



Issues in food miles and carbon labelling

Lindsay Hogan and Sally Thorpe

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Australian Bureau of Agricultural and Resource Economics

Postal address GPO Box 1563 Canberra ACT 2601 Australia

Location 7B London Circuit Canberra ACT 2601

Switchboard +61 2 6272 2000

Facsimile +61 2 6272 2001

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Foreword

The objective in this report is to examine international economic issues surrounding recent campaigns to label food products with indicators based on concepts such as ‘food miles’ and ‘carbon labelling’. These have been proposed as measures to inform consumers. Food miles is a measure of the distance food travels from farmer to consumer. Proponents of the food miles concept encourage consumers to purchase food products with lower food miles, mainly to reduce carbon emissions from energy use in the food supply chain. However, recent studies highlight the limitations of the food miles concept. Food miles has the potential to distort international trade outcomes and may result in higher, not lower, global carbon emissions.

In recent years, there has been growing interest in carbon labelling as an alternative approach to food miles. Carbon labelling addresses information market failures in climate change by providing consumers with more reliable information on the carbon footprint of food and other products. Product labelling is already part of the climate change policy response in Australia and elsewhere through, for example, the energy star ratings label. Carbon labelling may allow consumers to participate directly in climate change responses. However, further research would be needed to provide a comprehensive economic assessment of methodological issues and the interaction of carbon labelling with other climate change policies that a country may have in operation.



Phillip Glyde
Executive Director
December 2009

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Summary

The objective in this report is to examine international economic issues in food miles and carbon labelling. In the food miles campaign, consumers are encouraged by some environmental, community and farmer groups to purchase products with lower food miles, mainly to reduce energy use in transport and, hence, carbon emissions in the food supply chain. In recent years, there has also been increasing interest in carbon labelling to provide consumers with reliable information on the carbon footprint of food and other products.

The food miles campaign has been a key issue for the agricultural sector because of its potential to distort international trade outcomes and, in particular, to reduce market access for Australia's agricultural exports.

Analytical framework

The failure of private markets to produce a socially optimal level of goods and services provides the economic rationale for considering government intervention. Greenhouse gas emissions (referred to as carbon emissions in this report) are a negative externality, the key market failure in the climate change debate — externalities occur as an unpriced by-product or side effect of the production or consumption of a good or service. The climate change policy response also needs to take into account the presence of information and other market failures.

Major international climate change policy assessments advocate a range of information and education policies, including product labelling and mandatory disclosure, to address information market failures. Product labelling aims to provide consumers with information about credence attributes of a product — these are attributes of a product which typically may not be reasonably checked by consumers, even after consumption.

There is significant empirical evidence that non-eco labels, such as nutrition labels, can change market behaviour, although research concerning the impact and effectiveness of eco labels is more limited.

Limitations of food miles

The food miles concept originated in the United Kingdom (UK) in the early 1990s and has been supported by a range of environmental, community and farmer groups. Reflecting community concern about the carbon intensity of air transport and the rapid growth in air freighted food imports, two major UK retailers (Tesco, and Marks and Spencer) now place plane stickers on fresh produce that has been air freighted from abroad.

Empirical evidence indicates that food miles is an unreliable indicator of carbon emissions in the food supply chain. For example, in 2006 a major study on the validity of food miles found that New Zealand is substantially more energy efficient, and less carbon intensive, than UK producers in producing and delivering lamb and dairy products to the UK market.

Importantly, while food miles may have intuitive appeal among some consumers, the food miles concept results in less informed consumption choices and does not reflect the carbon emissions embodied in many products.

Carbon labelling

A survey undertaken by the UK Carbon Trust in 2006 found that three-quarters of UK consumers were concerned about climate change and the carbon footprint of their purchases, with two-thirds indicating they would purchase products with a low carbon footprint.

In 2007, the Carbon Trust introduced a carbon reduction label in partnership with several companies. Companies that choose to place the carbon reduction label on products agree to undertake a comprehensive carbon audit of the supply chains (including production and transport), and commit to reducing carbon emissions over a two year period. The PAS 2050 methodology, developed by the British Standards Institute (BSI), was launched in October 2008 and now underpins the carbon reduction label.

The Carbon Trust is reported to be working toward carbon reduction labels with Coca Cola, PepsiCo and other companies in the United States, and with the China Energy Conservation Investment Corporation. Other carbon labelling initiatives have been introduced or are under development in several other countries in Europe, the United States and Asia.

The Carbon Trust is reported to be working with the International Organisation for Standardisation (ISO) and the World Resources Institute (WRI) to develop a universally accepted standard for measuring embodied carbon emissions. In response to concerns about the high cost of implementing PAS 2050, the World Business Council for Sustainable Development (WBCSD) is developing a simplified low cost standard to achieve widespread adoption by businesses in both developed and emerging economies.

Issues with carbon labelling

Carbon labelling provides information on the carbon footprint of a product — a carbon footprint is a credence attribute which cannot be reasonably checked by consumers.

Carbon labelling may encourage behavioural change in consumers to achieve more sustainable consumption patterns. The costs of adjusting toward a low emissions economy may be reduced when both price and non-price signals are used to reduce demand for relatively carbon intensive products.

More generally, carbon labelling may facilitate consumer participation in climate change responses. For example, carbon labelling can help raise consumer awareness about environmental issues. However, the benefits of carbon labelling are uncertain because they depend on consumer perceptions of the reliability of the information and access to that information — especially where carbon labelling schemes are voluntary.

The administrative costs of carbon labelling are likely to vary according to the methodology or standards adopted. A more complex methodology would tend to increase the cost of data collection and calculation of the carbon footprint as well as the cost of the verification process. Mandatory disclosure imposes costs on all producers, while voluntary labelling would occur only if the investment is assessed by producers to be profitable.

There are various issues associated with each stage of the carbon labelling process — identifying the methodology; data collection and calculation of the carbon footprint; verification; and disclosure — which should be considered in assessing the benefits and costs of any given option.

There is a risk of consumer confusion about the reliability and interpretation of information provided in a carbon label. Third party verification of the estimate of the carbon footprint can enhance the reliability and credibility, and hence effectiveness, of carbon labelling. For example, market research may be used to test carbon labelling options, to reduce the risk of consumer confusion. Complementary information programs would also have a role.

Conclusions

Food miles is a misleading indicator of the carbon footprint of food products that, if widely used, would distort international agricultural markets and possibly increase global carbon emissions.

Carbon labels are a potential alternative to food miles, but it is important to ensure that carbon labelling, where implemented, represents a cost effective contribution to the climate change response on the part of consumers.

1 Introduction

The food miles concept originated in the United Kingdom in the early 1990s, largely in response to concern about increasing environmental costs associated with the food supply chain. The food miles concept has since generated significant global interest. Food miles — the distance food travels from farmer to consumer — is argued to be a reliable indicator of energy use, and hence carbon emissions, in the food supply chain. For simplicity, the term ‘carbon’ as used in this report is the carbon dioxide equivalent, CO₂-e, of greenhouse gas emissions.

The campaign to encourage consumers to purchase products with lower food miles is a key issue for the agricultural sector because of its potential to distort international trade outcomes and, in particular, to reduce market access for Australia’s agricultural exports. Agriculture is an important export oriented sector in Australia — agricultural exports were valued at A\$31 billion in 2007-08, accounting for 21 per cent of total commodity exports (ABARE 2009).

In recent years, there has been increasing recognition of the limitations of the food miles concept and growing interest in carbon labelling as a mechanism to provide consumers with more reliable information about the carbon footprint (or carbon content) of a product (see, for example, AEA Technology 2005; Saunders et al. 2006; and Brenton et al. 2008). A carbon footprint is commonly used to refer to the total carbon emissions caused by an organisation, individual, event or product and should be expressed in carbon dioxide equivalent terms (Carbon Trust 2007). Carbon labelling involves a number of stages including identifying the methodology (standards), data collection and calculation of the carbon footprint, verification and disclosure.

Carbon footprint methodologies — most notably, a Publicly Available Specification (PAS 2050) in the United Kingdom — have recently been developed that may be used in carbon labelling of consumer products (see, for example, Brenton et al. 2008). Notably, the UK Carbon Trust, in partnership with several companies, has been trialling carbon reduction labels for selected consumer products, most recently based on the PAS 2050 methodology (see, for example, BBC News 2007, 2008; and Carbon Trust 2008). Carbon labelling initiatives have also been introduced, or are under consideration, in several other countries in Europe, North America and Asia (see, for example, Stancich 2008a,b).

The objective in this report is to examine economic issues in the food miles concept and carbon labelling. Key issues include:

- What are the limitations of the food miles concept?
- What are some key economic issues to consider in assessing the benefits and costs of carbon labelling?

It should be emphasised that this report provides a discussion of issues from an international perspective and is not intended to be a comprehensive economic assessment of carbon labelling.

An analytical framework relevant to the economic assessment of product labelling is presented in chapter 2. Recent developments in food miles and the limitations of the food miles concept are discussed in chapter 3. Recent developments in carbon labelling and issues in assessing the benefits and costs of carbon labelling options are examined in chapter 4. A graphical analysis of the economic impact of carbon labelling options is presented in appendix A (single economy) and appendix B (two countries or regions), using a simplified supply-demand framework for a single product. Some concluding comments are provided in chapter 5.

2 Analytical framework

In this chapter, an analytical framework is presented to examine the economic rationale for carbon labelling. From an economic perspective, a product label should address identified information market failures and the benefits from implementing a product label should outweigh the costs. The analytical framework is presented in three parts: identifying market failures in climate change, particularly those relevant to product labelling; presenting an overview of the international policy response to climate change; and examining the economic rationale for information policies and product labelling in the climate change policy response.

Market failures in climate change

Greenhouse gas emissions — an international negative environmental externality

The failure of private markets to produce a socially optimal level of goods and services provides the economic rationale for considering government intervention. Greenhouse gas emissions are a negative externality, the key market failure in the climate change debate. In general terms, externalities occur as a by-product or side effect of the production or consumption of a good or service. A negative externality occurs when the actions of an individual — production or consumption decisions by a firm or consumer respectively — have a negative effect on others (third parties), where these effects are not fully reflected in the price of the good or service.

An important issue for environmental assets is that prices do not exist or understate the services provided by the environment. As a consequence, the price mechanism fails to provide the appropriate signal to markets about the value of the asset. This causes a divergence between optimal private behaviour and optimising the community's wellbeing (utility or social welfare).

Greenhouse gas emissions associated with human activity are a complex international and intergenerational issue (see, for example, IPCC 2007a,b,c; Stern 2007; and Garnaut 2008a,b). It is now widely recognised that there are likely to be major costs and risks associated with future global climate change resulting from the warming effect of increased concentrations of greenhouse gases in the atmosphere (Garnaut 2008a,b). While there continue to be significant uncertainties about the timing, nature and extent of climate change effects, achieving greenhouse gas emissions reductions has become an important policy priority in Australia and elsewhere (information on climate change policy assessments and priorities in Australia is presented in Wong 2008; Australian Government Department of Climate Change 2008a,b; and Australian Government Treasury 2008).

Other sources of market failure

The climate change policy response also needs to take into account the presence of other market failures. For example, Gupta et al. (2007, p.766) note that ‘several authors describe situations in which a combination of policies might be desirable’ and highlight market failures in technology development and diffusion, and lack of information. Stern (2007) and Garnaut (2008a,b) also highlight the importance of technology policy and policies to remove barriers to behavioural change (including information policies).

Information market failures

Information is a pure public good if it is not possible to exclude individuals from using it (non-excludable) and one individual’s use of the good does not prevent others from using it (non-rival). The public good nature of information results in a free rider problem and, as a consequence, private markets provide an inadequate level of information. Garnaut (2008a,b) discusses situations where, even with access to sufficient information, consumers and producers may not be able to make optimal decisions because of limited knowledge and processing abilities (referred to as bounded rationality). For example, consumers and producers may adopt rules of thumb in decision-making to avoid gathering and processing costs (an example of a rule of thumb is the payback period for a capital investment).

Asymmetric information occurs when information about the attributes of a good differs between buyers and sellers, or between the generators of externalities and the affected third parties. There are two types of asymmetric information problems: moral hazard and adverse selection. The moral hazard problem occurs when the actions of one individual are not observable to others. The adverse selection problem occurs when one individual cannot identify the type or character of others and, as a consequence, cannot assess the quality of a potential good or service.

Innovation market failures

Positive externalities in the technology innovation process result in private investment in research, development and deployment (RD&D) that are less than socially optimal, since these additional benefits are not incorporated in the decision-making processes of individual private companies. Market failures in innovation are discussed in some detail in Garnaut (2008a,b), including the public good nature of basic research. ABARE has also undertaken several studies on the technology innovation process (see, for example, Heaney et al. 2005 and Hogan et al. 2007).

Climate change policy response

Kyoto Protocol and the Bali Road Map

The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change (UNFCCC) which was adopted in Kyoto, Japan, in December 1997 and entered into force on 16 February 2005 (see <http://unfccc.int>). Under the Kyoto Protocol, 37 industrialised countries and the European community have committed to emissions targets which would, in aggregate, reduce their joint emissions of six greenhouse

1 Kyoto Protocol target commitments for Annex B countries

party	target % of base year or period
Australia	108
Austria	92 (87)*
Bulgaria a	92
Canada	94
Croatia	95
Czech Republic	92
Denmark	92 (79)*
Estonia	92
European Community	92
Finland	92 (100)*
France	92 (100)*
Germany	92 (79)*
Greece	92 (125)*
Hungary b	94
Iceland	110
Ireland	92 (113)*
Italy	92 (93.5)*
Japan	94
Latvia	92
Liechtenstein	92
Luxembourg	92 (72)*
Monaco	92*
Netherlands	92 (94)*
New Zealand	100
Norway	101
Poland c	94
Portugal	92 (127)*
Romania a	92
Russian Federation	100
Slovakia	92
Slovenia	92
Spain	92 (115)*
Sweden	92 (104)*
Switzerland	92
Ukraine	100
United Kingdom of Great Britain and Northern Ireland	92 (87.5)*
United States of America	93

a Base year: 1989. **b** Base year is average of years 1985-87. **c** Base year: 1988. * Agreed EU internal burden sharing arrangement.

gases (measured as the equivalent of carbon dioxide) by 5 per cent over the five year period from 2008 to 2012, compared with 1990 levels. These countries are listed in Annex B of the Kyoto Protocol and are often referred to as Annex B countries - the agreed emissions targets for these countries are listed in table 1. The 15 countries that were European Union (EU) members in 1990 are regarded as a 'bubble', whereby countries have individual emissions targets but there is an overall target for the group of countries under the Kyoto Protocol. The Kyoto Protocol also contains provisions for reporting and compliance.

Annex B countries must meet their emissions targets primarily through national measures. However, the Kyoto Protocol also provides three market-based mechanisms, referred to as flexible mechanisms, to provide greater flexibility for countries in meeting their emissions targets and to encourage developing countries to contribute to emissions reduction efforts through, for example, technology transfer. These are:

- **emissions trading** — based on a cap and trade system, countries that have reduced emissions below their allocated allowance may trade the surplus allowances to others that have exceeded their cap
- **clean development mechanism (CDM)** — project-based mechanism that allows Annex B countries to invest in sustainable development projects that reduce emissions in developing countries
- **joint implementation (JI)** — project-based mechanism which enables Annex B countries to carry out joint implementation projects with other Annex B countries.

These flexible mechanisms allow for the trading of carbon credits, or carbon emissions reduction units, that can be used to achieve emissions targets (Carbon Trust 2006c). These mechanisms resulted in the creation of the carbon market, which was valued at US\$30 billion in 2006 (see <http://unfccc.int>). A voluntary carbon market has also emerged that allows organisations and

individuals to reduce their carbon emissions by voluntarily purchasing carbon offsets. The compliance carbon market and voluntary carbon market are discussed further in Carbon Trust (2006c).

At the United Nations Climate Change Conference in Bali, held in December 2007, the Bali Road Map for a future international agreement on climate change was adopted. Formal negotiations on a strengthened international agreement on climate change were launched and it was agreed that these negotiations would be concluded by the end of 2009 at the Climate Change Conference in Copenhagen.

Gupta et al. (2007) note that the UNFCCC and Kyoto Protocol have been important first steps toward the implementation of an international response strategy to address climate change, but any future international agreement which does not include a larger share of global emissions will have a higher global cost or be less environmentally effective.

Mitigation policy options

The fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC) provides a summary of the literature on national mitigation policies and international cooperation (see Gupta et al. 2007 and IPCC 2007c). Gupta et al. (2007) assess the policy instruments defined in box 1, including information policies, noting that the design of the policy is important and all policy instruments must be monitored and enforced to be effective. The four principal criteria used to evaluate these policy options are:

- **environmental effectiveness** — the extent to which a policy meets its intended environmental objective
- **cost effectiveness** — the extent to which the policy can achieve its objectives at least cost to society
- **distributional considerations** — the distributional consequences of a policy, including fairness and equity
- **institutional feasibility** — the extent to which a policy option is likely to be viewed as legitimate, gain acceptance and be adopted.

An important international equity aspect is the need for the global climate change policy response to be consistent with sustainable economic development in developing economies. That is, energy consumption trends in these countries will need to be consistent with facilitating economic growth and development.

To date, national governments and the European Union have adopted, or are considering, a range of policy options. Gupta et al. (2007) note that there is an increasing amount of research focused on tradable permit schemes which can establish a carbon price and guarantee a particular level of emissions. This option has become an important part of the climate change policy response in Europe and elsewhere. The EU Emissions Trading Scheme (ETS), the world's largest tradable permit scheme, was initiated on 1 January 2005 and applies to around 11 500 installations across the European Union's 25 member countries (Gupta et al. 2007). The EU ETS covers around 45 per cent of the European Union's total carbon emissions and includes electricity and other major industrial sectors.

The New Zealand Government has also introduced an ETS to support the achievement of the country's international climate change obligations (see www.climatechange.govt.nz). New Zealand's Climate Change Response (Emissions Trading) Amendment Act 2008 was signed on

25 September 2008 and most of its provisions came into force on 26 September 2008. On 24 September 2009, the government introduced the Climate Change Response (Moderated Emissions Trading) Amendment Bill to Parliament, proposing a number of changes to the New Zealand ETS (see New Zealand Government 2009 for further information). In December 2008, the Australian Government released its Carbon Pollution Reduction Scheme White Paper and medium-term target range for reducing carbon emissions (see Australian Government Department of Climate Change 2008b). Legislation on the Australian Government's Carbon Pollution Reduction Scheme will be debated in both Houses of Parliament in 2009 (Wong 2008). An ETS is also currently under consideration in Japan (see Ministry of the Environment, Japan 2008).

box 1 Selected mitigation policy options to achieve emissions targets

Mitigation policy options available to governments to achieve emissions targets, based on Gupta et al. (2007, p.750), include:

- **regulations and standards** — these specify the abatement technologies (technology standard) or minimum requirements for pollution output (performance standard) necessary for reducing emissions
- **taxes and charges** — a levy imposed on each unit of undesirable activity by a source
- **tradable permits** — these are also known as marketable permits or cap-and-trade systems. This instrument establishes a limit on aggregate emissions by specified sources, requires each source to hold permits equal to its actual emissions and allows permits to be traded among sources
- **voluntary agreements** — an agreement between a government authority and one or more private parties, with the aim of achieving environmental objectives or improving environmental performance beyond compliance with regulated obligations. Not all voluntary agreements are truly voluntary: some include rewards and/or penalties associated with participating in the agreement or achieving the commitments
- **subsidies and incentives** — direct payments, tax reductions, price supports or the equivalent thereof from a government to an entity for implementing a practice or performing a specified action
- **information instruments** — required public disclosure of environmentally related information, generally by industry to consumers. These include labelling programs and rating and certification systems
- **research and development (R&D) programs** — activities which involve direct government funding and investment aimed at generating innovative approaches to mitigation and/or the physical and social infrastructure to reduce emissions. Examples of these are prizes and incentives for technological advances
- **non-climate policies** — other policies not specifically directed at emissions reduction but which may have significant climate-related effects.

Information policies and product labelling approaches

Information policies

IPCC (2007c), Stern (2007) and Garnaut (2008a,b) advocate a range of information and education policies, including product labelling and mandatory disclosure, to address information market failures. Gupta et al. (2007) note that 'Article 6 of the UNFCCC on Education, Training and Public Awareness calls on governments to promote the development and

implementation of educational and public awareness programmes, promote public access to information and public participation and promote the training of scientific, technical and managerial personnel' (UNFCCC 2006, pp. 764-5).

Gupta et al. (2007) conclude that information instruments may improve environmental quality by promoting more informed choices and lead to support for government policy, although there is only limited evidence that the provision of information can achieve emissions reductions.

Stern (2007, p. 377) identifies a number of information policies — performance labels, certificates and endorsements; more informative energy bills; wider adoption of energy use displays and meters; the dissemination of best practice; and wider carbon disclosure — the implementation of which would 'help consumers and firms to make sounder decisions and stimulate more competitive markets for more energy efficient goods and services'.

Garnaut (2008b, p. 408) argues that 'information and education programs have strong synergies with an ETS, as they can help individuals to identify the energy and other costs affected by a carbon price and respond to it'. Garnaut (2008b) further argues that public information programs should provide consumers with information about the benefits of energy efficiency and the costs and benefits of different low emissions practices.

Product labelling

As noted by Karl and Orwat (1999), Harris and Cole (2003) and Garnaut (2008a,b), products and product attributes can be grouped into three categories:

- **search** — product attributes may be checked by searching the product before purchase (for example, by looking at or feeling the product)
- **experience** — product attributes may be checked after the product is consumed or experienced
- **credence** — claims about product attributes may not be reasonably checked by consumers at all, even after consumption.

The environmental quality attributes of a product are typically in the credence category. For example, it is typically not possible for consumers to distinguish between production processes that have different environmental impacts when the final consumer product is the same.

There are three types of eco labels which vary according to the approach used to signal information on credence attributes to consumers (see, for example, Abe et al. 2002; Harris and Cole 2003; Bleda and Valente 2007):

- **Type I eco labels** are criteria based, third party certification programs — these eco labels signal to consumers that criteria, that define a minimum environmental quality level, have been met with verification by a reputable independent organisation.
- **Type II eco labels** are information self-declaration programs.
- **Type III eco labels** are quantified product information label programs, using preset indices — these eco labels are report cards that provide more information to consumers on the environmental quality attributes of the product.

Examples of Type I labels include organic certification, the Fairtrade mark, the dolphin-safe tuna label (eco labels) and the Heart Foundation tick (non-eco label). An example of a Type II label is the aircraft sticker (discussed in the next chapter). Examples of Type III labels include the energy star ratings label, the water star ratings label (eco labels) and nutrition labels (non-eco labels). A carbon label which provides consumers with quantitative information about the carbon footprint of a product is a type III eco label.

Product labelling may provide consumers with information about a credence attribute associated with a particular stage in the product's life cycle — stages include production and delivery (including processing, storage and transport), consumer use and product disposal. For example, performance labels provide consumers with information about an environmental attribute relevant to the product's use (such as the energy efficiency and water efficiency of refrigerators and washing machines).

Empirical evidence of behavioural change from product labelling

Teisl et al. (2002) note there have been three important developments in eco labelling in recent years:

- knowledge about the environmental attributes of products has become increasingly important to consumers
- governments and nongovernmental organisations have responded by organising, implementing and verifying eco labelling programs, which cover thousands of products in more than 20 countries
- there have been international efforts to standardise environmental labelling schemes.

Teisl et al. (2002) also note there is significant empirical evidence that non-eco labels, such as nutrition labels, can change market behaviour. Research concerning the impact and effectiveness of eco labels is more limited although there have been a number of empirical studies on the effect of environmental labels on consumer demand. For example, Teisl et al. (2002) found the introduction of the dolphin-safe tuna label increased consumer demand for canned tuna. Bjorner et al. (2004) also found empirical evidence of significant changes in consumer preferences following the introduction of a certified environmental label.

Stern (2007) argues that product labelling can have a significant effect on consumer behaviour, as demonstrated by organic certification and the Fairtrade mark. For example, global sales of Fairtrade products increased by 47 per cent in 2007 to more than €2.3 billion. Fairtrade labelling indicates that specified social and environmental standards are met and that producers receive the Fairtrade minimum price and premium (Fairtrade Labelling Organizations International 2008).

Garnaut (2008a,b) notes there is research to indicate that labelling programs for appliances have been successful in encouraging the uptake of more energy efficient products in Australia and elsewhere (citing George Wilkenfeld and Associates & Energy Efficient Strategies 1999). Australia's energy performance labels are also discussed in, for example, Holt and Harrington (2002) and Productivity Commission (2005, 2008). The Productivity Commission (2008, p. 136) found that, while 'the benefits of labelling may have been overstated in regulation impact assessments, it is likely to have produced net benefits for consumers'.

3 Limitations of the food miles concept

In this chapter, background information is presented on recent developments in food miles, with some emphasis placed on the United Kingdom where the food miles concept has gained significant support among environmental, community and farmer groups, and aircraft stickers have been adopted by some retailers to signify products that have been airfreighted from their source region.

Development of the food miles concept

The term food miles was originally coined by Tim Lang in the early 1990s. Tim Lang is currently Professor of Food Policy at City University in London (Rayner 2007). As Director of the London Food Commission between 1984 and 1990, Tim Lang helped found what has become Sustain, an alliance for better food and farming with a membership of around 100 national public interest organisations (see www.sustainweb.org). Noting that food and agriculture systems contribute significantly to human induced global warming, Sustain provides seven recommendations for consumers who wish to support a sustainable food system, including reducing carbon emissions. The first recommendation relates to the food miles concept:

- **‘Buy local, seasonally available ingredients as standard**, to minimise energy used in food production, transport and storage. To see which foods are in season, see, for example: <http://www.eattheseasons.co.uk/>’ (Sustain 2007, p. 1).

More broadly, the food miles concept, which encourages consumers to purchase food products with lower food miles or to eat local seasonal produce, has been argued to address three negative effects of long distance food (see, for example, Sydney Food Fairness Alliance 2008):

- **environmental** — carbon emissions in transport and storage, and environmental impacts of packaging and processing
- **health** — long distance transport increases the time from farmer to consumer and can reduce the nutritional value of the food
- **social** — imported food can be sourced from countries with inadequate environment and health standards and few regulations to protect workers from contamination.

Recent developments in food miles

The food miles campaign has generated significant interest in the United Kingdom and other countries. A range of environmental and community groups support the food miles

concept, including the World Wildlife Fund (2001) and Soil Association (2007). Some farmer organisations also support the food miles concept. For example, in the United Kingdom, Farmers Weekly (2008) recommends consumers look more closely at country of origin labels on food products and choose purchases accordingly to reduce food miles; one suggestion is to take a map of the world when food shopping.

The emergence of a group in San Francisco in 2005, referred to as the 'locavores', has gained significant attention in the media. Locavores encourage people to eat food grown or harvested within a 100 mile radius of their home (see www.locavores.com). The emergence of the 100 mile diet and 100 mile restaurants has been reported in the media (see www.100milediet.org).

In Australia, the food miles concept is supported by the Australian Conservation Foundation (2005, 2008), the Sydney Food Fairness Alliance (2008) and the Byron Shire Council (2008). A 100 mile cafe was opened in Melbourne in 2007. In a preliminary study, Gaballa and Abraham (2008) estimated the food miles and carbon emissions for a typical food basket in Victoria (the total distance travelled by these food items, representing 29 of Australia's most common food items, was 70 803 kilometres).

a Tesco's aircraft sticker



Aircraft stickers — indicator of air miles

Proponents of food miles in the United Kingdom have been particularly concerned about the carbon intensity of air transport and the rapid growth in air freighted food imports. Reflecting these concerns, two major UK retailers — Tesco, and Marks and Spencer — place plane stickers, illustrated in figure a, on fresh produce that has been air freighted from abroad (see, for example, Stacey 2008).

Empirical evidence of the limitations of food miles

Air freighted food products (air miles)

The practical experience in the United Kingdom with discouraging consumers from purchasing food products that have been air freighted from abroad has highlighted two key issues for proponents of food miles:

- the role of international trade in global poverty eradication
- the limited reliability of aircraft stickers in indicating air freighted food products are more carbon intensive than locally produced alternatives.

Placing aircraft stickers on green beans that have been air freighted from Kenya to the United Kingdom serves to highlight the importance of the UK market for the Kenyan economy and

the role of international trade in facilitating economic development. In addition, carbon emissions from green beans produced in Kenya that have been air transported to the United Kingdom may be lower than carbon emissions from green beans produced in the United Kingdom (see, for example, McKie 2008). Muller (2007) also discusses similar issues using the example of UK consumption of strawberries produced in Kenya.

There has been an increased awareness of the difficulties in assessing the trade-offs between different environmental and social attributes. For example, the negative impact of food miles on consumer demand for organic food imports has attracted significant attention in the media and resulted in the Soil Association, a leading UK organic certifier, modifying its approach to air freighted organic imports. In particular, Soil Association (2008) has moved to change its standards so organic produce can be air freighted provided it meets the Ethical Trade or Fairtrade Foundations' standards. However, as Wynen and Vanzetti (2008, p. 10) conclude, by 'banning imports (e.g., by denying organic certification to all air-freighted produce) or by espousing consumption of local goods, not only are importing countries reducing the options available to domestic consumers and hurting foreign producers to benefit local producers, but this practice may actually increase pollution'.

When the Soil Association was considering the eligibility of air freighted produce to be labelled organic, the International Trade Centre commissioned a review of the food miles literature, focusing on studies which consider air freight transport of fresh fruit and vegetables. In this review, Saunders and Hayes (2007, p. v) concluded that when a product's life cycle of emissions is considered, 'the emissions associated with air transport tend to be low. Most of the studies assume that the importing country could supply the market and reduce or replace imports. For many products this is unlikely to be the case and even where this may be possible this would be likely to lead to an intensification of production systems thereby raising energy and emissions intensity'.

The complexity of some of these issues is also noted in UK Cabinet Office (2008; see, in particular, pp. 15-17).

The validity of food miles as an indicator of sustainability

In response to the increased interest in the food miles concept, the UK Government Department for Environment, Food and Rural Affairs (DEFRA) commissioned AEA Technology to study the validity of food miles as an indicator of sustainability. The study presented four key findings (AEA Technology 2005):

- **The direct environmental, social and economic costs of food transport are estimated to be more than £9 billion each year, and are dominated by congestion** — this assessment includes external costs associated with congestion, accidents, carbon emissions, air pollution and infrastructure (road maintenance costs).
- **Food transport has significant and growing impacts** — food transport produced 19 million tonnes of CO₂-e emissions in 2002, of which 10 million tonnes were sourced in the United Kingdom. Air transport has the highest CO₂-e emissions per tonne and is the fastest growing transport mode.

- **A single indicator based on total food kilometres is an inadequate indicator of sustainability** — the study recommended constructing four indicators to reflect the adverse effects of food transport including:
 - a. UK urban food kilometres (main driver of congestion and accidents, but air pollution is also higher in urban areas)
 - b. heavy goods vehicles food kilometres in the United Kingdom and overseas (responsible for the majority of infrastructure, noise and air pollution costs)
 - c. air food kilometres (rapidly growing and has a higher environmental impact than any other transport mode)
 - d. total CO₂-e emissions from food transport in the United Kingdom and overseas (emissions from the transport sector are significant and growing).
- **Data are available to provide and annually update a meaningful set of indicators** — areas where data quality is poor are either of less policy interest to DEFRA (road transport overseas) or currently have a negligible role in UK food transport (rail, inland waterway).

The UK Government's approach to addressing the negative externalities associated with food transport is discussed in DEFRA's food industry sustainability strategy (DEFRA 2006). Two aspects of the UK Government response are: to encourage industry to achieve best practice in vehicle fleet utilisation and efficiency, and re-build the market for locally-sourced produce; and to encourage consumers to switch to food products with lower external effects by providing information on emissions across the whole life cycle in the food chain. 'In order to help increase consumer awareness of the origin of foods, the Government will press for EU labelling rules to be changed to extend origin marking', (DEFRA 2006, p. 55). DEFRA proposed to monitor progress in reducing the external costs associated with food transport, partly by calculating the four key indicators proposed by AEA Technology (2005), as listed above.

More recently, the UK Cabinet Office (2008, p. 15) found that 'the environmental case for "local" is less clear. "Food miles" are a poor indicator of the environmental impact of food products and small-scale production is not necessarily resource-efficient or low-impact. Evidence suggests that at some times during the year, transporting produce from other countries may have a lower environmental impact than heating or refrigerating produce grown in Britain. For consumers, driving six and a half miles to a shop to buy food emits more carbon than flying a pack of green beans from Kenya to the UK. And there are social equity arguments for imports as well as more local food – UK demand for fresh produce grown in Africa supports over 700,000 workers and their dependants.'

New Zealand food miles study

The validity of food miles as an indicator of carbon emissions in the food supply chain was examined at Lincoln University in New Zealand. Saunders et al. (2006) noted that New Zealand has attracted substantial attention in the food miles debate for three main reasons:

- geographic distance results in high food miles for NZ exports to the UK market
- the United Kingdom is an important traditional market for NZ exports

- New Zealand and the United Kingdom have similar climates, suggesting the land is suitable for similar farming activities.

Saunders et al. (2006) compared energy use and associated carbon dioxide (CO₂) emissions in the UK and NZ food supply chains for four food products — lamb, dairy, apples and onions — that are consumed in the UK market (table 1). The analysis accounted for energy use and CO₂ emissions associated with international transport for NZ exports.

2 Comparison of NZ and UK energy use and CO₂ emissions for four key food products key results from Saunders et al (2006)

	Unit	lamb b		dairy a		apples		onions	
		NZ	UK	NZ	UK	NZ	UK	NZ	UK
Energy									
Production	mj/t	8 588	45 859	22 912	48 368	950	2 961	821	678
Post harvest/production	mj/t								
Grading	mj/t							39	62
Storage	mj/t						2 069		3 020
Shipping	mj/t	2 030		2 030		2 030		2 030	
Total	mj/t	2 030		2 030		2 030	2 069	2 069	3 082
Total energy	mj/t	10 618	45 859	24 942	48 368	2 980	5 030	2 889	3 760
CO₂ emissions									
Production	kg CO ₂ /t	563.2	2 849.1	1 297.6	2 920.7	60.1	186.0	58.9	42.3
Post harvest/production	kg CO ₂ /t								
Grading	kg CO ₂ /t							0.7	2.6
Storage	kg CO ₂ /t						85.8		125.2
Shipping	kg CO ₂ /t	124.9		124.9		124.9		124.9	
Total	kg CO ₂ /t	124.9		124.9		124.9	85.8	125.6	127.8
Total CO ₂ emissions	kg CO ₂ /t	688.0	2 849.1	1 422.5	2 920.7	185.0	271.8	184.6	170.0

a Milk solids. **b** Carcass.

Saunders et al. (2006) found that New Zealand is substantially more energy efficient, and less carbon intensive, in producing and delivering lamb and dairy to the UK market compared with UK producers. New Zealand is also significantly more energy efficient, and less carbon intensive, in supplying apples to the UK market when the energy used in storage for UK produced apples is taken into account. However, New Zealand is slightly more carbon intensive in supplying onions to the UK market compared with UK producers.

Areas of concern in the food miles campaign

Overall, there are three key areas of concern relating to the use of food miles to influence consumer decisions:

- **misleading information** — based on the evidence presented in the previous section, food miles provides consumers with poor quality information about the carbon footprint of food

products. Consumer use of food miles would distort consumption, production and trade patterns in the world food market and may increase global carbon emissions

- **trade protection risk** — there is a risk that the food miles campaign may be used as a form of trade protection by encouraging consumers to buy local. Most interest in the food miles label has been in Europe and the United States where agricultural protection remains relatively high. Food miles is a private voluntary approach and is likely to fall outside the jurisdiction of the World Trade Organisation (WTO)
- **ignores government policy actions** — food miles fails to take into account government policy actions that address identified market failures in the food supply chain.

Following recent economic assessments, there is likely to be greater recognition by governments and others about the limitations of the food miles concept and the important role of international trade in enhancing global food security. For example, the UK Government has noted that maintaining a diversity of food supply sources is crucial to food security (DEFRA 2008).

In assessing the potential role of food miles, it is important to distinguish between domestic and international environmental impacts in the food supply chain. As noted in the previous chapter, these environmental impacts are often referred to as externalities or spillover effects that occur as a by-product of an economic activity. National governments need to address domestic externalities, while a coordinated international policy response would be most effective in addressing international externalities. In addition, each type of externality (or market failure) should be addressed on a case by case basis to assess the most cost effective response.

Local air pollution, traffic accidents and congestion associated with food transport are examples of domestic negative externalities. It is beyond the scope of this report to examine policy options to address domestic externalities in the food supply chain. Carbon emissions are an example of an international negative externality, where there is a critical role for international policy coordination.

Three options suggested by Muller (2007) to address the issue of carbon emissions in international trade, particularly for air freighted produce, are: carbon labelling; importers to purchase carbon offsets (using the Kyoto Protocol's Clean Development Mechanism — see chapter 2 for further information); and consumer countries to support producers in developing economies to shift from air transport to shipping in international trade. Muller (2007) also notes that the EU ETS will be extended to international flights into the European Union from 2012.

In the absence of carbon labelling, there is a risk consumers will continue to be encouraged by some environmental, community and farmer groups to use food miles or air miles as indicators of the carbon footprint of food products. For example, the European Union is moving toward country of origin labelling on all food products, and Saunders and Hayes (2007) note that the issue of food miles and country of origin labelling (COOL) is rising in importance in the United States. An alternative option for consumers who wish to contribute directly to reducing carbon emissions is to participate in the voluntary carbon market, although there may be significant transactions costs and quality assurance issues (see, for example, Carbon Trust 2006c and Kollmuss, Zink, and Polycarp 2008).

Even without carbon labelling, farmers markets do not need to use the food miles concept as a marketing tool to increase demand for local seasonal produce. In a recent survey of 416 shoppers at the Adelaide Showgrounds Farmers Market, the main reasons given for shopping at the farmers market were: to support local farmers; to support the rural economy; to support independent farmers; farmers market products taste better and are of higher quality; and there is more confidence in the source of food (Stringer and Umberger 2008). Shoppers were also asked to rank the importance of 16 food attributes — food miles and carbon labelling ranked 14th and 16th, respectively.

Food miles are also somewhat misleading in providing an indicator of the efficiency of transport associated with farmers markets. These markets provide a local or regional hub for producers and consumers who each access the market using their own transport option. For example, the Capital Region Farmers Market in Canberra has become a significant enterprise with between 5000 and 6000 people visiting the market each Saturday, where farmers come from the region and sometimes from the central-west and north coast of New South Wales (Doherty 2008).

4 Issues in assessing the benefits and costs of carbon labelling

In recognition of the limitations of the food miles concept, there have been moves in some countries to introduce carbon labelling as a more effective approach to address information market failures in identifying the carbon emissions content of products. Some economic issues in designing and assessing a carbon label are discussed in this chapter. Background information is first presented on recent developments in carbon labelling, with some emphasis again placed on the United Kingdom where carbon labels have been trialled and the PAS 2050 has been developed for estimating the carbon emissions of goods and services.

Recent developments in carbon labelling

The UK Carbon Trust's carbon reduction label

In the United Kingdom, encouraging consumers to switch to food products with fewer carbon emissions appears to be part of the policy response to addressing climate change (DEFRA 2006). The UK Cabinet Office (2008) examined options for supporting consumer behavioural change including through improved product labelling. In December 2008, the UK Environment Secretary Hilary Benn called for 'better labelling – to help us understand where food comes from, how it was made, which welfare standards were applied, and what its carbon content is' (Benn 2008, p. 5).

There is significant consumer demand for better information on the environmental impacts of food and other products. A survey undertaken by the UK Carbon Trust in 2006 found that three-quarters of UK consumers were concerned about climate change and the carbon footprint of their purchases, with two-thirds indicating they would purchase products with a low carbon footprint (BBC News 2006). The Carbon Trust is an independent organisation established by the UK Government in 2001 to work with business and the public sector to reduce carbon emissions and capture the commercial potential of low carbon technologies (Carbon Trust 2006a).

In recent years, the Carbon Trust has released a series of reports on various aspects of carbon footprints for organisations and products (Carbon Trust 2006a,b,c and 2007). The carbon footprint of a product is the carbon emissions across the supply chain for a single unit of that product. Carbon Trust (2006c, p. 3) argued that, in estimating the total carbon footprint of a product, the 'total carbon emissions are not just those due to the manufacturing processes or those due to "food miles" but should be based on all the steps in the supply chain to produce, use and dispose of or recycle' the product. However, at the time, there was no internationally agreed methodology for calculating the carbon footprint of a consumer product.

The Carbon Trust developed a methodology to measure a product’s carbon emissions and introduced a carbon reduction label in partnership with several companies including Walkers (crisps), Boots the Chemist (shampoo) and Innocent Drinks (fruit smoothies) (BBC News 2007). Several other companies subsequently participated in the trial. In early 2007, Tesco announced an objective to develop and implement a system of carbon labels for each of its 70 000 products (Spector 2008). In March 2008, Tesco announced its participation in the trial of the scheme operated by the Carbon Trust with labelling of 20 own-brand products (BBC News 2008).

In June 2007, the Carbon Trust and DEFRA commissioned the BSI to develop a more comprehensive carbon footprint methodology that would calculate the full life cycle of carbon emissions from goods and services. This methodology, referred to as PAS 2050, was launched in October 2008. The Carbon Trust’s carbon reduction label, now underpinned by PAS 2050, is illustrated in figure b. Background information on the carbon reduction label and PAS 2050 is provided in Carbon Trust (2009).

b Example of the UK Carbon Trust's carbon reduction label (including optional elements)

<p>working with the Carbon Trust</p>  <p>850g CO2 per wash</p>	<p>The carbon footprint of this product is 850g per wash and we have committed to reduce this</p>
	<p>By comparison the carbon footprint of non-biological washing liquid is 600g per wash</p>
	<p>Help to reduce this footprint. Washing at 30°C rather than 40°C saves 160g CO2 per wash</p>

Companies that choose to place the carbon reduction label on products agree to undertake a comprehensive carbon audit of their supply chains (including production and transport), and commit to reducing carbon emissions over a two year period. The four elements of the label are: the footprint; the carbon footprint measurement given in CO₂-e terms, but expressed as CO₂ for simplicity on the label; an endorsement by the Carbon Trust; and a commitment by the producer to reduce emissions or lose accreditation. Optional elements include: an educational element explaining how the footprint is created; product comparison information between different items produced by the same company and within the same category; and customer action tips on appropriate products.

The Carbon Trust is reported to be working with the International Organisation for Standardisation (ISO) and the World Resources Institute (WRI) to develop a universally accepted

standard for measuring embodied carbon emissions (see the profile for the carbon reduction label at www.pcf-project.de). The Carbon Trust is also reported to be working toward carbon reduction labels with Coca Cola, PepsiCo and other companies in the United States, and with the China Energy Conservation Investment Corporation.

Other carbon labelling schemes

Information on international carbon labelling initiatives is provided in Stancich (2008a,b) (see also www.pcf-project.de). Based on this information, carbon labelling schemes have been introduced in several countries in addition to the United Kingdom, including:

- **France** — voluntary carbon labels have been introduced in supermarket chains Casino (several own-brand products with an aim to label around 3000 products) and E. Leclerc (launched in two stores). These schemes have the support of the French Environment and Energy Agency, but do not require audits. The methodology underpinning the Casino carbon label is expected to be altered to incorporate the PAS 2050 approach
- **Switzerland** — Migros, Switzerland's top supermarket chain, has introduced the Climatop carbon label on several own-brand products. This label provides confirmation that the product is 20 per cent more carbon efficient than its counterparts within the same product category
- **United States** — Carbon Fund, an independent non-profit carbon offset provider, developed the Certified Carbon Free label to indicate that the product's carbon footprint has been calculated, is monitored and reported, and the carbon is being offset; a small number of products carry the label. Climate Conservancy, a spin-off from Stanford University, developed the Climate Conscious label that provides a rating (gold, silver and bronze) based on the product's carbon intensity. The assessment methodology is currently being trialled by the New Belgium Brewing Company
- **Canada** — CarbonCounted, a non-profit organisation, developed an online database web application, CarbonConnect, that allows companies to calculate product carbon footprints. Around 40 companies, including Standard Chartered Bank and investment bank UBS, carry the label.

Carbon labelling schemes or product carbon footprint methodologies are also being developed or piloted in Germany (Product Carbon Footprint pilot labelling scheme), Sweden (Climate Marking), the European Union (commissioned a carbon footprint measurement toolkit), California (Californian Carbon Label), Japan (30 companies have participated in a pilot scheme funded and coordinated by the Japanese Ministry of Economy, Trade and Industry), South Korea (Cool Label) and Thailand (carbon label being developed by the Thailand Greenhouse Gas Management Organisation).

The World Business Council for Sustainable Development is reported to be developing a simplified low cost standard to achieve widespread adoption by businesses in both developed and emerging economies (Stancich 2008b).

Carbon labelling options

Carbon leakage issues

The effects of carbon labelling in a simplified economic framework are discussed in box 2. An issue that has generated considerable concern is the potential for carbon leakage.

Carbon leakage occurs when carbon emissions are reduced in countries with agreed emissions targets (referred to as participating countries), but carbon emissions increase in other countries that do not have agreed emissions targets (referred to as non-participating countries). As discussed in, for example, Barker et al (2007) and Bohringer, Rutherford and Voß (2008), carbon leakage may occur through two basic mechanisms:

- **relocation of energy intensive production** — energy intensive industries close down in a participating country and are relocated in a non-participating country with a weaker climate change policy setting
- **fall in world energy prices** — reduced energy demand in participating countries may result in lower world energy prices and increased energy consumption in non-participating countries.

Barker et al. (2007) define carbon leakage as the increase in carbon emissions in non-participating countries divided by the reduction in carbon emissions by participating countries (expressed as a percentage). A carbon leakage rate above 100 per cent indicates that policy action in participating countries results in increased global carbon emissions, not less. In the latest IPCC assessment, Barker et al. (2007, p. 622) note that ‘estimates of carbon leakage rates for action under Kyoto range from five to 20 per cent as a result of a loss of price competitiveness, but they remain very uncertain’. For example, Barker et al. (2007) cite a study by Babiker (2005) who reports a range of carbon leakage rates between 25 and 130 per cent, but also indicate that other studies find these outcomes are unlikely in practice, possibly because of policy intervention.

Addressing the risk of carbon leakage because of the relocation of energy intensive production is a major focus of discussions. This type of carbon leakage may arise because the emissions targets under the Kyoto Protocol are based on a country’s production of carbon emissions. Production-based policies such as an emissions trading scheme or carbon tax on production, result in a carbon price which increases the costs of production in both the non-traded and traded goods sectors of the economy. When there is limited participation in the global climate change agreement, the implementation of production-based policies reduces the international price competitiveness of the country’s export and import competing industries (the traded goods sector).

The main policy approaches which Annex B governments have considered to address carbon leakage risks provide special provisions for energy intensive traded goods industries and include, for example, exemptions of industries and border tax adjustments. Border tax adjustments include import tariffs and export subsidies, based on the carbon footprint of the good, applied to goods traded with non-participating countries.

box 2 Effects of carbon labelling in a simplified economic framework

Single closed economy

No policy response

Economic impacts of carbon labelling may be examined using a simplified supply-demand framework for a single product in a single economy (see appendix A for a more detailed graphical analysis). Production is assumed to result in pollution that causes environmental damage. In the absence of a policy response, the market outcome for a single product occurs where the marginal benefit of consumption (demand curve) equals the private marginal cost of production (private supply curve). A negative production externality results in overproduction and excessive pollution because production decisions are based on private marginal costs, not social marginal costs — social marginal costs include both private marginal costs and environmental damage costs.

Supply side and demand side management of pollution

The objective in government policy is to achieve a level of production where the level of pollution is reduced to the socially optimal level. There are three broad policy approaches:

- **supply side management based on the polluter pays principle (PPP)** — production-based policies are adopted to ensure the damage costs of pollution are incorporated in the production decisions of producers. Policy options include, for example, an ETS between producers and a pollution tax on production
- **demand side management based on the user pays principle (UPP)** — consumption-based policies are adopted to ensure consumers take into account the environmental damage costs in their consumption decisions. Policy options include, for example, information policies and a pollution tax on consumption
- **mix of supply side and demand side management** — some combination of production and consumption-based policies are adopted to ensure that pollution is reduced to the socially optimal level.

In the simple case of a single closed economy, the optimal market outcome is achieved where the marginal benefit of consumption equals the social marginal cost of production (that includes environmental damage costs). Through supply side management, for example, the damage costs of pollution are incorporated in the production decisions of producers. As a result, price is increased and both production and environmental damage are reduced to achieve the socially optimal market outcome.

In box 1, the selected mitigation policy options under consideration to achieve carbon emissions targets under the Kyoto Protocol contain both supply side and demand side management approaches. Since the carbon emissions targets are based on a country's production of carbon emissions, the main focus in mitigation policies is on supply side management. For example, emissions trading schemes between producers have been implemented, announced or under consideration in most Annex B countries.

Carbon labelling

Carbon labelling enables consumers to take into account, on a voluntary basis, the environmental damage costs associated with the product. Assume the carbon label is mandatory — that is, the carbon label applies to all producers in the industry — such that all consumers have full

continued...

box 2 Effects of carbon labelling in a simplified economic framework *continued*

information about the carbon footprint of the product. Consumer demand is influenced by the introduction of the carbon label — the demand curve under a carbon label is given by the marginal benefit of consumption, less the willingness of consumers to pay (or forgo consumption) to reduce environmental damage. As a result, production, price and environmental damage costs are all reduced under the carbon label.

An important issue is the extent to which consumer demand is influenced by the carbon label. In theory, carbon labelling would be sufficient to address the negative externality if consumers are assumed to be fully rational, have perfect information about the environmental damage caused by carbon emissions and respond optimally to the carbon label. However, the carbon label is likely to only partly correct the negative externality because of the limited ability of consumers to assess the damage costs and free riding by some consumers. The success of a carbon label in achieving behavioural change will be significantly influenced by consumer sensitivity to the environment (Abe et al. 2002). However, there is a risk that some unconcerned consumers may increase demand in response to lower prices of emissions intensive products (Mattoo and Singh 1997).

If consumers are responsive to the carbon footprint information, carbon labelling may encourage producers to invest in low emissions technologies (Garvie 1999). Low emissions technologies include, for example, production processes with lower carbon emissions and carbon abatement equipment. More broadly, carbon labelling may be considered to be a demand pull policy option that encourages technology research, development and adoption — an important aspect, given market failures in innovation.

For simplicity, the costs in implementing the carbon label are ignored in the above discussion. Administrative costs are an important aspect of any assessment of the net economic benefits of a carbon label and are discussed later in this chapter.

Trade-environment linkages: coordinated international policy response

The economic impacts of carbon labelling in a simplified two country world are examined in appendix B, where pollution is assumed to occur as a by-product of production in both countries. In the absence of a policy response, the negative production externality results in global overproduction and excessive pollution. In the optimal global market outcome, both countries would reduce pollution to optimal levels by adopting supply side or demand side management options or some combination of these policy approaches.

A coordinated international policy response is critical in achieving the optimal global market outcome. For example, emissions trading schemes between producers are supply side management options that aim to directly limit the production of carbon emissions in the country or region in which they apply. In principle, production-based emissions trading schemes applied consistently across all countries with coverage of all carbon emissions would be sufficient to address the global climate change problem (see appendix B).

Consistent with the analysis for a single closed economy, the introduction of carbon labelling in both countries would reduce global production, price and environmental damage costs, compared with the outcome under no policy action. Carbon labelling would address information market failures in climate change but, as noted above, the extent to which consumer demand in each country would be influenced by the carbon label is uncertain given, for example, free riding issues among consumers.

The economic impacts of an asymmetric policy response in the simplified two country world are examined in appendix B. Production decisions are assumed to be based on social marginal costs in country A (the net importer) and private marginal costs in country B (the net exporter). Compared with the outcome of no policy action in either country, production and environmental damage costs are reduced in country A, but an increase in the world price provides profit opportunities for producers in country B. Carbon leakage occurs as both production and carbon emissions increase in country B. Exports from country B increase, moderating the fall in consumption in country A.

Carbon labelling options under an asymmetric policy response

A broader role for carbon labelling may be considered in the case of an asymmetric global policy response. Three carbon labelling options are:

- **option 1 carbon label** — the carbon label contains information on the carbon footprint of the consumer product. This is the traditional carbon labelling approach, although a wide range of options are currently being implemented, piloted or developed
- **option 2 carbon policy label** — the carbon label signals to consumers the product's country of origin has an agreed carbon emissions target in a global climate change agreement
- **option 3 extended carbon label** — combines options 1 and 2; that is, a carbon label that also provides consumers with information on the policy status of the product's country of origin.

An important issue with option 1 is that consumers are not given information about the climate change policy of the product's country of origin. Option 2 provides consumers with this information — this would be the most administratively simple of the three options since this information is available (although not readily available to consumers at the point of sale). Option 3 aims to address information market failures where information is defined broadly to include the carbon footprint of the product and the policy status of the product's country of origin.

The economic impacts of two carbon labelling options — options 1 and 3 — are considered in appendix B. Under option 1, the carbon label applies to both domestic and imported products but is adopted only in country A. As a result, demand for the product is reduced in country A, the world price is reduced and production in each country is reduced. The introduction of the carbon label reduces carbon leakage to country B, but producers in country A are adversely affected by the carbon label since consumers in country A do not distinguish between the domestic and imported product.

Under option 3, the extended carbon label provides consumers with the additional information that there has been no policy progress in country B to reduce pollution compared with policy progress in country A. As a result, consumers in country A reduce demand for the product imported from country B where there are no agreed emissions targets.

Other issues

There are several issues which should be taken into account in any economic assessment of carbon labelling options. A carbon label would be a cost effective policy option if the assessed benefits outweigh the assessed costs. In the previous section, the economic impacts of mandatory carbon labelling were examined using a simplified supply-demand framework that, importantly, excluded the administrative costs associated with the scheme. In this section, some of the main issues that should be considered in assessing the net economic benefits of carbon labelling are discussed briefly.

Benefits of carbon labelling

Carbon labelling would address information market failures in climate change and facilitate consumer participation in the climate change policy response, by providing the following benefits:

- gives consumers information necessary to express their preferences in the market (Johnstone 2003)
- helps raise the level of consumer awareness about environmental issues (Bleda and Valente 2007)
- facilitates public acceptance of broader policy responses such as an emissions trading scheme, through information provision (Kennedy et al. 1994).

Carbon labelling could encourage behavioural change in consumers to achieve more sustainable consumption patterns. The costs of adjusting to a low emissions economy may be reduced when both price and non-price signals are used to reduce demand for relatively carbon intensive products. For example, consumer demand for some energy intensive products is not very responsive to changes in price.

However, as noted above, the benefits of carbon labelling are uncertain because of bounded rationality and free riding issues among consumers. The benefits would also depend on consumer perceptions of the reliability of the information, and access to the information — consumers may have limited access to the information under a voluntary carbon labelling scheme.

Costs of carbon labelling

There are two major concerns relating to the costs of carbon labelling:

- **high administrative costs** — concerns have been expressed that the PAS 2050 methodology is relatively high cost and time intensive (see Stancich 2008b)
- **double taxation for producers in countries with an agreed emissions target in a global climate change agreement** — the price of a product (with the same carbon footprint) would tend to increase in a country where carbon policies are adopted, since

the carbon price would be incorporated in the product's cost structure. In the absence of supplementary information on the carbon policy status of the product's country of origin, consumers would reduce demand for the higher priced product.

The administrative costs of carbon labelling would vary according to the methodology or standards adopted. A more complex methodology would tend to increase the cost of data collection and calculation of the carbon footprint and the cost of the verification process. Mandatory disclosure imposes costs on all producers, while voluntary labelling would occur only if the investment is assessed by producers to be profitable.

Net economic benefits of carbon labelling

There are issues associated with each stage of the carbon labelling process which should be considered when assessing the benefits and costs of any given option. An assessment of the net economic benefits of alternative methodologies for estimating the carbon footprint of consumer products is beyond the scope of this study, but is an important issue for future research. Boardman et al. (2007) and White et al. (2007) discuss a wide range of practical issues concerning carbon labelling, including the cost of calculating a carbon footprint.

International policy coordination would be important to reach agreement on a standardised carbon label methodology and to avoid the additional costs associated with meeting different standards under inconsistent national or regional systems. There is a risk that a carbon label may be used as a technical barrier to trade, especially if the design and implementation of a national carbon labelling scheme is not coordinated with other countries (see, for example, Beghin 2000; Basu and Chau 2001; Abe et al. 2002; and Brenton et al. 2008).

Much of the economics literature on eco labelling focuses on voluntary disclosure of information rather than mandatory disclosure (see, for example, Mattoo and Singh 1997; Garvie 1999; and Sedjo and Swallow 1999). Under a voluntary labelling scheme, producers only participate if there is a profit incentive to do so. An important risk in voluntary labelling is that firms will obtain a label for a specific product to project a green image for the entire firm (a concept known as 'greenwashing'). The aim is to achieve a green reputation for the firm to increase consumer demand for other products produced by the firm which may be relatively polluting (see, for example, Dosi and Moretto 2001). Garnaut (2008a,b) argues that disclosure schemes will be more effective if they are mandatory, although the disclosure mechanism needs to be designed to be easily understood by individuals (to avoid bounded rationality issues such that consumers are not able to usefully apply the information contained in the label). Issues in voluntary and mandatory labelling are discussed further in Golan et al. (2000).

There is a risk of consumer confusion about the reliability and interpretation of information provided in a carbon label. Third party verification of the estimate of the carbon footprint enhances the reliability and credibility, and hence effectiveness, of the carbon label. Market research may be used to test carbon labelling options, to reduce the risk of consumer confusion. Complementary information programs would also have a role. These include:

- **education program** — an education program to inform consumers about the interpretation of the labels could complement the introduction of a carbon labelling scheme
- **monitoring program** — the government may consider monitoring consumer use of carbon labelling. For example, calculation of a consumer carbon index (analogous to a consumer price index) may provide useful information on the carbon footprint of a representative household basket of consumer goods. Such information may also be disseminated through quarterly reporting, similar to the consumer price index outcome.

As indicated in chapter 2, negotiations for the post Kyoto agreement are currently in progress. Two key issues for the post Kyoto agreement are: updating carbon emissions targets for annex B countries; and agreeing to carbon emissions targets for non-annex B countries. Given the growing interest in carbon labelling in Europe, the United States and elsewhere, a more comprehensive analysis of carbon labelling options may be warranted. As Brenton et al. (2008, p. 2) argue: 'the main challenge that carbon labelling schemes face is that, on the one hand, they must be simple for reasons of cost effectiveness and ease of communication, yet, on the other hand, they must be comprehensive in order to capture the many opportunities for emissions savings throughout a supply chain'.

5 Conclusions

Product labelling addresses information market failures and is part of the climate change policy response in many countries. For example, the energy star ratings label provides consumers with information on the energy efficiency of whitegoods and other products. Empirical and anecdotal evidence suggests that well designed and targeted product labels, such as nutrition labels and energy performance labels, have a significant influence on consumer choices.

Food miles labelling has been argued by some environmental, community and farmer groups to be a proxy for the carbon footprint of food products. However, empirical evidence indicates that food miles is an unreliable indicator of carbon emissions in the food supply chain. For example, Saunders et al. (2006) found that carbon emissions from lamb and dairy products sold in the UK market are substantially lower when sourced from New Zealand compared with the United Kingdom, although the distance the food has travelled is substantially higher. Importantly, while food miles may have intuitive appeal among some consumers, food miles results in less informed, rather than more informed, consumption choices and global carbon emissions may increase as a result.

The objective in carbon labelling is to provide consumers with reliable information on the carbon footprint of food and other products. Carbon labelling would allow consumers the opportunity to reduce demand for relatively carbon intensive products and encourage producers to consider options for investing in low emissions technologies. However, the benefits of carbon labelling would need to be assessed against the costs.

A major issue with carbon labelling is that carbon footprinting methodologies such as the UK's PAS 2050 have high implementation costs (including the costs of data collection, calculation of the carbon footprint and third party verification of the estimate). A further issue is that producers in countries with agreed carbon emissions targets may be subject to a form of double taxation under a carbon label since the product's cost structure would already incorporate a carbon price.

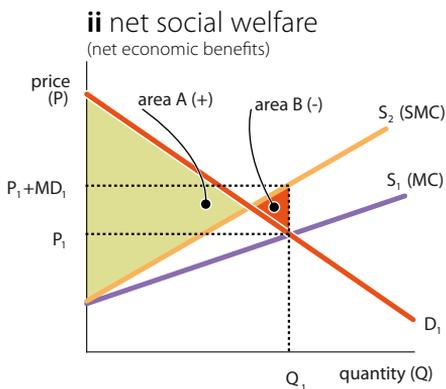
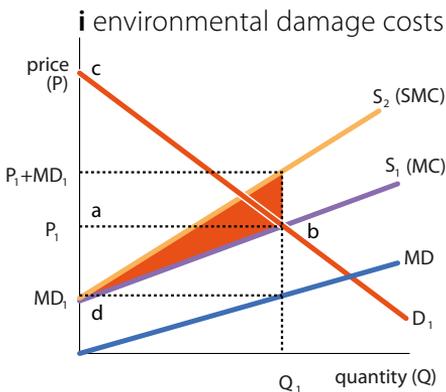
Carbon labels are being developed and trialled in several countries across Europe, North America and Asia. An important challenge for such countries is to ensure carbon labelling, if implemented, would represent a cost effective contribution to their climate change response.

Further economic research is required to assess the benefits, costs and risks of carbon labelling as an option that allows consumers to participate directly in the climate change response. In this context, potentially important future research directions may include: carbon labelling methodologies with a focus on assessing trade protection risks; and interactions of carbon labelling with other climate change policies.

A Simplified graphical analysis of carbon labelling in a single closed economy

In this appendix, a simplified supply-demand framework in a single closed economy is used to examine supply side (production-based) and demand side (consumption-based) policy options, when production of a good has negative environmental impacts, referred to as a negative production externality. Although production may impose external costs on the environment, there may be a role for demand side management in addressing the externality (that is, in reducing the level of pollution). Carbon labelling is a demand side policy option for reducing pollution (carbon emissions).

C Negative production externality in a single closed economy - no policy response



Market outcome with a negative production externality and no policy response

The simplified supply-demand framework for a product where there is a negative production externality and no policy response is presented in figure c. The marginal benefit of consumption is represented by the demand curve, D_1 , and the marginal cost (MC) of production is represented by the supply curve, S_1 (also referred to as the private MC curve). Production results in pollution which causes environmental damage — the cost of this damage is represented by the marginal damage curve, MD. These environmental damage costs may be added to the private marginal cost curve to derive the social marginal cost (SMC) of production — this is given by the supply curve, S_2 .

The market outcome where there is no policy response designed to address the negative production externality, occurs at the intersection of the demand curve and private supply curve — that is, where the marginal benefit of consumption equals the private marginal cost of production. In this market

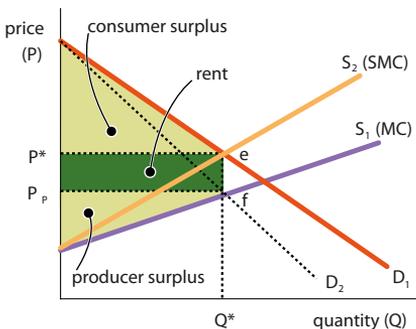
outcome, production is Q_1 and the market price is P_1 . Production provides economic benefits to consumers and producers — in figure c(i), the consumer surplus is given by area **abc** (the area where marginal benefits exceed the price paid) and the producer surplus is given by area **abd** (the area where the price received exceeds the marginal cost of production).

The marginal damage associated with production of Q_1 is given by MD_1 , and the social marginal cost, given by $P_1 + MD_1$, exceeds the marginal benefit of the product to society, given by P_1 . The total environmental damage costs associated with this level of production are given by the shaded area in figure c(i) between the private and social marginal cost curves. The net effect of the economic benefits and environmental damage costs is illustrated in figure c(ii) — net social welfare, also referred to as net economic benefits, is the consumer surplus plus the producer surplus, less environmental damage costs.

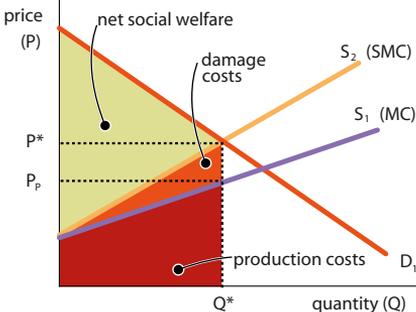
Optimal supply side or demand side management of a negative production externality

d Optimal supply side or demand side management

i distribution of economic benefits



ii net social welfare (net economic benefits)



From the analysis above, a negative production externality results in overproduction and excessive pollution. The objective in government policy is to achieve a level of production whereby the level of pollution is reduced to the socially optimal level. The government may choose to adopt supply side policies, demand side policies or some combination of these policies to address a negative production externality. Optimal supply side or demand side management is illustrated in figure d. A mixed approach is considered in the next section.

Optimal supply side management — polluter pays principle (PPP)

Optimal supply side management of a negative production externality is based on the polluter pays principle (PPP) and includes policy options such as an emissions trading scheme between producers and a pollution tax on production. Through supply side management, the damage costs of pollution are incorporated in the production decisions of producers. That is, the externality is internalised by ensuring production decisions are consistent with the social marginal cost

of production. The optimal market outcome is achieved where demand (the marginal benefit of consumption) equals the social marginal cost of production (the private marginal cost of production plus the marginal damage from production) such that, compared with figure c(i), production is reduced to Q^* and the consumer price is increased to P^* in figure d(i). The optimal market outcome is achieved if, for example, the government imposes a production tax equal to the vertical distance ef in figure d(i).

The distribution of economic benefits is indicated in figure d(i). Most notably, constraining production to Q^* generates rent which would be captured by the government under a production tax or an emissions trading scheme, with an auction of the pollution permits. If the permits are distributed without charge, the rent would be captured by producers. Net social welfare or net economic benefits, indicated in figure d(ii), is equal to the sum of the consumer surplus, rent and producer surplus, less the environmental damage costs.

Optimal demand side management — user pays principle (UPP)

Optimal demand side management of the externality is based on the user pays principle (UPP) and includes policy options such as an emissions trading scheme between consumers and a pollution tax on consumption. In this approach, the externality is internalised by ensuring consumers take into account the environmental damage costs in their consumption decisions. That is, consumption decisions are based on the demand curve, D_2 , which is adjusted to include the marginal damage costs (this is the social marginal benefit of consumption). The optimal market outcome is the same as under supply side management where production of Q^* has a consumer price of P^* . The net social welfare in figure d(ii) is identical under optimal supply side or demand side management. Notably, the consumer surplus is the same under each approach, since the marginal benefit of consumption is represented by the original demand curve, D_1 , in each case.

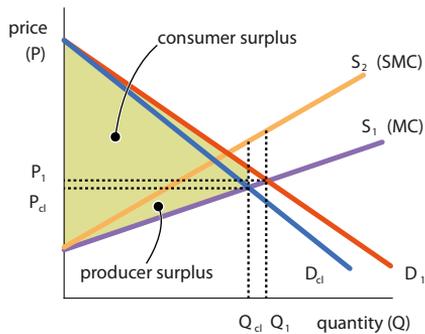
Carbon labelling

Carbon labelling is a demand side management option which may, at least partly, address a negative production externality. The economic impact of a carbon labelling system is illustrated in figure e — in the absence of other government policies in figure e(i) and with complementary supply side management in figure e(ii). In each case, it is assumed that the carbon label applies uniformly to all producers in the industry so that consumers have full information about the carbon footprint of the product. The objective in the carbon label is to provide information to enable consumers to take into account, on a voluntary basis, the environmental damage costs associated with the product. However, the nature and extent of the swivel, or shift, in the demand curve under a carbon label depends on the consumers' willingness to pay (or forgo consumption) to reduce pollution and the presence of market failures (bounded rationality and free riding by some consumers).

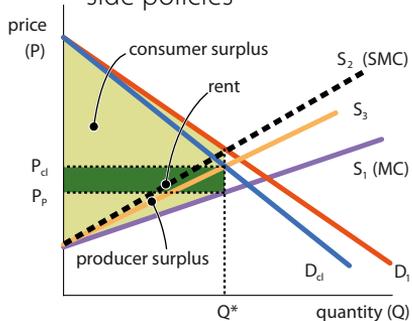
If consumers are assumed to be fully rational, have perfect information about the environmental damage caused by carbon emissions, and respond optimally to the carbon label, the demand curve under a carbon label would shift from D_1 to D_2 , as given in figure d(i).

e Carbon labelling as a demand side management option

i without other policies



ii with complementary supply side policies



a carbon label, compared with no policy action. Under the carbon label, production is reduced to Q_{ci} and the common consumer and producer price is reduced to P_{ci} . Notably, economic benefits to producers decrease (that is, the producer surplus is lower) under the carbon label, compared with no policy action.

In figure e(ii), the government is assumed to introduce complementary supply side management policies to ensure that the optimal level of production, Q^* , is achieved to fully internalise the negative production externality. Compared with figure d(i), the introduction of the carbon label results in an increase in the consumer surplus and a fall in the rent (where the latter may be captured by government and/or producers under supply side management). The supply curve shifts from S_2 to S_3 as consumers contribute directly to reducing environmental damage costs, by shifting demand inward to D_{ci} . The carbon price faced by producers is reduced, as consumers effectively self tax their carbon use.

Importantly, to the extent that the introduction of a carbon label results in changes in consumer behaviour such that environmental damage costs are reduced, this contributes to the management of the negative production externality and reduces the burden on other

In this case, carbon labelling would allow the external cost of emissions to be fully internalised at the optimal level. However, consumers have different abilities to assess the damage costs associated with the emissions embodied in goods (bounded rationality issue). In addition, there is likely to be free riding by some consumers, who benefit from the price fall resulting from the actions of other consumers (that is, from consumers who reduce demand for the product according to their marginal willingness to pay for reduced environmental damage).

In figure e(i), the introduction of the carbon label, where the consumer response is limited by bounded rationality and free riding issues, is compared with the market outcome in figure c where there is no other policy response to the negative production externality. For simplicity, the administrative costs of the carbon label are ignored—that is, the supply curves are unchanged under the carbon label. Demand for the product is assumed to be influenced by the introduction of the carbon label. The marginal benefit of consumption less the willingness of consumers to pay (or forgo consumption) to reduce environmental damage, is given by the demand curve, D_{ci} . Production, price and environmental damage costs are all lower under

supply side and/or demand side policies to address the market failure. Voluntary labelling is examined, for example, in Garvie (1999) and Sedjo and Swallow (2002). Further economic aspects of a carbon labelling approach are discussed in the main text. Of course, in the above example, the socially optimal solution could equally be achieved using a supply side measure alone.

B Simplified graphical analysis of carbon labelling in two countries

In this appendix, the supply-demand framework used in appendix A is extended to a two country world to analyse environment-trade linkages, including carbon leakage, and carbon labelling options. Pollution occurs as a by-product of production in both countries, referred to as countries A and B (that is, the negative production externality occurs in both countries A and B).

No international policy response

The effect of trade between countries A and B, where the negative production externality is not addressed in either country, is illustrated in figure f. For simplicity, it is assumed country A is larger than country B, but the private and social marginal costs of production in each country are identical. In country A, demand is represented by the curve, D_{A1} , and the private and social marginal costs of production are represented by the curves, S_{A1} and S_{A2} , respectively; the corresponding curves are indicated by a subscript B for country B. It is further assumed that the national value of the marginal damage of pollution is consistent with the global value of the marginal damage of pollution from each country (that is, global damage costs are equal to the sum of damage costs in each country).

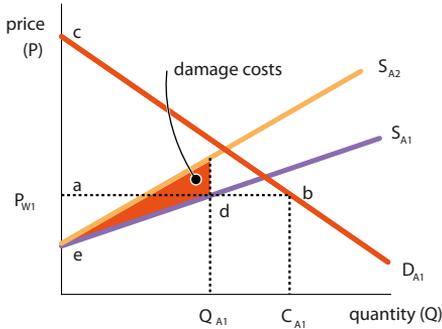
Without trade, production, price and environmental damage costs are higher in country A than in country B, reflecting the higher level of demand in country A. For brevity, the market outcome in each country when there is no international trade is not indicated explicitly in figure f. The market outcome for a closed economy was discussed in appendix A and the economic impact of trade in the presence of a negative production externality is discussed in, for example, Anderson (1999).

Most notably, with trade, there are opportunities for consumers in country A to benefit from access to lower priced imports from country B and, correspondingly, there are opportunities for producers in country B to benefit from access to an export market which is willing to pay a higher price than the domestic market. The price mechanism equilibrates supply (private marginal cost) and demand (marginal benefit) in the two countries. The market outcome is indicated in figure f where, at the world price P_{W1} , country A is a net importer with production of Q_{A1} and consumption of C_{A1} , and country B is a net exporter with production of Q_{B1} and consumption of C_{B1} .

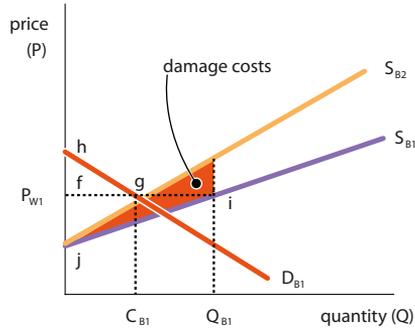
The environmental damage costs associated with production in each country is indicated by the shaded areas in figure f(i). The environmental damage costs are similar in the two countries, reflecting the assumption that cost structures and marginal damage are the same in each country (international transport costs are also ignored for simplicity — this issue is discussed further in the main text). The economic benefits production provides to consumers

f Negative production externality in a two country world
no policy response

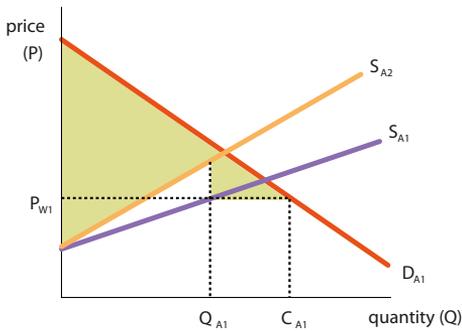
i environmental damage costs
country A - net importer



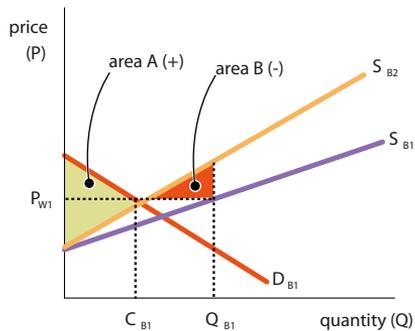
country B - net exporter



ii net social welfare (or net economic benefits)
country A - net importer



country B - net exporter



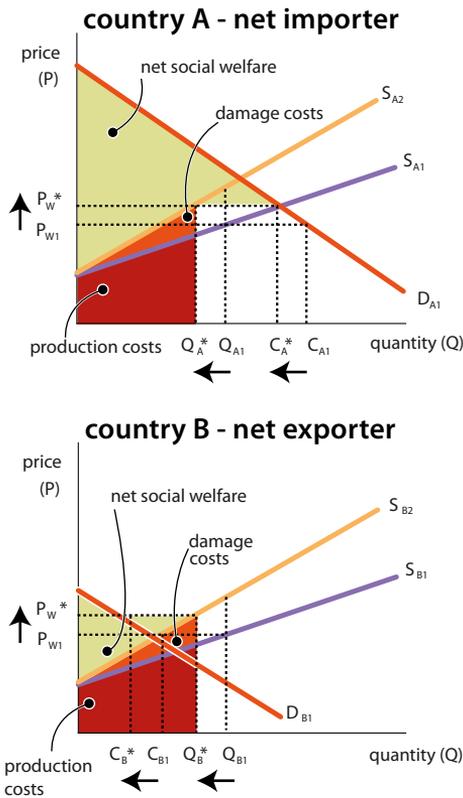
and producers are also indicated in the figure. In country A, the consumer surplus is given by area **abc** (the area where marginal benefits exceed the world price) and the producer surplus is given by area **ade** (the area where the world price exceeds the marginal cost of production). In country B, the consumer surplus is given by the area **fgh** and the producer surplus is given by the area **fij**.

Net social welfare or net economic benefits — the net effect of the economic benefits and the damage costs to the environment — is illustrated in figure f(ii). Net social welfare is the consumer surplus plus the producer surplus, less environmental damage costs.

Optimal global environmental policy response

In the optimal global market outcome illustrated in figure g, both countries are assumed to adopt supply side management policies to reduce pollution to optimal levels. The world price increases from P_w to P_w^* , reducing global production and associated environmental damage

g Optimal global environmental policy response



costs. Production falls to Q_A^* in country A and Q_B^* in country B, while consumption fall to C_A^* in country A and C_B^* in country B.

As noted in appendix A, the optimal outcome may be achieved through supply side or demand side management options, or some combination of these policy approaches. The carbon label is a demand side management option which allows consumers to voluntarily reduce their demand for relatively carbon intensive products. The economic impact of a carbon label was illustrated in figure e for a single closed economy, both without and with complementary supply side management to achieve the optimal market outcome. Carbon labelling is examined further in the next two sections.

Carbon labelling in both countries — no other policy response

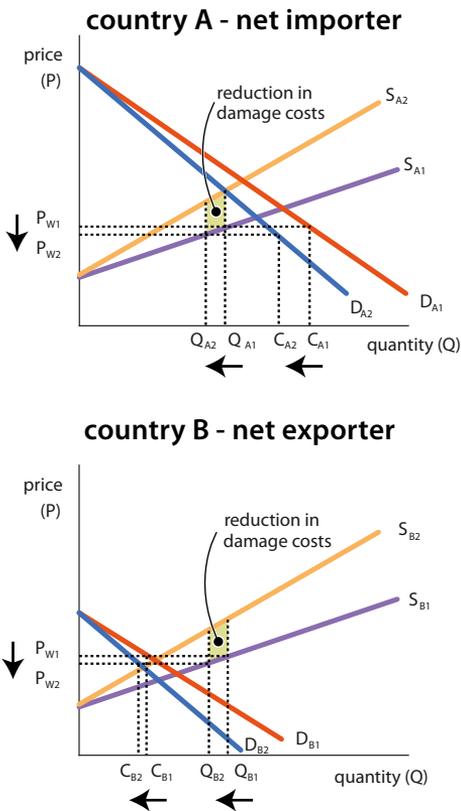
Carbon labelling is assumed to be introduced in both countries as a demand side management option to reduce the environmental damage costs associated with production. Consistent with the approach in appendix A, it is assumed that the carbon label applies uniformly to all

producers in the industry so that consumers have full information about the carbon footprint of the product. The economic impact of carbon labelling, in the absence of other government policies, is illustrated in figure h.

Demand for the product in each country is assumed to be influenced by the introduction of the carbon label. The marginal benefit of consumption, less the willingness of consumers to pay to reduce environmental damage, is given by the demand curves, D_{A2} in country A and D_{B2} in country B. Production, price and environmental damage costs are all lower under a carbon label, compared with no policy action. Under the carbon label, the world price is reduced to P_{W2}^* , production is reduced to Q_{A2} in country A and Q_{B2} in country B, and consumption is reduced to C_{A2} in country A and C_{B2} in country B. Notably, environmental damage costs are reduced in both countries. The effect of the carbon label on the economic benefits to consumers and producers is not identified explicitly in the figure (for brevity).

Consistent with the analysis in appendix A, the introduction of a carbon label may encourage consumers to reduce their demand for carbon intensive products, reducing environmental

h Carbon labelling in both countries no other environmental policy response



damage costs and the burden on other supply side and/or demand side policies, to address the market failure. To remain concise, the more complex case of carbon labelling with complementary supply side policies is not considered explicitly here (see figure e(ii) for the outcome in a single closed economy).

Policy response in country A only — carbon labelling and carbon leakage

The optimal global market outcome in figure g requires international policy agreement on emissions reduction targets for each country, and policy implementation to achieve those targets. An issue which has generated considerable concern is the potential for carbon leakage under an asymmetric policy response. Carbon leakage and two carbon labelling options defined in chapter 4 are illustrated in figure i, under the assumption that only country A chooses to adopt supply side

management policies to reduce environmental damage costs. In this case, carbon labelling is assessed for its potential to offset, at least partly, the extent to which pollution increases in country B, following environmental policy action in country A only.

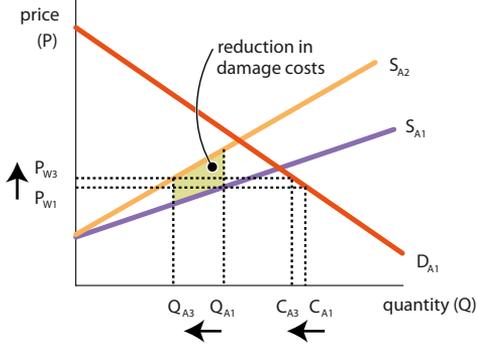
No carbon label

In the absence of carbon labelling, the effect of supply side policies applied only in country A is illustrated in figure i(i). In this case, production decisions are assumed to be based on the social marginal cost curve in country A (curve S_{A2}) and the private marginal cost curve in country B (curve S_{B1}). Compared with the outcome of no policy action in either country, as given in figure f, the world price increases from P_W^* to P_{W3} when there is a policy response in country A only — P_{W3} is still lower than P_W^* under the optimal policy response given in figure g. Production in country A falls from Q_{A1} to Q_{A3} as a result of higher domestic production costs (because of an emissions trading scheme or a carbon tax on production). Environmental damage costs are also reduced in country A. The effect of lower production on consumption in country A is partly offset by increased exports from country B. Importantly, the higher world price provides profit opportunities to producers in country B — carbon leakage occurs as both production and environmental damage costs increase in country B.

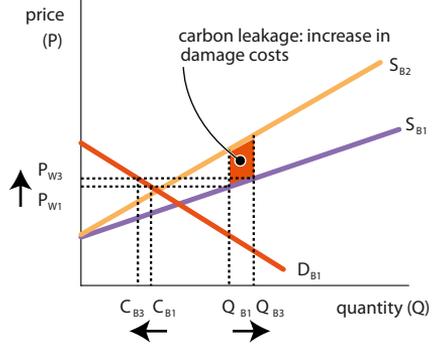
i Policy response in country A only
carbon labelling and carbon leakage

i no carbon label

country A - net importer

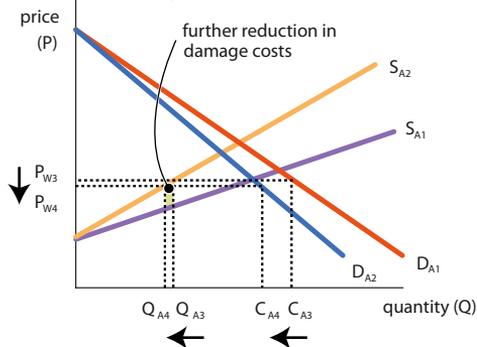


country B - net exporter

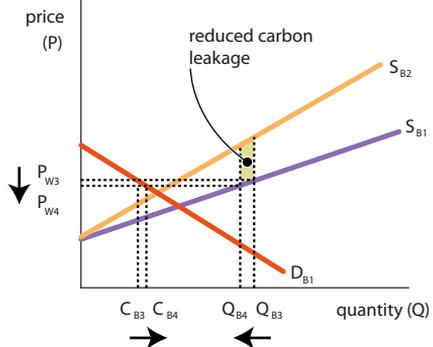


ii carbon label (option 1) in country A

country A - net importer

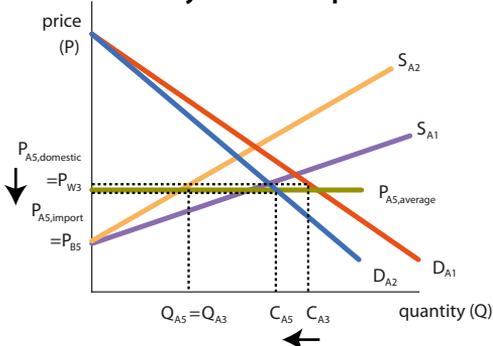


country B - net exporter

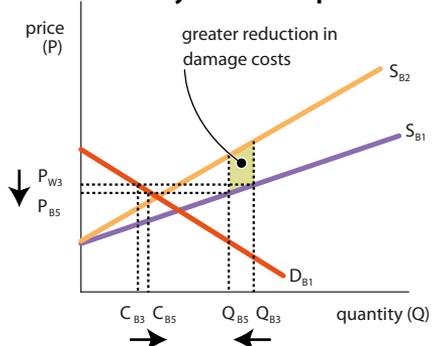


iii extended carbon label (option 3) in country A

country A - net importer



country B - net exporter



Carbon label (option 1)

The carbon label, illustrated in figure i(ii), is assumed to provide information on the carbon footprint of the product, where the label applies to both the domestic and imported product. Under a carbon label adopted only in country A, demand for the product is reduced in country A, the world price is reduced from P_{W3} to P_{W4} and production in each country is reduced. The introduction of a carbon label reduces carbon leakage to country B, but producers in country A are adversely affected by the carbon label since consumers in country A do not distinguish between the domestic and imported product (the carbon intensity of the product is assumed to be the same in country A and country B).

Extended carbon label (option 3)

The extended carbon label, illustrated in figure i(iii), is assumed to provide additional information on the environmental policy status of the product's country of origin. Under an extended carbon label adopted only in country A, consumers are given the additional information that there has been no policy progress in country B to reduce pollution, compared with policy progress in country A.

In figure i(iii), the introduction of the extended carbon label is assumed to result in consumers reducing demand, but only for the imported product where no policy progress has been achieved to reduce pollution in the country of origin. The outcome is unchanged demand for the domestic product from the no carbon label case — that is, production in country A is unchanged such that $Q_{A5} = Q_{A3}$. Consumers in country A differentiate between the domestic and imported product, resulting in a price differential based on country of origin (under the assumption that the carbon intensity is identical in each country). In country A, the price of the domestically produced product is $P_{A5' \text{ domestic}} (=P_{W3})$, the price of the imported product is $P_{A5' \text{ import}} (=P_{B5})$ and the average price is $P_{A5' \text{ average}}$ (weighted average of the domestic and import prices). Both production and environmental damage costs are reduced in country B, offsetting to some extent the carbon leakage which occurred when country A unilaterally applied supply side environmental policies.

The extended carbon label enables consumers to target products and countries which have achieved limited, if any, progress in addressing environmental damage costs. Carbon leakage concerns may be more effectively addressed under an extended carbon label than under a carbon label, but a more detailed economic assessment of these options is required.

References

- ABARE 2009, *Australian commodities*, vol. 16, no. 1, March quarter, Canberra.
- Abe, K, Higashida, K and Ishikawa, J 2002, 'Eco-labelling, environment, and international trade', chapter 10 in RM Stern (ed.), *Issues and Options for U.S.-Japan Trade Policies*, University of Michigan Press, Michigan.
- Australian Conservation Foundation (ACF) 2005, 'Cut back on 'Food Miles'', 3 August, available at www.acfonline.org.au.
- 2008, 'Food mile facts', available at www.acfonline.org.au, accessed 30 April.
- AEA Technology 2005, *The Validity of Food Miles as an Indicator of Sustainable Development*, final report produced for DEFRA, United Kingdom, July.
- Anderson, K 1999, 'The standard welfare economics of policies affecting trade and the environment', in K Anderson and R Blackhurst (eds), *The Greening of World Trade Issues*, Harvester Wheatsheaf, United Kingdom, pp. 25-48.
- Australian Government Department of Climate Change 2008a, *Carbon Pollution Reduction Scheme Green Paper*, Canberra, July, available at www.greenhouse.gov.au.
- 2008b, *Carbon Pollution Reduction Scheme: Australia's Low Pollution Future White Paper*, Volume 1, Canberra, December, available at www.climatechange.gov.au.
- Australian Government Treasury 2008, *Australia's Low Pollution Future: The Economics of Climate Change Mitigation*, Canberra, October, available at www.treasury.gov.au.
- Babiker, MH 2005, 'Climate change policy, market structure and carbon leakage', *Journal of International Economics*, vol. 65, no. 2, pp. 421-45.
- Barker, T, Bashmakov, I, Alharthi, A, Amann, M, Cifuentes, L, Drexhage, J, Duan, M, Edenhofer, O, Flannery, B, Grubb, M, Hoogwijk, M, Ibitoye, FI, Jepma, CJ, Pizer, WA, Yamaji, K 2007, 'Mitigation from a cross-sectoral perspective', chapter 11, in B Metz, OR Davidson, PR Bosch, R Dave, LA Meyer (eds), *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, United Kingdom and New York.
- Basu, AK and Chau, NH 2001, 'Market access rivalry and eco-labeling standards: are eco-labels non-tariff barriers in disguise?', working paper WP2001-15, Department of Applied Economics and Management, Cornell University, Ithaca, New York, August.
- BBC News 2006, 'Green issues 'concern shoppers'', 6 November, available at <http://newsvote.bbc.co.uk>.
- 2007, 'Labels reveal goods' carbon cost', 16 March, available at <http://newsvote.bbc.co.uk>.
- 2008, 'Supermarket trials carbon labels', 29 April, available at <http://newsvote.bbc.co.uk>.
- Benn, H 2008, 'Bread and roses: the politics of food - a Fabian Society Lecture by Hilary Benn', speech by the Rt Hon Hilary Benn MP, 10 December, available at www.defra.gov.uk.
- Beghin, JC 2000, 'Environment and trade in developing economies: a primer for the World Bank's Global Economic Prospects 2001', working paper 00-WP 247, Center for Agricultural and Rural Development, Iowa State University, Iowa, September.

- Bjorner, TB, Hansen, LG and Russell, CS 2004, 'Environmental labelling and consumers' choice—an empirical analysis of the effect of the Nordic Swan', *Journal of Environmental Economics and Management*, vol. 47, no. 3, pp. 411-34.
- Bleda, M and Valente, M 2007, 'Graded eco-labels: a demand-oriented approach to reduce pollution', presented at the 5th International EMAEE Conference, 17-19 May, MMU Business School, Manchester, UK.
- Boardman, B, Bright, S, Ramm, K and White, R 2007, *Carbon Labelling: Report on Roundtable*, final report for the Tesco-ECI (Environmental Change Institute) Carbon Labelling Workshop 3-4 May, organised by UKERC (UK Energy Research Centre), St Anne's College, University of Oxford, available at www.eci.ox.ac.uk.
- Bohringer, C, Rutherford, TF and Voß, A 2008, 'Global CO₂ emissions and unilateral action: policy implications of induced trade effects', *International Journal of Global Energy Issues*, vol. 11, nos. 1-4, pp. 18-22.
- Brenton, P, Edwards-Jones, G and Jensen, MF 2008, 'Carbon labelling and poor country exports', PREMnotes, Number 4, *Special Series on the Economics of Climate Change*, July, World Bank, Washington DC, available at www.worldbank.org.
- Byron Shire Council 2008, 'What are 'Food Miles'?', available at www.byron.nsw.gov.au, accessed 6 May.
- Carbon Trust 2006a, *The Carbon Emissions Generated In All That We Consume*, United Kingdom, January, available at www.carbontrust.co.uk.
- 2006b, *Carbon Footprints in the Supply Chain: The Next Step For Business*, United Kingdom, November, available at www.carbontrust.co.uk.
- 2006c, *The Carbon Trust Three Stage Approach To Developing A Robust Offsetting Strategy*, United Kingdom, November, available at www.carbontrust.co.uk.
- 2007, *Carbon Footprinting: An Introduction For Organisations*, United Kingdom, August, available at www.carbontrust.co.uk.
- 2009, 'The carbon reduction label: helping business and consumers reduce their carbon footprints together', available at www.carbon-label.com, accessed 16 January.
- DEFRA (UK Government Department for Environment, Food and Rural Affairs) 2006, *Food Industry Sustainability Strategy*, London, April, available at www.defra.gov.uk.
- 2008, *Ensuring the UK's Food Security in a Changing World*, DEFRA discussion paper, London, July, available at www.defra.gov.uk.
- Doherty, M 2008, 'Market turbulence: veggie swindlers weeded out', *Canberra Times*, p. 1, Canberra.
- Dosi, C and Moretto, M 2001, 'Is ecolabelling a reliable environmental policy measure?', *Environmental and Resource Economics*, vol. 18, no. 1, pp. 113-27.
- Fairtrade Labelling Organizations International 2008, *An Inspiration for Change: Annual Report 2007*, Bonn, Germany, available at www.fairtrade.net.
- Farmers Weekly 2008, 'The food miles campaign', available at www.fwi.co.uk, accessed 1 May.

- Gaballa, S and Abraham, AB 2008, *Food Miles In Australia: A Preliminary Study of Melbourne, Victoria*, CERES Community Environment Park, March, available at www.ceres.org.au.
- Garnaut, R 2008a, *Garnaut Climate Change Review Draft Report*, June, Canberra, available at www.garnautreview.org.au.
- 2008b, *The Garnaut Climate Change Review Final Report*, September, Canberra, available at www.garnautreview.org.au.
- Garvie, D 1999, 'Self-regulation of pollution: the role of market structure and consumer information' in B Bortolotti and G Fiorentini (eds), *Organized Interests and Self-Regulation: An Economic Approach*, Oxford University Press, pp. 206-35.
- George Wilkenfeld and Associates & Energy Efficient Strategies 1999, *Regulatory Impact Statement—Energy Labelling and Minimum Energy Performance Standards for Household Electrical Appliances in Australia*, Prepared for the NSW Department of Energy and the Australian Greenhouse Office, Sydney, February, available at www.energyrating.gov.au.
- Golan, E, Kuchler, F, Mitchell, L, Greene, C and Jessup, A 2000, *Economics of Food Labeling*, Agricultural Economic Report No. 793, Economic Research Service, US Department of Agriculture, Washington DC, available at www.ers.usda.gov.
- Gupta, S, Tirpak, DA, Burger, N, Gupta, J, Hohne, N, Boncheva, AI, Kanoan, GM, Kolstad, C, Kruger, JA, Michaelowa, A, Murase, S, Pershing, J, Saijo, T and Sari, A 2007, 'Policies, instruments and co-operative arrangements', chapter 13, in B Metz, OR Davidson, PR Bosch, R Dave, LA Meyer (eds), *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, United Kingdom and New York.
- Harris, J and Cole, A 2003, 'The role for government in ecolabelling – on the scenes or behind the scenes?', paper prepared for a conference on The Future of Ecolabelling in Australia, jointly organised by the Regulatory Institutions Network (ANU) and The Australian Environmental Labelling Association, Australian Academy of Science, Canberra, October 9-10, Department of Primary Industries, Victoria.
- Heaney, A, Hester, S, Gurney, A, Fairhead, L, Beare, S, Melanie, J and Schneider, K 2005, *New energy technologies: measuring potential impacts in APEC*, APEC energy working group, report no. APEC#205-RE-01.1, published by ABARE as research report 05.1, Canberra, April.
- Hogan, L, Curtotti, R and Austin, A 2007, *APEC energy security and sustainable development through efficiency and diversity: economic issues in technology R&D, adoption and transfer*, ABARE research report 07.12 prepared for the Australian Government Department of Industry, Tourism and Resources, Canberra, May.
- Holt, S and Harrington, L 2002, 'Lessons learnt from Australia's standards & labelling program', paper presented to ECEEE Summer Study, 2-6 June, available at www.energyrating.gov.au.
- IPCC (Intergovernmental Panel on Climate Change) 2007a, *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, S Solomon, D Qin, M Manning, Z Chen, M Marquis, KB Averyt, M Tignor and HL Miller (eds), Cambridge University Press, Cambridge, United Kingdom and New York.

- 2007b, *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ML Parry, OF Canziani, JP Palutikof, PJ van der Linden and CE Hanson (eds), Cambridge University Press, Cambridge, United Kingdom and New York.
- 2007c, *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, B Metz, OR Davidson, PR Bosch, R Dave, LA Meyer (eds), Cambridge University Press, Cambridge, United Kingdom and New York.
- Johnstone, N 2003, 'Efficient and effective use of tradeable permits in combination with other policy instruments', paper presented at OECD Global Forum on Sustainable Development: Emissions Trading, OECD Headquarters, Paris, 17-18 March, available at www.oecd.org.
- Karl, H and Orwat, C 1999, 'Economic aspects of environmental labelling', in H Folmer and TH Tietenberg (eds), *The International Yearbook of Environmental and Resource Economics 1999/2000*, Edward Elgar, Cheltenham, United Kingdom, pp. 107-70.
- Kennedy, PW, Laplante, B and Maxwell, J 1994, 'Pollution policy: the role for publicly provided information', *Journal of Environmental Economics and Management*, vol 26, no. 1, pp. 31-43.
- Kollmuss, A, Zink, H and Polycarp, C 2008, *Making Sense of the Voluntary Carbon Market: A Comparison of Carbon Offset Standards*, Stockholm Environment Institute (SEI) and Tricorona, published by WWF (World Wildlife Fund), Germany.
- Mattoo, A and Singh, HV 1997, 'Eco-labelling, the environment and international trade', in R Vossenaar, V Jha and S Zarrilli (eds), *Eco-labelling and International Trade*, Macmillan Press, London, pp. 37-53.
- Mckie, R 2008, 'How the myth of food miles hurts the planet', *The Observer*, 23 March, available at www.guardian.co.uk.
- Ministry of the Environment, Japan 2008, *Approach to Japanese Emissions Trading Scheme Interim Report (Executive Summary)*, Advisory Committee on the Emissions Trading Scheme, available at www.env.go.jp/en.
- Muller, B 2007, 'Food miles or poverty eradication? The moral duty to eat African strawberries at Christmas', Oxford Institute for Energy Studies, Oxford Energy and Environment Comment, October, available at www.oxfordclimatepolicy.org.
- New Zealand Government 2009, *Summary of the Proposed Changes to the NZ ETS*, Emissions Trading Bulletin no. 11, September (available at www.climatechange.govt.nz).
- OECD 2008, *Counting Carbon in the Marketplace: A Scoping Paper*, Joint Working Party on Trade and Environment, COM/TAD/ENV/JWPTE(2008)58, Paris, 4-5 December.
- Rayner, J 2007, 'The man who invented food miles', *Observer Food Monthly*, Guardian News and Media, 25 March, available at <http://observer.guardian.co.uk>.
- Productivity Commission 2005, *The Private Cost Effectiveness of Improving Energy Efficiency*, report no. 36, 31 August, Canberra, available at www.pc.gov.au.
- 2008, *Annual Review of Regulatory Burdens on Business: Manufacturing and Distributive Trades*, draft research report, Canberra, June, available at www.pc.gov.au.

- Saunders, C, Barber, A and Taylor, G 2006, *Food Miles – Comparative Energy/Emissions Performance of New Zealand's Agriculture Industry*, research report no. 285, Lincoln University, New Zealand, July.
- Saunders, C and Hayes, P 2007, *Air Freight Transport of Fresh Fruit and Vegetables*, research report no. 299, report for the International Trade Centre (ITC), Geneva, October.
- Sedjo, RA and Swallow, SK 2002, 'Voluntary eco-labeling and the price premium', *Land Economics*, vol. 78, no. 2 (May), pp. 272-84.
- Soil Association 2007, 'Local food – overview', Information Sheet, 21 February, available at www.soilassociation.org.
- 2008, 'Ensuring limited organic air freight is fair and ethical', Press Release, 6 March, available at www.soilassociation.org.
- Spector, M 2008, 'In measuring carbon emissions, it's easy to confuse morality and science', *The New Yorker*, 25 February, available at www.newyorker.com.
- Stacey, C 2008, 'Food miles', *BBC Food*, February, available at www.bbc.co.uk.
- Stancich 2008a, 'Summary of global carbon labels', 5 December, available at www.climatechangecorp.com.
- 2008b, 'Special report: carbon labelling goes global', 5 December, available at www.climatechangecorp.com.
- Stern, N 2007, *The Economics of Climate Change: The Stern Review*, Cambridge University Press, Cambridge, United Kingdom (pre-publication edition available at www.hm-treasury.gov.uk).
- Stringer, RS and Umberger, WJ 2008, *Food Miles, Food Chains and Food Producers: Consumer Choices in Local Markets*, School of Agriculture, Food and Wine, University of Adelaide, available at http://www.thinkers.sa.gov.au/images/Food_miles_food_chains_and_food_producers.pdf.
- Sustain 2007, *Eat Well and Save the Planet! A Guide for Consumers on How to Eat Greener, Healthier and More Ethical Food*, December, available at www.sustainweb.org.
- Sydney Food Fairness Alliance 2008, 'The long journey of our well-travelled food: understanding food miles', discussion sheet, available at www.sydneyfoodfairness.org.au, accessed 6 May.
- Teisl, MR, Roe, B and Hicks, RL 2002, 'Can eco-labels tune a market? Evidence from dolphin-safe labeling', *Journal of Environmental Economics and Management*, vol. 43, no. 3, pp. 339-59.
- UNFCCC (United Nations Framework Convention on Climate Change) 2006, Synthesis Report on Regional Workshops on Article 6 of the Convention, FCCC/2006/SBI/17, Bonn.
- UK Cabinet Office 2008, *Food Matters: Towards a Strategy for the 21st Century*, The Strategy Unit, London, July, available at www.cabinetoffice.gov.uk.
- White, R, Boardman, B and Thottathil, S 2007, 'Carbon labelling: evidence, issues and questions', briefing paper for the Tesco-ECI (Environmental Change Institute) Carbon Labelling Workshop, 3-4 May, organised by UKERC (UK Energy Research Centre), St Anne's College, University of Oxford, available at www.eci.ox.ac.uk.

Wong, P 2008, 'Ministerial Statement – Carbon Pollution Reduction Scheme White Paper and medium-term target range for reducing Australia's carbon pollution', media release, Senator the Hon. Penny Wong, Minister for Climate Change and Water, 1 December, available at www.environment.gov.au.

World Wildlife Fund (WWF) 2001, 'Time to count the food miles?', 8 March, available at www.panda.org.

Wynen, E and Vanzetti, D 2008, *No Through Road: The Limitations of Food Miles*, ADB Institute Working Paper No. 118, Asian Development Bank Institute, Tokyo, October, available at www.adbi.org.

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