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Sustainability in Business Economics

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Introduction

The widely quoted definition of sustainable development, 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development 1987), requires that society carefully considers how best to use scarce resources that have competing uses. This is the mission of economics and for centuries economists have been considering the challenges of sustainable development, beginning with the work by Thomas Malthus on limits to growth (Malthus 1798), with prominent later additions such as Hotelling's work on the optimal extraction of non-renewable resources (Hotelling 1931), Ronald Coase on the problem of social cost (Coase 1960), and more recently work by David Pearce on the Green Economy (Pearce et al. 1989).

Mainstream economic thinking on sustainability has coalesced into the field of environmental economics, a branch of welfare economics

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(Perman et al. 2011). In keeping with the tradition of welfare economics, environmental economics is more comfortably taught as part of a syllabus that focuses on social, rather than private decisions. This legacy has meant that teaching sustainability in business economics has mostly focused on how governments change market signals, via green taxes, emissions trading, or subsidies, to coerce business into more sustainable modes of operation. Hence, sustainability in business economics is taught as a distinct topic within a business microeconomics module/course, focusing on the rationale and logic of government environmental policy intervention.

This chapter proposes that practice has now moved beyond this view of sustainability in business economics. Sustainable action is often led by business as a means of gaining competitive advantage, creating, or destroying barriers to entry, or creating new markets. We suggest that sustainability thinking should be infused through both microeconomic and macroeconomic teaching, rather than being a distinct topic on a microeconomics module or course. This thinking follows the philosophy of the 2012 United Nations Conference on Sustainable Development, also known as 'Rio+20', which proposed that macroeconomic policy should be designed for sustainability in a 'top down' approach, known as the *green economy*, and firms should incrementally improve their environmental performance in a 'bottom up' approach, known as *green growth* (Barbier 2011, 2012).

Accordingly, we propose that a microeconomics syllabus should view sustainability from a firm's perspective, as a means of improving competitiveness, creating new barriers to entry, or disruptive innovation, rather than viewed entirely through a lens of government intervention. A macroeconomics syllabus should include questions around how to measure economic growth, adjusted for environmental gains and losses, or in a way that more closely links to human wellbeing. Consideration should also be given to what concepts such as the *green economy*, *circular economy* (Ghisellini et al. 2016), and *steady state economy* (Daly 1973) mean in the context of macroeconomic planning.

To date, environmental economics, by definition, has focused on markets and the environment. However, in practice firms must also consider their effect on employees and surrounding communities: the other pillar of sustainability. In this respect, theory and teaching can lead practice. While firms clearly understand and act upon their environmental responsibilities, they are less clear how best to add value to local communities and measure impact. Business economics courses can help build best practice in this respect. However, this chapter focuses on the current body of literature, so is more focused on environmental than social sustainability.

Sustainability in Business Economics

Following the Brundtland Commission's work (World Commission on Environment and Development 1987), economists set about understanding how economic concepts could be applied to help society achieve sustainable development. This led to two competing views of sustainability: *weak* and *strong*, which can be distinguished by the pattern of consumption of three types of capital (Hanley et al. 2006):

- *human capital*—the knowledge level, skills, and experience within society;
- *man-made capital*—the stock of goods that can be used to create other goods; and
- *natural capital*—stocks of natural resources, including biophysical cycles and biodiversity.

Weak sustainability allows human or man-made capital to be substituted for natural capital, as long as aggregate capital remains constant over time (stemming from work by Solow 1986 and Hartwick 1977). This is consistent with the requirements of welfare maximisation where ecological degradation is accepted as long as this creates compensating net benefits to society across generations. For instance, a habitat could be used for development as long as the gain in human and man-made capital exceeds the loss of natural capital. But, if taken to the extreme, this does raise tricky questions as to how we compare the value of the different forms of capital (Bordt 2018; O'Niell 1993)—how many textbooks compensate for the loss of a panda bear? Indeed several economists have questioned the long-term sustainability of weak sustainability (Ekins et al. 2003).

Strong sustainability differs in that natural capital is sacrosanct and society cannot be compensated for its loss (Aslaksen et al. 2013; Daly and Cobb 1989). Every capital vector must remain intact and stay above a critical minimum level of over time (Rao 2000). This is a more restrictive view of sustainable development and suggests economic development should only take place when it requires no natural capital, or where natural capital can be directly replaced. This view is precautionary, where natural capital levels are maintained to avoid any risks of permanent, catastrophic ecological damage (Aslaksen et al. 2013).

Thus, it should be appreciated that weak and strong sustainability are very different views, with the former becoming associated with environmental economics, the latter with ecological economics (Ang and Van Passel 2012). Environmental economics broadly studies the interdependence of business and the environment, with a focus on how markets can be used to manage environmental issues, whereas ecological economics is concerned with the management of ecological critical limits (Hanley et al. 2006). Hence ecological economics bridges economics and biophysical sciences, while environmental economics bridges business and the environment. This chapter focuses on environmental economics and weak sustainability, because it is more relatable to business studies. This does not mean that ecological economics is any less important, just that it will be studied in different educational contexts.

Teaching Sustainability in Business Economics

Environmental economics can be broadly understood and taught through the concept of optimal pollution (Fig. 4.1). The curve representing *marginal benefit of production (MB)* of a good or service is downward sloping, reflecting consumer willingness to pay: each successive unit of output is valued less highly than the previous unit. The *marginal damage cost of production (MDC)* is proportionate with output: more production causes more pollution and associated costs to society (e.g., health impacts associated with poor air quality). Where the MB curve crosses the MDC curve,

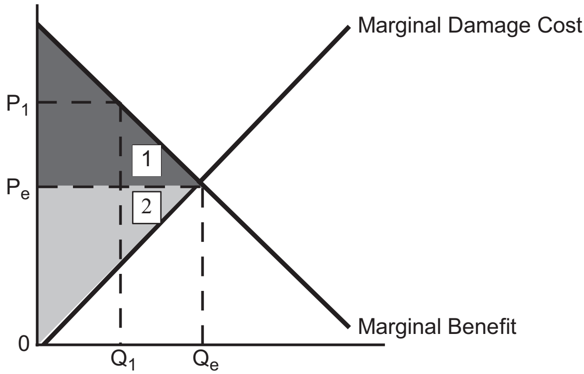

Fig. 4.1 The concept of optimal pollution

the benefits of production are equal to the costs such that any further increase in output will mean that social costs exceed benefits.

Similarly, any decrease in output will lower social wellbeing. For instance, a reduction in output from Q_e to Q_1 will reduce the number of transactions that could be made where benefits exceed damage costs, resulting in a deadweight loss of areas 1 and 2. Area 1 represents the loss of *consumer surplus*, transactions where consumers' willingness to pay (represented by MB) would have been above the price they would have actually had to pay (P_e). Area 2 represents lost supplier surplus, transactions where the revenue received (P_e) would have been in excess of MDC. Therefore, output at Q_1 is socially too low: the point of optimal pollution is a Pareto-optimal outcome.

The objective of environmental economics is to help society recognise and achieve optimal pollution. As a branch of welfare economics, environmental economics assumes that a perfectly functioning market will provide a Pareto-optimal allocation of resources, but recognises that markets fail in several ways, collectively termed *market failures*. *Market failures* are particularly pertinent for environmental goods and services, which tend to generate indirect value, but are not traded in the market place. For instance, wetlands offer flood protection to surrounding villages and towns, which would otherwise be periodically flooded, resulting in households paying higher insurance premiums. But as the wetland's function is a *public good*, it is not valued by the market. Therefore, the loss of environmental functions often manifest themselves as external costs (often referred to as *externalities*), lying outside the property rights system and the market.

Welfare economics views it as government's role to correct the market system so that damage costs are internalised in market price and costs (Johansson 1991). Therefore, achieving optimal pollution requires a monetised estimate of the environmental loss associated with MDC. To this end economists have developed several techniques, such as the *hedonic pricing method*, which derives a demand curve for the environmental characteristics of market goods, based on observations of user behaviour. For example, the decision to buy a house is partly related to the quality of the environment—Hedonic pricing isolates the element of the final sale price that is the buyer's desire to live within a particular environment (Rivas Casado et al. 2017; Glen and Nellis 2010). Another technique is the *contingent valuation method*, which asks people how much they would be willing to pay to attain an improvement in environmental quality, or how much they would be willing to accept in compensation for the loss of environmental amenity (Kahneman and Knetsch 1992). Through statistical analysis these methods construct a demand curve for an environmental amenity.

The second element of achieving optimal pollution is the design of instruments that correct market failures. This is usually achieved by changing the nature of incentives that firms and individuals face when transacting (Burtraw and Woerman 2013; Parson and Kravitz 2013; Hahn 2000). To this end several economic instruments have been proposed, such as environmental taxes, or emissions trading, which increase the cost of using the environment, while other instruments, such as subsidies, make it less expensive for firms to install technology that reduces pollution (Taylor et al. 2012; Jordan et al. 2003).

Thus, a session on sustainability in business economics can introduce the high-level concepts of weak sustainability and how markets can be corrected to provide sustainable development. This view on the topic is usually well received by students, broadening their thinking on sustainability and how government interventions affect industry profitability and competitiveness. The subject matter can be used to develop class debate about whether markets can be used to manage the environment or markets only damage the environment. However, many students fail to see the application of concepts to day-to-day business and this has been a frequent criticism in student feedback.

This criticism is difficult to avoid. Environmental economics treats sustainability from a societal viewpoint, focusing on how governments can intervene to correct markets. The mainstream textbooks say comparatively little about the organisational changes and economic trade-offs that occur inside a business when they have to respond to changes in government sustainability policy. In business education it is arguably more important for managers to understand how to respond to market changes, rather than the broad governmental drivers, although both clearly matter. Over the years we have found that increasingly, many students' interest goes beyond a broad understanding of weak sustainability to what businesses gain from sustainable action. A session on the basic drivers misses some crucial elements of the opportunities that arise from sustainable business. Therefore, there is scope for thinking more widely about how sustainability is applied to business.

A Conceptual Framework for Teaching Sustainability in Business Economics

Figure 4.2 presents a conceptual framework of how businesses interact with sustainability. The 'Societal Reference Point' can be interpreted as government's vision of sustainable development. It represents society's expectations of business environmental and social performance. The reference point is not static, but moves according to the attitudes of society at that time. Generally the direction has been upwards, moving the minimum acceptable standard higher. Traditional teaching on sustainability in business economics has been around the setting of this reference line: examining the drivers of sustainability, government sustainability targets, and what mechanisms are used to achieve these targets.

Below the reference line are the compulsory actions that businesses must take to meet the reference line and in so doing reduce operational

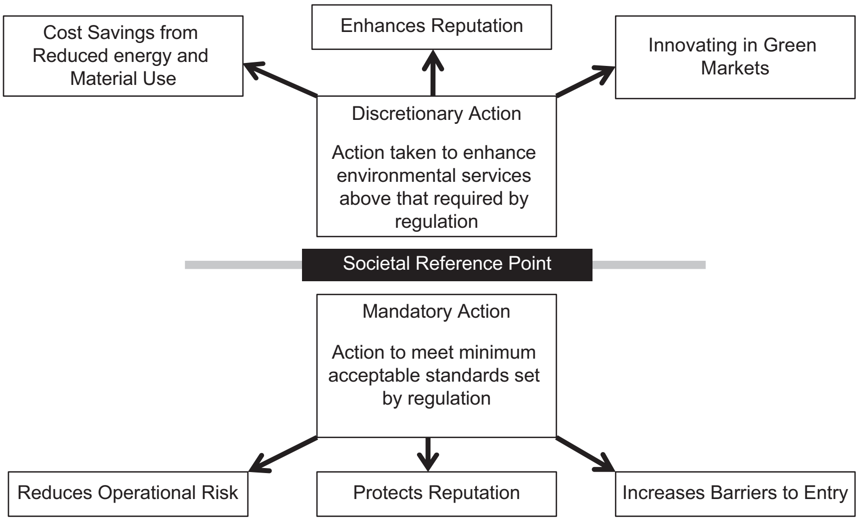

Fig. 4.2 The environmental reference level (Adapted from Hodge 1989)

risk, including mandatory shutdowns, legal action, and associated reputational impact. This is reactive. Business must comply with regulation to escape prosecution. However, this has some positive externalities, where increased compliance burdens raise the barriers to entry in particular industries. Furthermore, by complying with regulation the firm will avoid the reputational damage of any sustainability scandals.

Above the reference point are discretionary actions above minimum acceptable standards, where businesses perceive advantages of sustainable action. In other words, businesses are taking action beyond that required by regulation, motivated by a desire to reduce expenditure on energy or resources, to innovate and to defend existing market share or differentiate their products from competitors.

The foregoing describes a broad spectrum of activity that goes beyond the traditional focus on the reference line. It highlights three areas of business activity: compliance activity, resource efficiency, and market exploitation. Crucially these are important managerial competencies providing a more relevant focus for teaching sustainability in business economics. The following sections discuss how teaching can be focused on these managerial competencies.

Focusing Teaching on Business Compliance

The bulk of business sustainability activity will be organising compliance with government regulation, which usually requires firms to limit their emissions of a pollutant to the required standard, or remove dangerous processes or systems (reference line in Fig. 4.2). Sessions focused around regulatory compliance can be useful in equipping managers with a framework for understanding the operational implications of sustainability, while at the same time allowing the exploration of additional economic concepts such as cost-effectiveness. This teaching mode also makes the subject more relevant to managers than teaching based on optimal pollution.

Compliance with regulation entails a series of managerial and technical responses, all of which have a financial cost. To minimise the impact on a firm's competitiveness, it is imperative for the company to comply at least cost. *Cost-Effectiveness Analysis (CEA)* identifies management options capable of achieving a specified target at least cost, or making the best return from a specific input (Perman et al. 2011). CEA provides a framework for identifying, prioritising, and applying the emission reduction measures that achieve regulatory compliance at least cost. The output of CEA is a cost-effectiveness ratio, which provides a measure, for a given pollution reduction technology, of how much cost is required to achieve a unit reduction in pollution. In this way CEA does not require the calculation of the social benefits of an abatement action, which can be a difficult and expensive process.

A company can plan its most cost-effective response to regulation by arranging the cost-effectiveness ratios of all available abatement options in ascending order, known as a *Marginal Abatement Cost Curve (MACC)*. A MACC graphically represents the relative costs of achieving successive increases in pollution reduction over a specified timeframe (over and above some counterfactual) by successively adopting interventions in order of least marginal cost (Yin et al. 2018; Morris et al. 2009). Of course this requires that a manager has first collected information from specialists within a firm on the techniques available to reduce pollution, their reduction potential, and costs. Costs include additional investment costs, spread over the relevant investment life to give an annual equivalent cost, plus changes in annual operating costs such as fuel, maintenance, and other costs like training where relevant. MACCs are derived from models focused on emission reductions from industrial plants, but can be expanded to industrial sectors or countries (Liu and Feng 2018).

Table 4.1 shows example data for a MACC. The first column lists the various pollution (in this case CO_2) reduction techniques, the second lists the cost-effectiveness ratio of each abatement technique (expressed in $000/tonne), and the third lists the abatement potential of each technique. This can be visualised as a MACC (Fig. 4.3).

Figure 4.3 shows that some initial pollution abatement options, such as energy efficiency, which could include things like motion detecting lights, offer 'win-win' opportunities, with negative marginal abatement costs. Here, the avoided costs (energy bills) from energy efficiency exceed the cost of adopting the intervention. Beyond the 'win-win' options, which can collectively reduce emissions by 6 tonnes, achieving further emission reductions will involve extra net costs per unit of emission. Marginal abatement costs might be expected to be relatively small for small-scale options, but higher for methods that require large capital expenditure.

The MACC allows a manager to determine the most cost-effective way to respond to regulation. For instance, if this particular firm was required to reduce emissions by 18 tonnes then the most cost-effective response would be to install all techniques from energy efficiency to chemical scrubbers. Installing carbon capture and retrofitting machinery would be unnecessary.

Table 4.1 Example of marginal abatement cost data

	$000/tonne CO_2 reduced	Tonnes reduced
Energy efficiency	−5	1
Product lightweighting	−3	2
Solar panels	−1	3
Reconfigure build process	1	4
Chemical scrubbers	5	8
Carbon capture	7	2
Retrofit machinery	10	6

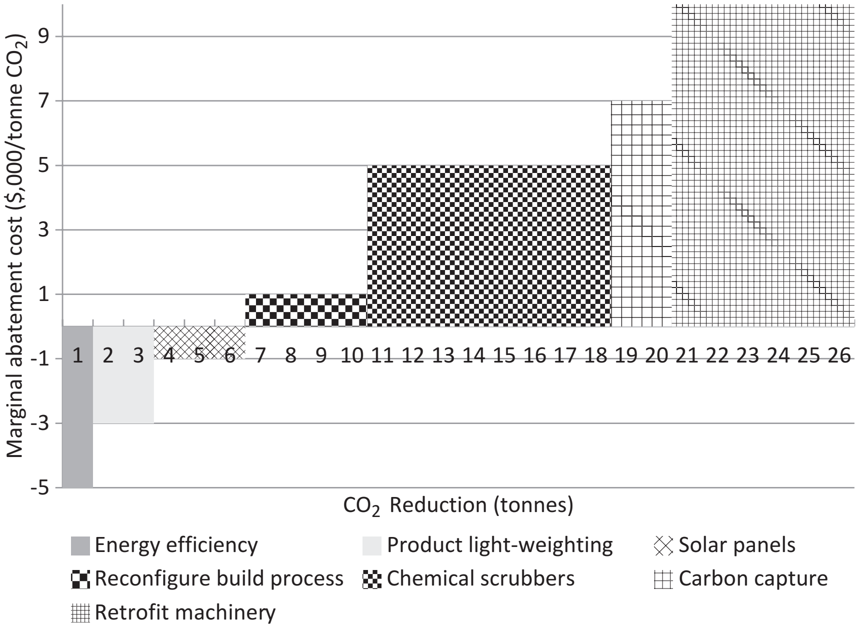

Fig. 4.3 A marginal abatement cost curve

Using multiple MACCs allows a more subtle insight into how regulation affects competitiveness. By comparing Figs. 4.3 and 4.4 it can be seen that the firm represented in Fig. 4.4 has higher abatement costs, so it will be more expensive for this firm to comply with the regulatory standard that requires a reduction of 18 tonnes CO_2, relative to the firm represented in Fig. 4.3.

This demonstration can be used as an entry point to a discussion of how environmental regulation could change the competitive nature of the sector. The firm in Fig. 4.3 could see environmental regulation as a low-cost way of reducing the market power of the firm in Fig. 4.4. This is why we see some firms lobbying for more stringent environmental regulation, because it disproportionately disadvantages their competitors.

MACCs can also be used to help managers understand the most cost-effective response to economic instruments, such as an emission tax. For instance, if a tax rate was set at $5000 per tonne of CO_2 emitted, then the firm represented in Fig. 4.4 would choose to install all techniques from

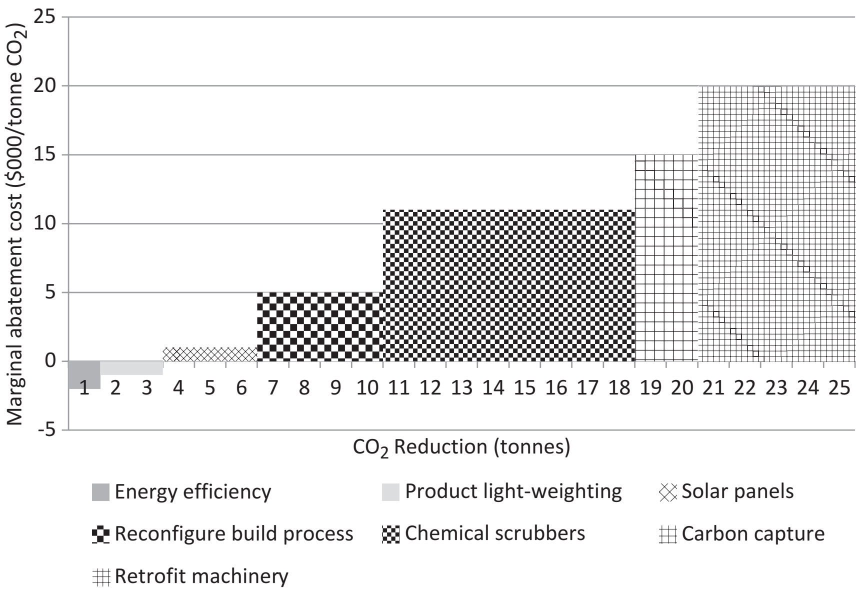

Fig. 4.4 A marginal abatement cost curve

energy efficiency to reconfiguring build process. This is because it would be less expensive to install these technologies than pay the $5000 per tonne CO_2 tax. However, it will pay a tax on the remaining 8 tonnes of CO_2 emitted, as paying the tax is less costly than installing carbon capture and retrofitting machinery.

The use of multiple MACCs allows the simulation of an emissions trading policy (see Corrigan 2011 and Ando and Harrington 2006 for good examples), which allows a demonstration of how the price of permits affects a firm's cost-effective response and how this policy instrument achieves regulatory requirements more cost-effectively than regulation. To teach these concepts the authors have developed a simulation of an industry comprising five firms, each with an equal market share. Each firm differs in terms of the type of product they manufacture, their capital vintage, and quantity of emissions. This means each firm has a different MACC (an example is given in Fig. 4.5), which represents a different business to the firms represented in Figs. 4.3 and 4.4.

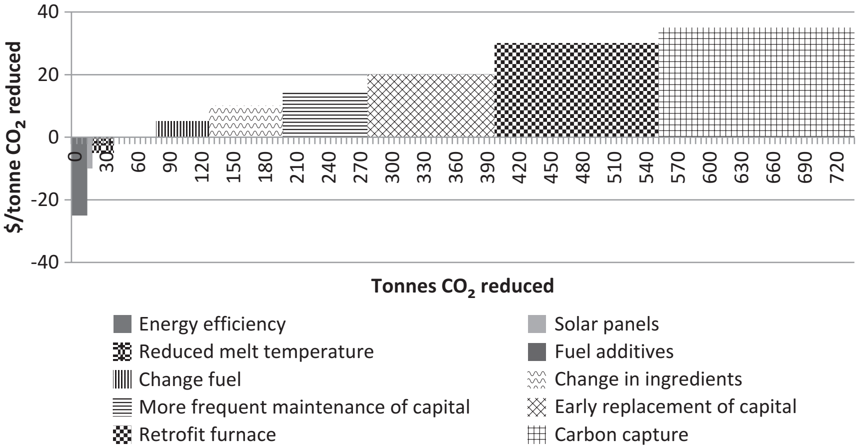

Fig. 4.5 Simulation—marginal abatement cost curve

The simulation begins when the facilitator (who acts as the government's environment protection agency) announces it will introduce regulation to achieve a reduction of CO_2 emissions across the industry. To ensure fairness, all companies are compelled to reduce their CO_2 emissions by the same quantity, which collectively meets the government's reference line, a total of 330 tonnes of CO_2 per company and 1650 tonnes in total.

The regulations take the form of a technology standard, similar to most environmental regulation applied worldwide. Technology standards specify the exact production processes, management procedures, or technology that must be used in an economic activity. These packages of measures are usually termed *Best Available Techniques (BAT)*. BAT is usually specified by environmental regulators on the basis that they will achieve the required environmental standard without excessive cost. When firms are certified as using a BAT they are then issued a permit to operate.

The simulation begins when students are divided into five teams, given their MACC and the facilitator provides each group with the list of BAT that all firms must apply (Table 4.2). Students are told that application of BAT will guarantee reduction of 330 tonnes of CO_2 in every firm and is

Table 4.2 Best available techniques

Energy efficiency (motion detecting lights, improve building insulation, etc.)
Install solar panels
Reduced glass melt temperature
Fuel additives
Change fuel type
Change glass ingredients
More frequent maintenance of capital

a legally binding requirement. BAT must be implemented to receive an environmental permit, without which the firm cannot legally operate. In this first part of the simulation the students must answer two questions: how much does the application of the BAT cost and by how much does it reduce emissions?

Comparing Fig. 4.5 and Table 4.2 this firm will over-comply when it deploys BAT (all techniques listed in Table 4.2). The regulation compels it to undertake more frequent maintenance of capital, which means that the firm will reduce close to 360 tonnes of CO_2. This will be similar for all firms. Capital items cannot be partially installed, which means that most firms will over-comply, highlighting the inflexibility of technology standards. At the conclusion of the round it is clear that the regulation is causing some firms to pay more than others, thus changing relative competitiveness. This allows an exploration of how regulation could change competitiveness and whether it is fair on those firms with higher costs, but also higher levels of pollution.

The next step of the simulation is to introduce an emissions trading scheme, where firms are allocated enough permits to cover all but 330 tonnes of their baseline emissions. The rules of the game are that there must be one permit submitted to the facilitator at the end of the game for each tonne of CO_2 emitted. The difference between this and regulation is that firms can now buy and sell surplus permits. Therefore, they must carefully consider their breakeven price at which it becomes cheaper to buy permits to satisfy regulatory requirements, or make the reduction internally.

Usually this process is stimulated by a facilitator calling out permit prices (much like an auction), which allows students to judge how different permit prices affect their decisions. There is one price that will clear the market for permits and meet the regulatory requirements. This can either be given to students at the beginning or students can be left to trade permits in a 'free market' scenario, which is more time consuming. Once they are given the optimal permit price students are asked to calculate their costs of compliance and emission reductions.

Following this process, it becomes clear that emissions trading gives firms the option to outsource compliance, where this is cheaper than doing it themselves. For several firms they over-comply, but make a profit from this, since they are able to sell their permits where the abatement costs are below the permit sale price. Others do not reduce their emissions to 330 tonnes because it is cheaper to buy permits. At the market clearing price emissions trading will achieve the required compliance at less cost than the regulation. This should allow a discussion of why economic instruments allow more flexibility and there should be recognition that those who are able to undertake abatement most cheaply achieve the bulk of emission reductions, but they are adequately compensated by the permit market.

Exploring MACCs is a useful exercise in that it allows students to understand what is required to comply cost-effectively with a range of regulatory instruments. It also has the benefits of showing some insight into the rationale of why economists promote the use of economic instruments over regulation and how this can affect firm profitability. In this way it focuses on the sustainability from a managerial perspective, rather than a societal perspective.

The main drawback of this approach is that it is a time-consuming exercise, needing at least two hours to complete. To complete this exercise in two hours there also needs to be some pre-session reading, which defines key concepts, such as abatement, and explains how MACCs are constructed and used. In practice this has also needed a lot of explanation and control from faculty members, particularly when class size goes above 50. This is often difficult to accommodate, given the already crammed nature of a microeconomics (business) course syllabus. The general feedback has been that the session is useful and interesting, but also challenging. This type of simulation may be best reserved for when exclusively focusing on sustainability in business economics, but as a part of a microeconomics course, there may not be enough time available to cover this topic.

Infusing Sustainability into Economics

The previous section discussed teaching how businesses comply with environmental regulation. This applies when business activity or excessive competition causes damage to the environment or society. Figure 4.2 showed that businesses could also use sustainable actions beyond the reference line to exploit markets, defend market share, or to achieve greater resource efficiency. These are important elements of many corporate strategies and so sustainability in business economics teaching could be mixed into other sessions, rather than being a distinct topic. Over time many companies have used sustainability as a critical element of their strategy (Epstein et al. 2015) and so there is a wealth of applied case study material.

Mixing sustainability into a microeconomics (business) course gives the content an immediate relevance to all students, regardless of the level of their interest in sustainability. It has the added advantage that it allows them to root economic theory into practical applications, which is helpful to those studying economics for the first time. The investigation and discussion of applied case studies allows students to debate and build each other's knowledge. This can be a powerful tool when teaching sustainability. It is an emotive subject for some and for others it is not. Bringing these two types of students together is useful to challenge the former and to stimulate the interest of the latter. The rest of this section discusses where we believe sustainability in business economics can provide useful examples or cases to illustrate key concepts.

From a broad strategic viewpoint sustainability can be used to think about demand, supply, and prices. Presenting students with broad trends provides material to support student thinking on how socio-economic trends affect markets. Figure 4.6 presents some major emerging trends that will shape future markets but also present some sustainability concerns. For instance, The United Nations (UN) projects that the global population will increase by approximately 14% to 9.8 billion people in

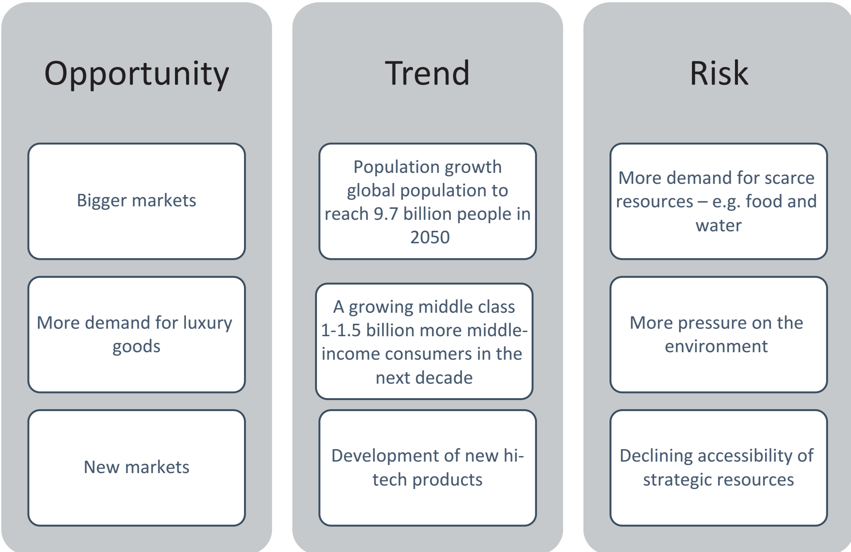

Fig. 4.6 Emerging opportunities, trends, and risks

2050 (UN 2017), raising questions as to what this will do to the demand for food and other commodities (FAO 2017). The Brookings Institute (2017) expects 1–1.5 billion people to join the middle class in the next decade, meaning they will have money to spend once they buy everything necessary for survival. Again this is likely to mean more demand for technology products, hi-tech entertainment, cars, air travel, and education. The innovation of new hi-tech products is accelerating and provides new markets.

In this type of exercise students can draw out demand and supply schedules to explore what these broad trends mean for demand, supply, and prices. They can then further reflect what happens if supplies of commodities are reduced or disrupted because of climate change or overuse of resources. This enables a thoughtful, purposeful use of demand and supply schedules to determine prices, but also a free scope to imagine future implications of these trends.

This should enable students to develop the link between broad demand and supply trends (Fig. 4.6) and market exploitation opportunities, where successful firms are innovating products and services that rely on fewer resources or increase productivity. The Organisation for Economic Co-operation and Development (OECD) defines this market development as 'green growth', investments and innovations that will underpin sustained growth and give rise to new economic opportunities. Current practice is replete with examples of green growth. For instance, the multinational conglomerate General Electric (GE), which has had well-publicised pollution issues (*The New York Times* 2016), has developed its Ecomagination wing, which aims to develop incrementally more efficient technologies. Fortune magazine (2016) reports that through the end of 2015, GE had invested $17 billion in clean tech R&D through Ecomagination while generating $232 billion in revenue from its products.

Many companies have embraced environmental markets as a new opportunity and there is scope to explore how environmental innovations can be used to bypass competition and exploit new markets. The environmental technology market was worth $1.05 trillion in 2015 (Select USA 2015). More and more governments have now raised their reference line for car emissions, banning the sale of petrol and diesel cars post 2040 to improve air quality. This has made innovation around electric engines critically important to car manufacturing (Boretti 2017). One example that has been particularly useful in generating classroom discussion is the urine powered mobile phone charging technology (Walter et al. 2017). On first consideration students find the idea frivolous and even a little unpleasant, but after further consideration they appreciate the value of taking an abundant, waste product and using it to replace other scarce resources like electricity. This is the essence of sustainable technology, taking waste and using it as a resource.

Beyond market trends, sustainability-based case studies can be used to illustrate concepts such as barriers to entry and product differentiation. For instance, regulation increases the cost of market participation because it requires firms to invest in capital items and have more sophisticated environmental and safety systems in place (Costantini and Mazzanti 2012; Rennings and Rammer 2011; Angerer et al. 2008). This has the effect of raising the cost of competing in a sector. For example, stricter waste regulations tend to have the effect of concentrating waste management markets, away from smaller operators. Environmental policy instruments, such as emissions trading, also can have the effect of ensuring the continuance of emission rights for incumbents, but more stringent laws for new entrants (Revesz and Kong 2011; Gurtoo and Antony 2007). Governments have frequently deployed environmental standards as a non-tariff barrier to entry for imports (Ederington and Minier 2003).

Hence, several sectors may actually lobby for tighter regulation, because they perceive that it limits competition in their sector (Taylor et al. 2015). In general, the more onerous environmental regulation is for new entrants, the less competition there is likely to be, thus protecting incumbents. However, once in the market firms can lobby for even stricter regulation: low-cost airlines, with newer fleets frequently call for more onerous air quality regulation, in the knowledge that it will hurt older fleets.

Sustainability can also be used as the basis for product differentiation in oligopoly or monopolistic competition market structures. For instance, Puma uses sustainability to differentiate its brand in the sports apparel market. While most sports brands have a sustainability strategy, Puma have made sustainability a central part of their ethos and competitive strategy (Gröschl et al. 2017; Cameron 2011), going as far as committing their strategic suppliers to sustainability reporting. While this is not necessarily a market acquiring strategy, as Nike dominates the sector but does not focus their strategy on sustainability, it is a way that Puma can appear different and appeal to sustainability-minded buyers. Similar examples exist in the cosmetics sector, with companies that have taken the lead in avoiding animal testing and in the coffee sector with fair trade products.

The resource efficiency element of sustainability can be used as an example to draw out the principles of *Cost-Benefit Analysis (CBA)* within a classroom session analysing the appraisal of capital items. Resource efficiency refers to reductions in material or energy inputs that lower overall costs of production, while maintaining or increasing output. This usually involves upfront investment in a relatively expensive capital item that allows for energy or resource savings over a longer timeframe. These characteristics make such investments a good case study of CBA.

The authors have used the example of solar panels as an applied example within teaching sessions. Most of the costs of installation are experienced in the installation phase, usually the project start-up year (year 0). Against this most of the benefits of solar panels flow across the lifetime of the project, which can be 20 years and beyond. These benefits comprise savings made by generating, rather than buying electricity and also payment for any surplus energy that is 'exported' to the grid. Hence there is a need to make all costs and benefits comparable across time for accurate comparison against a risk-free alternative. Given the long lifetime of the investment, the length of the payback period is also an important aspect of the appraisal.

There are several elements about a renewable energy investment that can be expanded to give a more nuanced treatment of CBA. The return on investment depends on the wholesale electricity price and assumptions regarding solar cell efficiency over the life of the investment. This provides opportunity to explore sensitivity analysis and how the analyst can use multiple scenarios to judge the reliability of the outcome of a CBA.

The use of CBA to determine resource savings is critical for demonstrating sustainability at the board level. Unless it is for compliance reasons, most action needs to be financially viable and outputs of a CBA will demonstrate this. There are lots of prominent examples of other input efficiency projects that could be developed into a case study. Coors Brewers Ltd. successively reduced the weight of its 300 ml Grolsch beer bottle, saving approximately 8000 tonnes of glass annually (WRAP 2007). However, usually financial appraisal is taught in other modules on a business course, so CBA in the sustainability context can often repeat previous material.

Corporate social responsibility is supported by the three pillars of social, economic, and environmental sustainability. Most focus to date has been on the environmental pillar, which has meant that the social pillar has received less attention. This is something that, by definition, has remained outside environmental economics. However, to be relevant to business teaching sustainability economics also needs to address how businesses improve their social performance.

Sustainability Teaching in Macroeconomics

Environmental economics has predominantly focused on issues related to microeconomics. However, this does not mean that the macroeconomic elements should be ignored. At the *2012 Rio+20 Conference* world leaders met to agree a range of measures that would ensure 'decent jobs, clean energy and a more sustainable and fair use of resources'. This discussion centred on the creation of a 'Green Economy': how the current 'business as usual' economy can be re-shaped to achieve better social outcomes (UNEP 2012).

This followed widespread recognition that the way in which society has approximated economic wellbeing may not accurately reflect social wellbeing (Pearce et al. 1989). For instance, gross domestic product (GDP) does not account for the depreciation of natural capital. Studies have shown a divergence between economic growth (as measured by GDP) and the *Index of Sustainable Economic Welfare (ISEW)* which includes environmental as well as other welfare indicators (Kubiszewski et al. 2013; Fleurbaey 2009). The rationale for using alternative measures is that GDP treats consumption as a positive economic activity. This is not always true. For example, deforestation, wetland drainage, and oil spills all cause an increase in economic activity in the short term, but are outweighed by longer term social and environmental costs.

Methods for green accounting such as the *UN System of Environmental and Economic Accounts* have been developed to put monetary values on environmental degradation so that they can be included in national income accounts. In this way a decline in the stock of natural capital is shown as a sign of unsustainable activity. There has also been widespread use of sustainability indicators, used to determine broad movements in national sustainability.

Incorporating elements of green accounting into a macroeconomics syllabus forms the basis of discussions around what constitutes the measurement of economic growth, how should we adjust our estimates of wellbeing to include environmental gains and losses, or in a way that more closely links to human wellbeing? This is particularly pertinent with the rise of concepts such as the *circular economy*, which conceptually is a model where end-of-life products are used as intermediate inputs for a new range of products, thus reducing waste and use of natural resources.

Final Reflections

In many ways teaching sustainability in business economics is similar to teaching quantitative methods. Students come to the classroom with varying amounts of knowledge, confidence, and interest. This makes it challenging, if not impossible, to deliver something that satisfies everyone in the classroom. For some students discussion about the basics of sustainability including the history, broad concepts, and policy implications can in itself be enlightening, while for others this may not extend their knowledge nor satisfy their enquiring minds and they can leave the classroom disappointed. Investigating compliance issues introduces complex managerial issues, but often there is a need to stress the strategic nature of compliance to those that see it as an otherwise operational issue. This way of teaching is time consuming, where sustainability is just one topic on a crowded syllabus. Infusing sustainability within the syllabus offers a way to make sustainability interesting to all, while providing highly relevant examples and case studies that support wider learning of economic concepts.

This is consistent with the direction of business practice. There are many examples of successful businesses that have put sustainability at the heart of their economic strategies and these can be utilised to build effective case studies or examples. Taught material should reflect this. There is a need to move from teaching sustainability as a distinct topic within economics and instead blend it into the syllabus. This also provides an opportunity to broaden the scope of sustainability. To date sustainability in business economics has focused on environmental economics from a social perspective, but sustainability includes elements of social responsibility and care for employees. Again there are many examples of companies that embrace this wider view of sustainability in their economic strategies that can be used as a basis of taught examples.

It is the hope of many sustainability professionals that sustainability becomes extinct as a separate subject and instead becomes an intrinsic part of business. This appears to be the direction of travel in teaching sustainability business economics. However, for those wanting to teach *Sustainability in Business Economics* as a distinct module, we briefly set out a short module outline. Naturally, this can be flexed to suit particular module lengths and target audiences.

- *Demand, supply, and price determination*: using projections of population growth and resource demand and creation of new markets for environmentally sustainable technology as stimulus material (see Fig. 4.5).
- *Competitive strategy*: analysing the use of sustainability as a means of product differentiation and new market creation.
- *Resource efficiency and CBA*: creating competitive advantage through the selection of efficient or renewable technology.
- *Government and business*: the use of MACCs and compliance with regulation.
- *Macroeconomics*: green accounting and alternatives to GDP.

References

Ando, Amy, and Donna Harrington. 2006. Tradable Discharge Permits: A Student Friendly Game. *Journal of Economic Education* 37: 187–201.

Ang, Frederic, and Steven Van Passel. 2012. Beyond the Environmentalist's Paradox and the Debate on Weak Versus Strong Sustainability. *BioScience* 62: 251–259.

Angerer, Gerhard, Ralf Nordbeck, and Christian Sartorius. 2008. Impacts on Industry of Europe's Emerging Chemicals Policy REACH. *Journal of Environmental Management* 86: 636–647.

Aslaksen, Iulie, Solveig Glomsrod, and Anne Myhr. 2013. Post-normal Science and Ecological Economics: Strategies for Precautionary Approaches for Sustainable Development. *International Journal of Sustainable Development* 16: 107–126.

Barbier, Edward. 2011. The Policy Challenges for Green Economy and Sustainable Economic Development. *Natural Resources Forum* 35: 233–245.

———. 2012. The Green Economy Post Rio+20. *Science* 338: 887–888.

Bordt, Michael. 2018. Discourses in Ecosystem Accounting: A Survey of the Expert Community. *Ecological Economics* 144: 82–99.

Boretti, Aleberto. 2017. The Future of the Internal Combustion Engine after "Diesel-Gate". Paper presented at SAE International Conference on Advances in Design, Materials, Manufacturing and Surface Engineering for Mobility, ADMMS 2017; Chennai; India; July 19, 2017.

Brookings Institute. 2017. The Unprecedented Expansion of the Global Middle Class. Accessed January 16, 2018. https://www.brookings.edu/research/the-unprecedented-expansion-of-the-global-middle-class-2/.

Burtraw, Dallas, and Matt Woerman. 2013. Economic Ideas for a Complex Climate Policy Regime. *Energy Economics* 40: S24–S31.

Cameron, Andrew. 2011. A Sustainable Workplace—We're All in It Together. *Strategic Direction* 28: 3–5.

Coase, Ronald. 1960. The Problem of Social Cost. *The Journal of Law and Economics* 3: 1–44.

Corrigan, Jay. 2011. The Pollution Game: A Classroom Game Demonstrating the Relative Effectiveness of Emissions Taxes and Tradable Permits. *Journal of Economic Education* 42: 70–78.

Costantini, Valeria, and Massimiliano Mazzanti. 2012. On the Green and Innovative Side of Trade Competitiveness? The Impact of Environmental Policies and Innovation on EU Exports. *Research Policy* 41: 132–153.

Daly, Herman. 1973. *Towards a Steady State Economy*. New York: W. H. Freeman & Co Ltd.

Daly, Herman, and John Cobb. 1989. *For the Common Good: Redirecting the Economy Toward Community, the Environment and a Sustainable Future*. Boston: Beacon Press.

Ederington, Josh, and Jenny Minier. 2003. Is Environmental Policy a Secondary Trade Barrier? An Empirical Analysis. *Canadian Journal of Economics* 36: 137–154.

Ekins, Paul, Sandrine Simon, Lisa Deutsch, Carl Folke, and Rudolf De Groot. 2003. A Framework for the Practical Application of the Concepts of Critical Natural Capital and 'Strong Sustainability. *Ecological Economics* 44: 165–185.

Epstein, Marc, Adriana Buhovac, and Kristi Yuthas. 2015. Managing Social, Environmental and Financial Performance Simultaneously. *Long Range Planning* 48: 35–45.

FAO. 2017. *The Future of Food and Agriculture: Trends and Challenges*. Accessed January 16, 2018. http://www.fao.org/3/a-i6583e.pdf.

Fleurbaey, Marc. 2009. Beyond GDP: The Quest for a Measure of Social Welfare. *Journal of Economic Literature* 47: 1029–1075.

Fortune Magazine. 2016. How GE Is Changing the World. Accessed January 16, 2018. http://fortune.com/2016/08/19/general-electric-change-world/.

Ghisellini, Patrizia, Catia Cialani, and Sergio Ulgiati. 2016. A Review on Circular Economy: The Expected Transition to a Balanced Interplay of Environmental and Economic Systems. *Journal of Cleaner Production* 114: 11–32.

Glen, John, and Joe Nellis. 2010. 'The Price You Pay': The Impact of State-Funded Secondary School Performance on Residential Property Values in England. *Panoeconomicus* 57: 405–428.

Gröschl, Stefan, Patricia Gabaldón, and Tobias Hahn. 2017. The Co-evolution of Leaders' Cognitive Complexity and Corporate Sustainability: The Case of the CEO of Puma. *Journal of Business Ethics*, 1–22.

Gurtoo, Anijula, and Simon Antony. 2007. Environmental Regulations: Indirect and Unintended Consequences on Economy and Business. *Management of Environmental Quality* 18: 626–642.

Hahn, Robert. 2000. The Impact of Economics on Environmental Policy. *Journal of Environmental Economics and Management* 39: 375–399.

Hanley, Nick, Jason Shogren, and Ben White. 2006. *Environmental Economics in Theory and Practice*. 2nd ed. Basingstoke: Palgrave.

Hartwick, John. 1977. Intergenerational Equity and the Investing of Rents from Exhaustible Resources. *American Economic Review* 67: 972–974.

Hodge, Ian. 1989. Compensation for Nature Conservation. *Environment & Planning A* 21: 1027–1036.

Hotelling, Harold. 1931. The Economics of Exhaustible Resources. *Journal of Political Economy* 39: 137–175.

Johansson, Per-Olov. 1991. *An Introduction to Modern Welfare Economics*. Cambridge: Cambridge University Press.

Jordan, Andrew, Rudiger Wurzel, and Anthony Zito. 2003. New' Instruments of Environmental Governance: Patterns and Pathways of Change. *Environmental Politics* 12: 1–26.

Kahneman, Daniel, and Jack Knetsch. 1992. Valuing Public Goods: The Purchase of Moral Satisfaction. *Journal of Environmental Economics and Management* 22: 57–70.

Kubiszewski, Ida, Robert Costanza, Carol Franco, Philip Lawn, John Talberth, Tim Jackson, and Camille Aylmer. 2013. Beyond GDP: Measuring and Achieving Global Genuine Progress. *Ecological Economics* 93: 57–68.

Liu, Jing-Yue, and Chao Feng. 2018. Marginal Abatement Costs of Carbon Dioxide Emissions and Its Influencing Factors: A Global Perspective. *Journal of Cleaner Production* 170: 14–33.

Malthus, Thomas. 1798. *Essay on the Principle of Population*. Oxford: Oxford University Press.

Morris, Joe, Rowbotham, Alex, Angus, Andrew, Mann, Michael, and Poll, Ian. 2009. A Framework for Estimating the Marginal Costs of Environmental Abatement for the Aviation Sector. *OMEGA Project 14*. Bedford: Cranfield University.

O'Niell, John. 1993. *Ecology, Policy and Politics: Human Well-being and the Natural World*. London: Routledge.

Parson, Edward., and Eric Kravitz. 2013. Market Instruments for the Sustainability Transition. *Annual Review of Environment and Resources* 38: 415–440.

Pearce, David, Anil Markandya, and Barbier Edward. 1989. *Blueprint for a Green Economy*. London: Earthscan Publications Ltd.

Perman, Robert, Yue Ma, Michael Common, David Maddison, and J. McGilvray. 2011. *Natural Resource and Environmental Economics*. 4th ed. London: Addison Wesley.

Rao, Pinninti. 2000. *Sustainable Development: Economics and Policy*. Padstow: Blackwell Publishers.

Rennings, Klaus, and Christian Rammer. 2011. The Impact of Regulation-Driven Environmental Innovation on Innovation Success and Firm Performance. *Industry and Innovation* 18: 255–283.

Revesz, Richard, and Allison Kong. 2011. Regulatory Change and Optimal Transition Relief. *North Western University Law Review* 106: 1582–1626.

Rivas Casado, Monica, Jan Serafini, John Glen, and Andrew Angus. 2017. Monetising the Impacts of Waste Incinerators Sited on Brownfield Land Using the Hedonic Pricing Method. *Waste Management* 61: 608–616.

Select USA. 2015. Environmental Technology Spotlight: The Environmental Technology Industry in the United States. Accessed January 16, 2018. https://www.selectusa.gov/environmental-technology-industry-united-states.

Solow, Robert. 1986. On the Intergenerational Allocation of Natural Resources. *Scandinavian Journal of Economics* 88: 141–149.

Taylor, Chris, Simon Pollard, Sophie Rocks, and Andrew Angus. 2012. Selecting Policy Instruments for Better Environmental Regulation: A Critique and Future Research Agenda. *Environmental Policy and Governance* 22: 268–292.

———. 2015. Better by Design: Business Preferences for Environmental Regulatory Reform. *Science of the Total Environment* 512–513: 287–295.

The New York Times. 2016. G.E. Spent Years Cleaning Up the Hudson. Was It Enough? Accessed January 16, 2018. https://www.nytimes.com/2016/09/09/nyregion/general-electric-pcbs-hudson-river.html.

UN. 2017. World Population Prospects 2017. Accessed January 16, 2018. https://esa.un.org/unpd/wpp/.

UNEP. 2012. A Guidebook to the Green Economy: Issue 1: Green Economy, Green Growth, and Low-Carbon Development—History, Definitions and a Guide to Recent Publications. Accessed January 16, 2018. https://sustainabledevelopment.un.org/content/documents/GE%20Guidebook.pdf.

Walter, Xavier, Andrew Stinchcombe, John Greenman, and Ioannis Ieropoulos. 2017. Urine Transduction to Usable Energy: A Modular MFC Approach for Smartphone and Remote System Charging. *Applied Energy* 192: 575–581.

World Commission on Environment and Development. 1987. *Our Common Future*. Oxford: Oxford University Press.

WRAP. 2007. Lightweight Glass Containers: Understanding Consumer Perceptions. Accessed January 16, 2018. http://www.wrap.org.uk/sites/files/wrap/14325%2003%20Consumer%20Perceptions%20CS%20for%20web%2027th%20March%2007.pdf.

Yin, Kwong, Adrian Ward, Paul Dargusch, and Anthony Halog. 2018. The Cost of Abatement Options to Reduce Carbon Emissions from Australian International Flights. *International Journal of Sustainable Transportation* 12: 165–178.