP6inGAMS’, draws on the Global Trade Analysis Project (GTAP) database (Dimaranan, 2006) and is programmed using the General Algebraic Modelling System (GAMS). GTAP6inGAMS is a static, perfectly competitive, multi-regional representation of the global economy that determines the production and allocation of goods. Models like GTAP6inGAMS are widely used to evaluate the outcomes of trade policies (see, for example, Francois and Wignaraja, 2008; Grant *et al.*, 2007; Philippidis and Sanjuán, 2007; and Winchester, 2006). We outline the basic structure of the model below. Rutherford (2005) sets out the model in detail.

Important empirical observations not replicated in standard trade models include intra-industry trade and failure of the law of one price for traded goods. Accordingly, imports in GTAP6inGAMS are differentiated by country of origin according to a constant elasticity of substitution (CES) function (i.e., the import demand specification is separable). Composite imports are also differentiated from domestic products using a CES function following Armington (1969). Elasticity parameters for our import specification are sourced from Hertel *et al.* (2007). In general, elasticities of substitution between imports from different sources are twice as large as elasticities governing substitution possibilities between composite imports and domestic goods.

Production technologies exhibit constant returns to scale and product and factor prices adjust to maintain zero profits. Output in each sector is produced by a Leontief nest of an intermediate input composite and a primary factor composite. The intermediate input composite is derived from a further Leontief aggregation of different products (which are themselves composites of domestic and imported varieties).

Expenditure in each region is allocated by a representative consumer. Expenditure shares across savings and government and private spending are constant. Savings is used as a proxy for future consumption, but the stock of capital is fixed. Private expenditure and government expenditure are Cobb-Douglas aggregates of commodities. As with intermediates, commodities entering final demand are composites of imported and domestic varieties.

Turning to closure, factor prices are endogenous, there is full employment, and factors are perfectly mobile across sectors (but immobile internationally). Fiscal balances are achieved by lump sum transfers from private households to governments. The capital account closure stipulates that savings and investment move together, so each region has a constant current account deficit.

We model food miles-induced preference changes using an ‘iceberg’ specification. That is, we assume that a proportion of agro-food commodities exported to active countries melts during transportation. This specification has two interpretations relevant for our analysis. First, the quantity of the product that melts may represent the amount of resources producers must use to persuade consumers to continue to buy the product after the implementation of food miles campaigns. Second, melting can be interpreted as a quality-adjustment by consumers in active countries. Specifically, following the introduction of a food miles campaign, consumers in active countries might value, say, a foreign apple at 80 per cent of its pre-food miles value. We favour the latter interpretation.

Preference changes can be modelled using alternative frameworks. In partial equilibrium settings, Conrad (2005) and Richardson and Stähler (2008) include (variable) social concerns directly in the consumer’s utility function. Nielsen and Anderson (2001), on the other hand, add preference shift parameters to linearised demand functions in a global, economy-wide model. These methods and an iceberg formulation have qualitatively similar impacts on producers. We use an iceberg specification as this framework has a simple interpretation and is commonly used to capture non-tariff barriers (see, for example, Philippidis and Sanjuán, 2007).

We relate iceberg costs to distance using a flexible functional form. The proportion of exports from region *r* to active region *s* that melts during transportation ($\lambda_{r,s}$) is given by:

$$\lambda_{r,s} = \alpha + \beta d_{r,s}^{\rho} \qquad (1)$$

where $d_{r,s}$ is the distant between region *r* and active region *s*, and *α*, *β* and *ρ* are positive parameters.

4. DATA

Version six of the GTAP database identifies 87 regions and 57 commodities. We aggregate the database to form 15 regions and 14 sectors. The composition of regions and sectors identified in our model in terms of components recognised in the GTAP database is highlighted in Table 1. We identify 10 agro-food sectors, forestry, resource based sectors, other manufacturing and services. Our regional aggregation identifies Australia, New Zealand, several Sub-Saharan African regions, countries with active food miles campaigns (the UK, France and Germany – henceforth 'active nation'), and other regions. Our treatment of Sub-Saharan African nations singles out Madagascar and Malawi as Europe is a key export market for these nations. Other African nations, such as Kenya, may also suffer large losses from European food miles campaigns. Unfortunately, both version six and the soon-to-be-released version seven of the GTAP database include Kenya in a composite region. See Wynen and Vanzetti (2008) for a discussion of the impact of food miles on Kenya.

Table 2 displays agro-food exports relative to GDP. Agricultural exports to the UK are highest for (in descending order) Malawi (1.88 per cent of GDP), Rest of South African CU (1.27 per cent) and New Zealand (1.10 per cent). With respect to exports to France, exports-to-GDP ratios are relatively high for Madagascar (3.08 per cent), Malawi (0.76 per cent) and Rest of sub-Saharan Africa (0.57 per cent). Germany, on the other hand, is a relatively important export market for Malawi (3.10 per cent) and New Zealand (0.72 per cent).

Turning to figures for all active nations, significance measures are considerably higher for Malawi and Madagascar, 5.73 per cent and 3.42 per cent respectively, than those for other nations. Moderately high numbers are observed for New Zealand (2.15 per cent), Rest of South African CU (1.91 per cent) and Rest of Sub-Saharan Africa (1.62 per cent). Overall, the data indicate that agro-food exports to active nations are more important for several Sub-Saharan African countries than other countries. As, other factors held constant, food miles preference shifts will have the largest impact on intensive agro-food exporters, this suggests that food miles welfare losses may be most severe in some of the world's poorest nations.

Table 3 reports agricultural exports to active nations by product category relative to total agricultural exports to active nations. Focusing on countries likely to experience the largest losses, New Zealand's agro-food exports to active nations are dominated by meat products (50.8 per cent), vegetables and fruit (18.6 per cent) and dairy products (13.2 per cent). Madagascar's exports to active nations are largely made up of other food products (70.8 per cent), vegetables and fruits (14.9 per cent) and other crops (12.2 per cent). Malawi's agro-food exports to active nations are dominated by other crops (85.9 per cent).

To measure distance, we employ harmonic-mean weighted distance measures available from the Centre D'Etudes Prospectives et D'Informations Internationales (CEPII, see http://www.cepii.fr/anglaisgraph/bdd/distances.htm). Guided by Head and Mayer (2002), CEPII calculate bilateral distance between two countries as a population-weighted average of distances between the major cities belonging to those two countries. For distances between active and composite regions in our analysis, such as Rest of Sub-Saharan Africa and Rest of World, we calculate GDP-weighted averages of distances between each nation included in a composite region and each active nation.

Table 4 reports distances between active nations and other regions identified in our analysis. The data highlight Australia's and, in particular, New Zealand's isolation from Europe. Nearly 19,000 kilometres separates New Zealand from active nations. South Africa, Rest of South African CU, Madagascar and Malawi are about 9,000 kilometres from Western Europe, but these nations are geographically disadvantaged in European markets relative to the US, Rest of Sub-Saharan Africa, Rest of EU and Rest of World.

We examine preference changes in active nations individually and as a group. There is little empirical evidence to guide calibration of our iceberg specification. We choose a "ballpark" melting percentage guided by our earlier observations. In our base simulations, we set $\alpha = 0$, $\rho = 1$ and calibrate β so that $\lambda^{s}_{New\ Zealand}$ is equal to 0.2.[1] As New Zealand is the nation most isolated from active regions, the fraction of exports to active countries from other regions that melts is less than 0.2.

5. SIMULATIONS RESULTS

We measure welfare changes using Hicksian equivalent variation in income, which allows us to quantify the impact of food miles in monetary terms. Reported welfare changes are increments to welfare that can be expected in each and every succeeding year. Equivalent variation in 2001 US dollars and equivalent variation as a fraction of GDP are reported in Tables 5 and 6 respectively. In general, it is not possible to infer welfare changes for nations that experience preference changes (von Weizsäcker, 2005). Purchasing more local produce following food miles campaigns will increase a consumer's utility, but, as the measuring rod used to determine welfare has changed, it is not possible to determine whether the new consumption bundle dominates the pre-food miles consumption bundle. For this reason, we do not report preference changes for active nations.

In all simulations, Japan, South East Asia and Rest of EU experience welfare improvements. Two forces drive this result. First, relative to other regions, especially in the case of Rest of EU, food miles campaigns increase the competiveness of exporters in active regions relative to exporters from other regions. Second, imports become cheaper in Japan, South East Asia and Rest of EU as exports from other nations are diverted away from active countries.

[1] In our 'all active nations' simulation we calibrate β so that the iceberg parameter applying to New Zealand's exports to France (the most distant market) is equal to 0.8.

New Zealand (-0.30), Malawi (-0.28) and Madagascar (-0.12) experience the largest proportional welfare losses when our food miles shock applies to all active nations. As noted above, this result is a function of (a) the distance between these nations and European markets, and (b) the importance of agro-food trade to these economies. To put the numbers into perspective, Winchester (2006) estimates that a free trade agreement between New Zealand and China will increase New Zealand welfare relative to GDP by 0.23 per cent. Rest of South African CU (-0.07) and Rest of Sub-Saharan Africa (-0.04) also experience relatively large welfare decreases when the food miles shock is applied to all active nations.

Turning to results when our food miles shock is applied to each active country individually, New Zealand experiences the largest welfare loss relative to GDP from the UK food miles shock (0.15) and a relatively large welfare decline following the German food miles shock (0.10). Malawi's largest welfare decline occurs for the German food miles shock (0.17) and Madagascar suffers a large welfare decline (0.10) from the French food-miles shock. These findings concur with our qualitative conclusions regarding the relative importance of each active country's market to distant agro-food exporters.

5.1 Sector-specific preference changes

Our base simulations assumed that preference changes were equal across agro-food commodities. However, consumers may apply the food miles concept in a discriminatory fashion across commodities. We consider two alternative cases. First, as food miles campaigns have focused on meat and dairy products, we consider food-miles preference changes for meat and dairy in isolation. Welfare changes relative to GDP, reported in Table 7, reveal that New Zealand is by far the largest loser from such a change in preferences. In all variants of the simulation, New Zealand exports of meat and dairy to active nations decrease by around 75 per cent (not reported in Table 7), and exports to other regions increase. When there are preference changes in all active countries, New Zealand output of meat products falls by about 11 per cent and there is little change in dairy production (not reported in Table 7). This is because active nations are the destination for 51 per cent of New Zealand's meat exports but only 13 per cent of dairy exports. Elsewhere, Madagascar and Malawi are largely unaffected by the shock and Rest of South African CU experiences a moderate welfare loss.

Consumers' perceptions of environmental damage from imported food may also differ across transport modes. Air transportation is many times more carbon intensive that sea transportation, as noted above. Products transported by air in the food miles spotlight include flowers and some types of fruits and vegetables. Cut flowers and several other perishable products are included in 'other crops'. We assume that the preference change for other crops is twice as large as that for other products to investigate preference changes influenced by transport modes. Table 8 reports welfare changes relative to GDP. When there are preference changes in all active countries, the decrease in New Zealand's welfare is similar to that in our base simulation, but the decrease in Malawi's welfare is nearly twice as large as that in Table 6. Moreover, Malawi's proportional welfare decrease is significantly larger than that for New Zealand, or any other nation. Welfare reductions for Madagascar and Rest of Sub-Saharan Africa are also moderately larger in Table 8 than in our base simulations.

5.2 Alternative distance-preferences relationships

Consumers in active nations may consider imported food to be harmful independent of distance travelled. We vary the value α to gauge the impact of anti-import preference changes that are similar across sources. We continue to calibrate β so that 20 per cent of New Zealand's exports to active nations melt (and ρ equals one) and consider preference changes in all active nations for all products. Welfare changes relative to GDP for alternative values of α are reported in Table 9. By design, results in the second column of Table 9 (α = 0) are identical to those in the final column of Table 6. As α increases, food miles-related preference shifts are more similar across countries. When α = 0.2 all nations face the same iceberg costs (i.e., β = 0). The numbers reveal that, as might be expected, welfare losses in geographically distant countries are smaller as α increases. Consequently, for relatively small values of α the welfare loss in Malawi, relative to GDP, is larger than that in New Zealand. Increasing α also increases the relative welfare loss in Rest of Sub-Saharan Africa.

Alternatively, consumers may assume there is a nonlinear relationship between distance and environmental damage. When ρ is less (greater) than one, the marginal impact of distance decreases (increases) as distance increases. Welfare changes for alternative values of ρ when α = 0 and β is calibrated in the usual way are reported in Table 10. We consider preference changes in all active nations for all products. By design, when ρ = 1 the results are the same as in our base simulation. Welfare reductions in nations relatively close to Europe, including Sub-Saharan African regions, are larger as ρ decreases. When ρ = 0.3, Malawi experiences a much larger welfare reduction than other regions. Conversely, food miles movements have a smaller impact on Sub-Saharan African nations and a larger influence on distant nations such as New Zealand when ρ is greater than one.

6. CONCLUSIONS

We considered the impact of changes in preferences in several European countries against imported agro-food commodities. We considered food miles shocks in the UK, France and Germany as food miles campaigns are most active in these nations. The impact of food miles movements on other nations depends on the importance of agro-food commodities to each economy and each nation's distance from Europe. Although there is some uncertainty concerning the nature of food miles-induced preference changes, the largest losers from declining demand for imported food, in a relative sense, include Sub-Saharan African nations, such as Malawi and Madagascar, and New Zealand. With the exception of New Zealand, this finding indicates that some of the world's poorest nations will suffer the most from European food miles lobbying. Furthermore, due to the relatively large proportion of African agro-food commodities transported by air, we found that welfare losses in Sub-Saharan Africa may be particularly severe if European preference changes are largest for agro-food commodities imported using carbon-intensive transportation modes.

The Doha Development Agenda seeks to place the needs and interests of developing countries at the forefront of multilateral trade negotiations (WTO, 2001). Our findings indicate that food miles campaigns will oppose this objective. Furthermore, there is no guarantee that substituting local food for imported produce will improve environmental outcomes.

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Table 1: Regional and commodity aggregation

	Regions		Commodities
1.	**New Zealand**	1.	**Vegetables, fruits and nuts**
2.	**Australia**	2.	**Animal products** Bovine cattle, sheep and goats, horses; animal products not elsewhere classified (nec)
3.	**United States**	3.	**Raw milk**
4.	**Japan**	4.	**Wool**
5.	**South East Asia** China, Hong Kong, Indonesia, Malaysia, Philippines, Singapore, Taiwan, Thailand, Vietnam, Rest of South East Asia	5.	**Other crops**
6.	**South Africa**	6.	**Other agriculture** Paddy rice; wheat; cereal grains; oil seeds; sugar cane, sugar beet; plant-based fibres; fishing
7.	**Rest of South African Custom Union** Botswana, Rest of South African Customs Union	7.	**Meat products** Bovine meat products; meat products nec
8.	**Madagascar**	8.	**Dairy products**
9.	**Malawi**	9.	**Other food products**
10.	**Rest of Sub-Saharan Africa** Botswana, Mozambique, Tanzania, Zambia, Zimbabwe, Rest of South African Development Community, Uganda, Rest of Sub-Saharan Africa	10.	**Miscellaneous food products** Vegetable oils and fats; processed rice; sugar; beverages and tobacco products
		11.	**Forestry**
		12.	**Resource based sectors** Coal; oil; gas; minerals nec
11.	**United Kingdom**	13.	**Other manufacturing** Textiles; wearing apparel; leather products; wood products; paper products, publishing; petroleum, coal products; chemical, rubber, plastic products; mineral products nec; ferrous metals; metal nec; metal products; motor vehicles and parts; transport equipment nec; electronic equipment; machinery and equipment nec; manufacturing nec
12.	**France**		
13.	**Germany**		
14.	**Rest of EU** Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Italy, , Latvia, Lithuania, Luxemburg, Malta, Netherlands, , Poland , Portugal, Slovakia, Slovenia, Spain, Sweden		
15.	**Rest of World (ROW)** All other regions	14.	**Services** Electricity; gas manufacture, distribution; water; construction; trade; transport nec; water transport; air transport; communication; financial services nec; insurance; business services nec; recreational and other services; public administration, defence, education, health; dwellings

Table 2: Agro-food exports to active countries relative to GDP, per cent

	UK	France	Germany	All active nations
Australia	0.19	0.04	0.06	0.29
New Zealand	1.10	0.33	0.72	2.15
United Sates	0.01	0.00	0.01	0.03
Japan	0.00	0.00	0.00	0.00
South East Asia	0.04	0.03	0.06	0.13
South Africa	0.44	0.12	0.19	0.75
Rest of South African CU	1.27	0.45	0.19	1.91
Madagascar	0.05	3.08	0.29	3.42
Malawi	1.88	0.76	3.10	5.73
Rest of Sub-Saharan Africa	0.63	0.57	0.41	1.62
United Kingdom	-	0.10	0.06	0.16
France	0.26	-	0.32	0.58
Germany	0.10	0.15	-	0.25
Rest of EU	0.32	0.36	0.59	1.28
Rest of World	0.08	0.07	0.10	0.25

Source: GTAP 6 Database (Dimaranan 2006)

Table 3: Agricultural exports to the UK, France and Germany by product relative to total agricultural exports, per cent

	Vegetables etc	Animal products	Raw milk	Wool	Other crops	Other agriculture	Meat products	Dairy products	Other food products	Misc food products
Australia	2.9	1.9	0.0	14.6	1.0	4.5	11.6	4.8	4.3	54.6
New Zealand	18.6	2.4	0.0	6.3	0.5	0.2	50.8	13.2	2.6	5.5
United Sates	16.7	7.3	0.0	0.1	14.3	11.9	4.0	1.6	22.8	21.3
Japan	1.9	18.2	0.0	0.1	10.1	5.0	13.4	1.0	38.1	12.4
South East Asia	8.4	8.3	0.0	0.1	23.0	4.8	12.7	0.1	29.6	12.9
South Africa	55.0	0.9	0.0	2.3	8.6	0.8	2.7	0.1	6.7	22.9
Rest of South African CU	3.6	1.6	0.0	0.2	0.9	0.8	47.8	0.2	12.1	32.7
Madagascar	14.9	0.4	0.0	0.0	12.2	0.5	0.0	0.0	70.8	1.3
Malawi	1.2	0.1	0.0	0.0	85.9	0.9	0.0	0.0	0.4	11.5
Rest of Sub-Saharan Africa	19.7	1.2	0.0	0.1	40.9	5.0	1.0	0.1	20.9	11.0
United Kingdom	1.2	3.5	0.0	0.3	2.7	8.1	10.3	7.6	35.1	31.2
France	9.8	2.0	0.0	0.0	2.1	9.5	11.7	12.4	21.1	31.2
Germany	2.7	2.1	0.0	0.1	3.8	3.2	14.3	12.3	42.4	19.1
Rest of EU	16.8	2.9	0.0	0.1	7.3	2.8	17.4	10.6	26.6	15.4
Rest of World	19.7	3.2	0.2	0.5	14.5	12.0	6.7	2.2	29.2	11.7

Source: GTAP 6 Database (Dimaranan 2006).

Table 4: Distances between regions, kilometres

	United Kingdom	France	Germany
Australia	16,602	16,513	15,935
New Zealand	18,521	18,894	18,220
United Sates	6,878	7,457	7,595
Japan	9,436	9,803	9,086
South East Asia	9,295	9,427	8,771
South Africa	9,489	8,770	9,111
Rest of South African CU	8,675	8,313	8,480
Madagascar	9,265	8,582	8,666
Malawi	8,204	7,492	7,701
Rest of Sub-Saharan Africa	5,996	5,867	5,902
United Kingdom	-	750	809
France	750	-	790
Germany	809	790	-
Rest of EU	1,277	1,049	1,008
Rest of World	6,128	6,182	6,262

Source: Based on distance data from http://www.cepii.fr/anglaisgraph/bdd/distances.htm.

Table 5: Global welfare changes (equivalent variation, 2001 US dollars, million)

Preference changes in:	UK	France	Germany	All active nations
Australia	-44.4	-13.7	-19.2	-76.0
New Zealand	-67.3	-21.4	-45.5	-135.4
United Sates	-280.5	-81.2	-129.5	-486.6
Japan	66.4	23.1	39.6	128.1
South East Asia	133.7	29.8	29.5	193.4
South Africa	-9.8	-1.5	-5.3	-15.9
Rest of South African CU	-5.7	-1.2	-0.1	-6.8
Madagascar	-0.4	-4.4	-0.6	-5.4
Malawi	-1.2	-0.7	-2.7	-4.4
Rest of Sub-Saharan Africa	-29.1	-27.4	-22.2	-77.4
United Kingdom	-	-10.6	-16.0	-
France	67.4	-	28.3	-
Germany	68.2	26.1	-	-
Rest of EU	148.2	65.7	147.3	358.1
Rest of World	-43.0	-66.4	-105.6	-208.3

Source: Authors' simulations as described in the text.

Table 6: Global welfare changes (equivalent variation relative to GDP, per cent)

Preference changes in:	UK	France	Germany	All active nations
Australia	-0.014	-0.004	-0.006	-0.023
New Zealand	-0.149	-0.047	-0.101	-0.299
United Sates	-0.003	-0.001	-0.001	-0.005
Japan	0.002	0.001	0.001	0.004
South East Asia	0.006	0.001	0.001	0.008
South Africa	-0.010	-0.001	-0.005	-0.016
Rest of South African CU	-0.057	-0.012	-0.001	-0.069
Madagascar	-0.008	-0.098	-0.014	-0.119
Malawi	-0.073	-0.042	-0.168	-0.279
Rest of Sub-Saharan Africa	-0.017	-0.016	-0.013	-0.044
United Kingdom	-	-0.001	-0.001	-
France	0.006	-	0.002	-
Germany	0.004	0.002	-	-
Rest of EU	0.004	0.002	0.004	0.011
Rest of World	-0.001	-0.001	-0.002	-0.004

Source: Authors' simulations as described in the text.

Table 7: Global welfare changes (equivalent variation relative to GDP, per cent), preference changes for meat and dairy products only

Preference changes in:	UK	France	Germany	All active nations
Australia	-0.003	-0.001	-0.002	-0.006
New Zealand	-0.108	-0.045	-0.072	-0.227
United Sates	-0.001	0.000	-0.001	-0.002
Japan	0.001	0.000	0.000	0.001
South East Asia	0.002	0.001	0.001	0.004
South Africa	0.002	0.000	0.001	0.003
Rest of South African CU	-0.058	-0.003	-0.004	-0.064
Madagascar	-0.002	-0.001	-0.001	-0.004
Malawi	0.001	0.000	0.000	0.001
Rest of Sub-Saharan Africa	-0.002	-0.001	-0.001	-0.004
United Kingdom	-	0.000	0.000	-
France	0.001	-	0.001	-
Germany	0.001	0.001	-	-
Rest of EU	0.001	0.000	0.000	0.001
Rest of World	0.000	0.000	0.000	0.000

Source: Authors' simulations as described in the text.

Table 8: Global welfare changes (equivalent variation relative to GDP, per cent), double preference changes for other crops

Preference changes in:	UK	France	Germany	All active nations
Australia	-0.014	-0.004	-0.006	-0.024
New Zealand	-0.149	-0.047	-0.101	-0.300
United Sates	-0.003	-0.001	-0.001	-0.005
Japan	0.002	0.001	0.001	0.004
South East Asia	0.006	0.001	0.001	0.008
South Africa	-0.013	-0.002	-0.006	-0.020
Rest of South African CU	-0.055	-0.011	0.000	-0.066
Madagascar	-0.008	-0.112	-0.017	-0.138
Malawi	-0.132	-0.077	-0.327	-0.532
Rest of Sub-Saharan Africa	-0.023	-0.021	-0.020	-0.064
United Kingdom	-	-0.001	-0.001	-0.133
France	0.006	-	0.003	-0.070
Germany	0.004	0.002	-	-
Rest of EU	0.005	0.002	0.006	0.013
Rest of World	-0.001	-0.002	-0.003	-0.006

Source: Authors' simulations as described in the text.

Table 9: Welfare changes (equivalent variation relative to GDP, per cent) for alternative values of α when there are food miles changes in all active nations, per cent (ρ = 1)

	α					
	0	**0.04**	**0.08**	**0.12**	**0.16**	**0.20**
Australia	-0.023	-0.021	-0.018	-0.014	-0.011	-0.007
New Zealand	-0.299	-0.273	-0.241	-0.204	-0.161	-0.110
United Sates	-0.005	-0.004	-0.004	-0.003	-0.002	-0.001
Japan	0.004	0.003	0.003	0.002	0.001	0.001
South East Asia	0.008	0.007	0.005	0.003	0.000	-0.002
South Africa	-0.016	-0.014	-0.012	-0.010	-0.007	-0.005
Rest of South African CU	-0.069	-0.069	-0.069	-0.069	-0.070	-0.071
Madagascar	-0.119	-0.113	-0.107	-0.099	-0.091	-0.082
Malawi	-0.279	-0.272	-0.265	-0.258	-0.250	-0.243
Rest of Sub-Saharan Africa	-0.044	-0.046	-0.048	-0.050	-0.052	-0.054
Rest of EU	0.011	-0.002	-0.015	-0.028	-0.041	-0.054
Rest of World	-0.004	-0.005	-0.006	-0.007	-0.008	-0.009

Source: Authors' simulations as described in the text.

Table 10: Welfare changes (equivalent variation relative GDP, per cent) for alternative values of ρ when there are food miles changes in all active nations, per cent (α = 0)

	ρ				
	0.3	**0.7**	**1**	**1.3**	**1.6**
Australia	-0.020	-0.023	-0.023	-0.023	-0.023
New Zealand	-0.257	-0.287	-0.299	-0.305	-0.308
United Sates	-0.004	-0.005	-0.005	-0.005	-0.005
Japan	0.003	0.003	0.004	0.004	0.003
South East Asia	0.005	0.007	0.008	0.009	0.010
South Africa	-0.022	-0.020	-0.016	-0.010	-0.006
Rest of South African CU	-0.088	-0.081	-0.069	-0.056	-0.044
Madagascar	-0.141	-0.135	-0.119	-0.102	-0.086
Malawi	-0.361	-0.332	-0.279	-0.226	-0.179
Rest of Sub-Saharan Africa	-0.067	-0.056	-0.044	-0.034	-0.025
Rest of EU	-0.003	0.008	0.011	0.010	0.009
Rest of World	-0.009	-0.007	-0.004	-0.003	-0.001

Source: Authors' simulations as described in the text.