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An empirical evaluation of food miles-based preference changes

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Preface

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Authorship and acknowledgements

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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 an intuitively appealing idea to consumers and supported by import-competing producers.

We investigate the economic implications of food miles-induced preference changes in Europe using a global, economy-wide model. We observe large welfare losses for New Zealand and several Sub-Saharan African nations. This suggests that food miles campaigns will increase global inequality without necessarily improving environmental outcomes.

We then consider the implications of our results for New Zealand businesses and government agencies. We conclude that there is an ongoing requirement for careful monitoring of offshore consumer trends and that New Zealand firms need to demonstrate their sustainability credentials to avoid suffering negative demand shocks.

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

JEL codes: F18, D58

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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 now 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. To our knowledge, the economic implications of the food miles movement have not been empirically investigated elsewhere.

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. New Zealand's reliance on primary exports and its distance from major markets also results in relatively large welfare losses.

This paper is structured as follows. The next section provides an overview of the food miles movement. Section 3 outlines our general equilibrium modelling framework. Section 4 describes the data and details our sources. Section 5 presents our central simulation results and a sensitivity analysis. Section 6 concludes and considers some implications for businesses and policymakers, with a focus on New Zealand.

2. Overview of food miles

2.1 A brief history

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 associated with their purchases and the 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 protectionism, commercial advertising, food security and lobbying by environmental groups.

- **Protectionism**: Farming associations have been at the centre of efforts to promote the purchase of locally-produced food (at supermarkets and at farmers' markets) over imported products. The UK Farmers' Weekly website launched a concerted food miles advertising campaign with the slogan "Local food is miles better" in 2006.[1] This campaign aimed to tap into the UK's long-standing emotional attachment to the rural sector, where farming is seen as a traditional lifestyle. This campaign has been labelled 'protectionism in disguise' by some New Zealand Ministers concerned about its impact on trade flows and global emissions.[2]

- **Commercial**: Sensing that there was growing consumer awareness of the distance travelled by, and environmental impact of, food, some UK producers launched their own advertising campaigns highlighting the perceived environmental evils of imported food. In 2006 a print advertisement by a UK dairy producer showed a picture of a

[1] See http://www.fwi.co.uk/gr/foodmiles/index.html.

[2] New Zealand's Trade Minister suggested that "calls for food miles to be used in fact contradict the goal of reducing global emissions and are often a thinly disguised appeal for self-interested protectionism". (See http://www.beehive.govt.nz/release/food+miles+claims+miss+target) Also New Zealand's Agriculture Minister's commented that "[food miles] is being used in Europe by self interested parties trying to justify protectionism in another guise".

rusting freight ship belching smoke (supposedly portraying the pollution caused by transporting butter from New Zealand) alongside a picture of a sun-drenched, thatched traditional farmer's cottage (supposedly representing the way that butter is made in the UK).[3] The caption asked readers why they would want to buy butter that has been transported 11,000 miles when they could purchase a similar product from local sources.

- **Food security**: Food security has always been a concern of some portions of society in the post-War era, due to the shortage of food available in the World Wars. There is thus reluctance in some quarters to become overly reliant on other countries for essential food items and that a shift to greater self-sufficiency in food production would be a good idea.[4]

- **Environmental**: As the concept of food miles became more commonly used, environmental lobby groups and NGOs adopted the idea and suggested that households could reduce their carbon footprint by reducing their imports of foodstuffs and buying more locally produced items.[5] As outlined below, this simple assertion is misplaced, but for households wanting to be seen to 'do their bit' to combat climate change, it seems like a fairly intuitive and easy thing to do.

A combination of these various drivers resulted in food miles becoming an increasingly oft-used expression amongst media, consumers and retailers in the UK in particular.

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.[6]

2.2 Why might New Zealand be concerned about food miles?

Despite the clear flaws in the concept of food miles as a measure of environmental sustainability (as outlined below in section 2.3), New Zealand has a significant interest in how food miles and other sustainability-related issues develop in countries such as the UK, Germany and France, for the following reasons:

- Despite the diversification of the New Zealand economy in recent decades, the primary sector remains central to New Zealand's economic prospects.

[3] See http://www.foodanddrinkeurope.com/news/ng.asp?n=69206-dairy-crest-anchor-butter.

[4] See, for example, http://www.go-self-sufficient.com/ containing comments such as "in wartime, when the sea lanes were under attack, the country nearly starved."

[5] Saunders et al. (2006, p4) note that "The Women's Environmental Network went as far as to say that importing apples from New Zealand is 'insanity'".

[6] See http://grownunderthesun.com.

- Nearly 55% of New Zealand's merchandise exports are related to food and beverages (Statistics New Zealand, 2008).

- The UK, Germany and France account for over $2.2 billion of food and beverage exports (Statistics New Zealand, 2008) – over 10% of New Zealand's total food and beverage exports.

- There is no escaping that New Zealand is the most geographically-distant developed country from the UK. Any goods transported from New Zealand must travel a long way to market. And some of these exported goods compete with domestically produced items and/or similar items transported shorter distances, such as lamb, apples and dairy products.

- Inbound tourism is also an important source of export earnings (around as large as the New Zealand dairy export sector) and could also be negatively affected if consumers start to avoid long-haul air travel due to concerns over the GHG emitted during these flights.

Therefore New Zealand has tended to be portrayed as the 'poster child' of food miles – if a European journalist is looking to run a story along the lines of "Why buy good X from far-away country Y when you could buy something similar that is produced locally and thus reduce your food miles?", then New Zealand has often been used as Country Y.

2.3 Catchy phrase, flawed concept[7]

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 & 2008; 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, even after taking into account transport to the UK, the energy associated with consuming dairy products, lamb, apples and onions from New Zealand is still 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

[7] We would like to thank Neil Fraser of MAF for this characterisation of food miles.

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.

2.4 Consumer preferences

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.[8] Some UK retailers (Tesco 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

[8] It might be expected that in the current economic environment in the UK, the importance of prices in consumers' food purchasing processes would rise, and more peripheral concerns such as the sustainability of their purchases might be less vital.

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[9]

3.1 Introduction

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.

3.2 Structure of GTAP 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.

GTAP6inGAMS takes into account several important empirical observations that are not replicated in standard trade models. These include intra-industry trade and the 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

[9] Readers interested in the results rather than the specifics of the methodology may wish to move ahead to section 5.

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.

3.3 Specification of preference change scenarios

We model food miles-induced preference changes using an 'iceberg' specification. That is, we assume 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:

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

where

$d_{r,s}$ is the distant between region *r* and active region *s*

α, β and ρ are positive parameters.

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 it is equal to 0.2. 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. We go on to consider a range of values for these parameters, reflecting the fact that the extent and nature of food miles-related preference changes are not yet easy to identify with any certainty.

4. Data

4.1 GTAP database

Version 6 of the GTAP database identifies 87 regions and 57 commodities and is a representation of the global economy in 2001. For computational ease, 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 7 (Annex). 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 nations'), and other nations.

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 6 and the recently-released version 7 of the GTAP database place Kenya in a composite region.[10] See Wynen and Vanzetti (2008) for a discussion of the impact of food miles on Kenya.[11]

[10] Version 7 of the GTAP database was released after this paper was drafted. It updates the global economy to a 2004 base year and contains 113 regions, compared to 87 in version 6. It is unlikely that running our simulations using version 7 would make a significant difference to the direction and percentage change of the results, although the levels may change somewhat.

[11] The issue is well – albeit melodramatically – summarised by the following: "In floppy hats and gumboots, Kenya's Kikuyu farmers are preparing for war. There isn't an AK-47 in sight, though there

As the impacts of food miles preference changes will be highly dependent on the share of agriculture in an exporting country's economy and the distance that country is from key markets, we provide some background information on these two considerations below.

4.2 Agro-food trade shares

Table 1 displays agro-food exports relative to GDP – a measure of how important agriculture is to a country's economy. 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 (the sum of UK, France and Germany), 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 food miles preference shifts impact more heavily on countries that are further away and/or on countries with high proportion of agro-food exports, this suggests that food miles welfare losses may be most severe in some of the world's poorest nations. New Zealand also stands out as having an unusual industry structure compared to most developed nations, with agriculture accounting for a much larger share of the economy than in most OECD countries.

are plenty of organic cucumbers, carrots, French beans and cauliflowers. It's a battle over who is to blame for climate change – poor African farmers who export their food by air, or Western consumers who care about food miles" (Hartley, 2007).

Table 1 Agro-food exports to active countries
Share of 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 States	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 v6 database (Dimaranan 2006)

Table 2 reports agricultural exports to active nations by product category relative to total agricultural exports to active nations. Focusing on countries likely to be most affected by food miles preference shifts, New Zealand's agro-food exports to active nations are dominated by meat products (50.8 per cent, largely lamb[12]), vegetables and fruit (18.6 per cent, largely apples and onions) 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, largely coffee), vegetables and fruits (14.9 per cent, largely vanilla and cloves) and other crops (12.2 per cent). Malawi's agro-food exports to active nations are dominated by other crops (85.9 per cent, largely tobacco and sugar).

[12] See Statistics New Zealand (2008) for a comprehensive overview of New Zealand's merchandise trade profile and other international linkages (services, investment, migration, etc).

Table 2 Agricultural exports to the UK, France and Germany by product

Share of 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 States	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 v6 database (Dimaranan 2006)

4.3 Distance from markets

To measure distance, we employ harmonic-mean weighted distance measures available from the Centre D'Etudes Prospectives et D'Informations Internationales (CEPII).[13] 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 composite nation and each active nation.

Table 3 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.

Table 3 Distances between regions
Kilometres

	United Kingdom	France	Germany
Australia	16,602	16,513	15,935
New Zealand	18,521	18,894	18,220
United States	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.

[13] See http://www.cepii.fr/anglaisgraph/bdd/distances.htm.

5. Simulation results

We measure welfare changes using Hicksian equivalent variation in income, which allows us to quantify the impact of food miles preference shifts in monetary terms.[14] Reported welfare changes are increments to welfare that can be expected in each and every succeeding year. Equivalent variation as a fraction of GDP is reported in Table 4 below.[15,16]

Table 4 Global welfare changes
Equivalent variation relative to GDP, per cent

Preference change in:	United Kingdom	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 States	-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' calculations

New Zealand (-0.30 per cent), Malawi (-0.28) and Madagascar (-0.12) experience the largest proportional welfare losses when our food miles shock applies to all active

[14] In the context of our analysis, equivalent variation measures the amount of money required to maintain a country's satisfaction, or economic welfare, at the level it would be at after the introduction of food miles related preference shifts in major European markets.

[15] Note that 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 is it not possible to determine whether the new consumption bundle dominates the pre-food miles consumption bundle. For this reason, we do not report own-country preference changes for active nations.

[16] The results are presented in levels terms (millions of US dollars) in Table 8 (see Annex).

nations.[17] 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. 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.

In all simulations, Japan, South East Asia and Rest of EU experience small 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 competitiveness of exporters in active regions relative to exporters from other regions. Second, imports become cheaper in Japan, South East Asia and the rest of the EU as exports from other nations are diverted away from active regions (i.e. agro-food exporters seek to supply more to countries which are less concerned about food miles).

This latter point is reinforced when the results for changes in exports to key markets are considered.[18] For example, New Zealand's agro-food exports to the UK, France and Germany drop substantially once food miles preference shifts are introduced. However, these exports are re-directed towards other markets such as the US, Asia and the rest of the EU, with the result that overall agro-food exports from New Zealand are not significantly decreased.

5.1 Sector-specific preference changes

Our base simulations assumed that preference changes were equal across agro-food commodities (i.e. that concerns over food miles apply in the same proportions for lamb, apples, wine, dairy products, etc). However, it is possible that consumers may apply the food miles concept in a discriminatory fashion across types of commodities, so some products may be more susceptible than others to preference shifts regarding food miles.

We consider two alternative sector-specific cases:

(i) Preference changes for meat and dairy only

(ii) Preference changes that are stronger for air-freighted products

[17] 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.

[18] These results not shown but are available upon request from authors.

5.1.1 Meat and dairy preference changes

As food miles campaigns have largely 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 5, 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 5), 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 5). 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.

Table 5 Global welfare changes: preference changes for meat and dairy products only
Equivalent Variation relative to GDP, per cent

Preference change in:	United Kingdom	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 States	-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' calculations

5.1.2 Preference changes differentiated by transport mode

Consumers' perceptions of environmental damage from imported food may also differ across transport modes. Air transportation is many times more carbon intensive than sea transportation, as noted above in section 2.3. 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 agri-food products to investigate preference changes influenced by transport modes.

Table 6 reports welfare changes relative to GDP. When there are preference changes differentiated by transport modes in all active countries, the decrease in New Zealand's welfare is similar to that in our base simulation. This is not surprising as the vast majority of New Zealand's agri-food exports are sea-freighted to Europe, rather than being air-freighted, and New Zealand's exports of 'other crops' are relatively low as a share of total exports.

This scenario has a much more significant effect on the Sub-Saharan African countries in our model. The decrease in Malawi's welfare (see Table 6) is nearly twice as large as that in the base scenario (Table 4 above). 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 6 than in our base simulations.

Table 6 Global welfare changes: double preference changes for other crops

Equivalent Variation relative to GDP, per cent

Preference change in:	United Kingdom	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 States	-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' calculations

5.2 Alternative distance-preferences relationships

Consumers in active nations may also consider imported food to be harmful independent of distance travelled. That is, once the distance travelled by food crosses a certain threshold (say, 1,000 kilometres), it is deemed to be imported from "a long way away" and then not differentiated at the margin. To consider this possibility, we vary the value of 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 (Annex).

By design, results in the second column of Table 9 (α = 0) are identical to those in the final column of Table 4. 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 (Annex). 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 and implications

We evaluated 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. The key conclusions and implications of our analysis, with a focus on New Zealand's interests, are as follows.

Developing countries and developed country food exporters will suffer welfare losses from rich-country food miles campaigns

It is uncertain how much preferences change due to the food miles movement. The magnitude of the modelling results can thus only be interpreted as indicative. But it is

clear that New Zealand is one of the largest losers from declining demand for imported food, in a relative sense, alongside Sub-Saharan African nations, such as Malawi and Madagascar. 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.

It is possible that consumers in countries with food miles campaigns will experience welfare gains which may offset the losses demonstrated in our modelling exercise. The extent of these welfare gains depends largely on the degree to which these consumers derive utility from buying – in their eyes – better 'quality' food and feeling less guilty about the environmental impact of the food that they are purchasing, even if this guilt is misplaced. However, even if welfare did improve in these countries, food miles campaigns could be seen to increase global income equality, with some developed nations becoming better off at the expense of some developing nations.

In addition to imposing economic costs, food miles campaigns are unlikely to deliver environmental benefits

Previous research has shown that there is no guarantee that substituting local food for imported produce will reduce overall GHG emissions and thus improve environmental outcomes. Therefore food miles campaigns cannot be assumed to deliver environmental benefits. Our results indicate that food miles campaigns may also generate non-trivial economic costs for a number of agri-food exporters. Aside from New Zealand, these costs are likely to be imposed on agriculture-dependant developing countries. Interestingly, it is these very countries that have benefited from other developed country ethical consumer campaigns such as 'Fair Trade', so there may be conflicting pressures on ethically-aware and environmentally-conscious supermarket shoppers. It may prove difficult for shoppers to support African economic development *and* reduce their carbon footprints at the same time. Consumers will not have the same guilt pangs regarding New Zealand's welfare loss however.

Efforts to correct misperceptions about the environmental impact of New Zealand's food exports have been worthwhile

When food miles began to gain prominence as a concept, considerable efforts were made in New Zealand to thwart the misconceptions and risks to exporters. The results indicate that the effort that New Zealand government agencies, politicians and businesses have put into demonstrating the flaws in the concept of food miles as a measure of environmental sustainability has been beneficial. If the concept had not been robustly challenged, it is possible that consumers in key markets would have made more significant changes to their food purchasing behaviour than has been witnessed. This could have resulted in a non-trivial drop in New Zealand's economic welfare.

The results also point to the need for businesses, supported by their industry bodies and government agencies, to continue monitoring developments in consumer demand as they

relate to sustainability matters. Spotting and then responding at an early stage to "the next food miles" with scientific and empirical evidence will reduce the risk that New Zealand's exporters are negatively impacted upon by erroneous pseudo-environmental concepts.

Consumer preferences for sustainable products do matter for New Zealand exporters

While sustainability factors may not currently be the top priority for either domestic or overseas consumers right now (relative to other more pressing economic concerns), they will re-emerge strongly in the medium term. Our analysis shows that the potential economic impacts of sustainability-related demand shifts could be significant. Preferences have – and will likely continue to – change as major retailers and consumers become more aware of the sustainability credentials of the products that they purchase. This suggests that New Zealand firms will need to continue to invest in measuring, monitoring, reducing and then communicating the environmental footprint of their products, as export income is at stake.

The New Zealand government can support industry on sustainability-related matters

In some ways the types of consumer preference shifts that we have outlined in this report are simply a new market consideration to which New Zealand firms have to be prepared to respond.

But there is a case to be made for the New Zealand government to support New Zealand firms on issues related to sustainability. The justification comes from:

- Lack of consumer understanding of the true environmental impacts of their purchasing decisions (an information problem).
- The high fixed cost for individual firms seeking to garner information on overseas consumer demand trends. Current examples of such support are MAF's Greenhouse Gas Footprinting Strategy[19] and MFAT and NZTE's overseas market intelligence gathering and dissemination projects[20].
- The need for negotiation on policy measures and effective campaigns to rectify consumer perceptions across our export markets that will benefit whole sectors, not just individual firms.

For example, on the latter point New Zealand's officials have a role to play in working with overseas government to ensure that any policy measures (such as food miles taxes or border tax adjustments based on the GHG-intensity of imported products) introduced to deliver environmental benefits do not unfairly discriminate against products that are transported long distances to market. Ongoing attention to the role of sustainability issues in multilateral, regional and bilateral trade negotiations should also remain a focus.

[19] See http://www.maf.govt.nz/climatechange/slm/ghg-strategy/.

[20] See http://www.marketnewzealand.com/MNZ/services/14703.aspx.

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Appendix A Additional tables

Table 7 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	5	Other crops
	China, Hong Kong, Indonesia, Malaysia, Philippines, Singapore, Taiwan, Thailand, Vietnam, Rest of South East Asia		
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 Africa Customs Union	7	Meat products
	Botswana, Rest of South African Customs Union		Bovine meat products; meat products nec
8	Madagascar	8	Dairy products
9	Malawi	9	Other food products
10	Rest of Sub-Saharan Africa	10	Miscellaneous food products
	Botswana, Mozambique, Tanzania, Zambia, Zimbabwe, Rest of South African Development Community, Uganda, Rest of Sub-Saharan Africa		Vegetable oils and fats; processed rice; sugar; beverages and tobacco products
11	United Kingdom	11	Forestry
12	France	12	Resource-based sectors
			Coal; oil; gas; minerals nec
13	Germany	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
14	Rest of EU	14	Services
	Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Italy, , Latvia, Lithuania, Luxemburg, Malta, Netherlands, , Poland , Portugal, Slovakia, Slovenia, Spain, Sweden		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
15	Rest of World		
	All other regions		

Source: GTAP v6 database (Dimaranan 2006)

Table 8 Global welfare changes

Equivalent variation, 2001 US dollars, million

Preference change in:	United Kingdom	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 States	-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' calculations

Table 9 Welfare changes for alternative values of α when there are food miles changes in all active nations (ρ = 1)

Equivalent Variation relative to GDP, per cent

	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 States	-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
United Kingdom	0.011	-0.002	-0.015	-0.028	-0.041	-0.054
France	-0.004	-0.005	-0.006	-0.007	-0.008	-0.009
Germany	0	0.04	0.08	0.12	0.16	0.20
Rest of EU	-0.023	-0.021	-0.018	-0.014	-0.011	-0.007
Rest of World	-0.299	-0.273	-0.241	-0.204	-0.161	-0.110

Source: Authors' calculations

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

Equivalent Variation relative to GDP, per cent

	ρ					
	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 States	-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
United Kingdom	0.011	-0.002	-0.015	-0.028	-0.041	-0.054
France	-0.004	-0.005	-0.006	-0.007	-0.008	-0.009
Germany	0	0.04	0.08	0.12	0.16	0.20
Rest of EU	-0.023	-0.021	-0.018	-0.014	-0.011	-0.007
Rest of World	-0.299	-0.273	-0.241	-0.204	-0.161	-0.110

Source: Authors' calculations