



Low-Greenhouse-Gas Consumption Strategies and Impacts on Developing Countries

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ABSTRACT

A growing body of research shows how shifts in consumer behaviour could lead to reductions in greenhouse gas (GHG) emissions. By buying less “stuff” and fewer high-GHG items (e.g. red meat), and redirecting any spending to low-GHG alternatives, consumers could help reduce emissions. Altogether, these shifts could reduce emissions associated with consumption in high-income countries by at least 10 per cent, and likely more. Many of the goods consumed in high-income countries are produced in low-income countries, however, raising questions about the economic impact of reduced consumption on those countries. Starting with the United Kingdom as an example, we analyse the potential economic impacts of low-GHG consumption strategies. We find that if the U.K. and all other high-income countries shifted spending to lower GHG products and services, lower-income countries would be disproportionately affected, with average GDP losses greater than 5 per cent in the world’s poorest countries. These findings raise a flag of caution about how to pursue low-GHG consumption in high-income countries. International trade can raise incomes and standards of living in developing countries. Measures that reduce trade –under the banner of low-GHG or “sustainable” consumption or in other ways, such as by promoting local purchasing – can hurt poorer countries that critically depend on that income. It is possible, however, that by preferentially sourcing products from low-GHG and low-income regions, high-income countries could foster both GHG and development benefits. Further work is needed to identify specific opportunities, taking into account factors – such as marginal energy sources and production practices – that affect the GHG-intensity of increased production in low-income countries.

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1. INTRODUCTION AND CONTEXT

Greenhouse gases are accumulating in the atmosphere to levels that could dangerously disrupt the global climate system (IPCC 2007). As nations have debated how far to reduce greenhouse gas emissions, what mechanisms to employ, and how to distribute responsibility, analysts have created scenarios of how particular technologies and measures could reduce emissions over time. These scenarios, developed by international quasi-governmental organisations (e.g., the Intergovernmental Panel on Climate Change or the International Energy Agency), research institutions, and private-sector analysts, have played important roles in demonstrating what levels of GHG emission reduction are possible.

Most emission reduction scenarios have focused especially on widespread changes in energy infrastructure and technologies, such as how electricity is produced and what technologies or fuels are used to make goods, move people and goods, or heat and cool buildings (IEA 2010; WWF 2011; McKinsey & Company 2010; Metz et al. 2007). In constructing these scenarios, analysts largely focus on how to provide goods, services, and other amenities with fewer emissions, rather than on changing the mix of goods and services consumed. In other words, most mitigation scenarios focus largely on shifts in production, rather than in consumption (except for behavioural responses to a price on carbon, typically in the form of reducing the direct use of fossil fuels – e.g. less driving). In general, the same types of goods and services are consumed, at roughly the same levels, in mitigation scenarios as in the corresponding business-as-usual scenarios.

However, limiting warming to 2°C or 1.5°C, a widely embraced policy goal (United Nations Framework Convention on Climate Change 2011a), and averting the worst impacts of climate change may require broader shifts in what and how we consume. While widespread adoption of low-GHG technology will be essential, shifts to low-GHG lifestyles may also be needed. This realisation, coupled with lagging progress in international negotiations and within key countries (e.g., the United States), has helped bring a resurgence of interest in consumption-based approaches for climate mitigation. For example, several recent bottom-up studies have quantified the potential impacts of consumption-based actions on greenhouse gas emissions. These studies demonstrate that low-GHG consumption behaviours, such as reduced consumption of red meat, can contribute substantially to global GHG emissions abatement (Scott et al. 2009; Dietz et al. 2009; Jones and Kammen 2011; BioRegional and London Sustainable Development Commission 2009; Stehfest et al. 2009).

The goal of this paper is to reflect on some possible global economic implications of low-GHG consumption. In particular, we explore how shifting to low-GHG consumption, as defined by recent assessments of its role in climate mitigation, may or may not contribute to another key objective of sustainable development: global development and poverty alleviation.

For guidance, we take a cue from the United Nations Earth Summit, held in Rio de Janeiro in 1992, which brought sustainable consumption and production to the world stage, and which cited poverty alleviation as a key “basis for action”. From the UN’s *Agenda 21*:

...the major cause of the continued deterioration of the global environment is the unsustainable pattern of consumption and production, particularly in industrialised countries, which is a matter of grave concern, aggravating poverty and imbalances... (United Nations 1992).

According to *Agenda 21*, over-consumption in industrialised countries is depriving poor nations of access to resources. At the same time, poor countries benefit from consumption in

industrialised countries through trade of raw materials and products. As international trade has grown substantially in the nearly 20 years since the Earth Summit,² the links between consumption in high-income countries and development in lower-income exporter countries are even more relevant. Low-income countries have become more reliant on trade – with exports comprising 12 per cent of their GDP in 1992, 20 per cent in 2010, and as much as 22 per cent immediately before the recent global recession (World Bank 2011). These trends helped lead to higher standards of living in increasingly export-oriented countries (Irwin and Terviö 2002), and create a dilemma: If high-consumption countries were to decrease trade in the course of pursuing low-GHG consumption,³ what would be the effect on their low-income trading partners? This is the question we explore in this paper. Other researchers have presented a similar case for individual products, such as strawberries from Africa (Müller 2007); here, we instead look at a broad range of measures, and bring a quantitative perspective that we have not yet seen in the literature.

We first describe our methodology, which includes a review of scenarios of low-GHG consumption in higher-income countries, selection of one particular scenario for further analysis, and use of a multi-regional input-output (MRIO) model of the global economy. We then present results of our analysis, showing the impacts of low-GHG consumption in high-income countries on per-capita incomes in low-income countries. Lastly, we discuss potential options for research and practice on low-GHG consumption patterns that can simultaneously reduce global GHG emissions and increase development benefits in developing countries.

We should note that while we raise the question of consumption here, we do so only in terms of type, not overall levels. In other words, we keep overall consumption levels constant in the United Kingdom and other high-income countries (redirecting any freed-up income in our analysis to other, low-GHG services) and do not attempt to address pathways or global economic effects of reduced overall consumption (such as Jackson 2009) in this analysis.

2. METHODOLOGY

To explore trade impacts on lower-income countries, we first define a set of low-GHG consumption behaviours that have gained traction in recent analyses. We then explore the trade-related impacts of these behaviours on lower-income countries, defined here as all countries that the World Bank categorises as low or medium-income.⁴ Our primary tool for analysis is a global, multi-regional input-output (MRIO) model, a type of tool that has become common in assessing the GHG and economic impacts of trade (Minx et al. 2009; Wiedmann et al. 2011). These steps are described further below.

Defining a Set of Low-GHG Behaviours

The focus of this analysis is on consumer purchasing behaviours, which have drawn increasing attention in recent years as a means to reduce GHGs. Consumer purchasing also presents an opportunity for development impacts, due to the substantial international trade of consumer goods produced in lower-income countries.

² According to the World Bank (2011), trade (exports) represented 15 per cent of global GDP in 1972, 20 per cent in 1992, and 28 per cent in 2010.

³ High-consumption countries could also reduce or change consumption in response to other factors or trends, such as buying “local” (a theme we will return to at the end of the paper) or due to other environmental burdens beyond GHGs, such as water or toxics. We do not evaluate other motivations for changing consumption, or other environmental burdens or limits, in this paper.

⁴ See <http://data.worldbank.org/about/country-classifications>.

Our focus is on shifts in consumption that extend beyond the direct use of energy, such as diet shift, reduction in food waste, longer product lifespans, and overall reduced purchasing of “stuff”. The reason for this focus is that although there is widespread agreement that changes in energy production and consumption will be necessary to address climate change, the role of other consumer choices is less clear, and the potential economic impacts on lower-income countries are, arguably, larger. (Lower-income countries produce many goods and services for high-income countries, but those other than fossil fuels yield about six times more economic added value than fossil fuels.⁵)

We know of no widespread agreement (implicit or explicit) on what behaviour changes could have significant impacts on global GHGs. Whereas measures that address energy supply and efficiency (among others) have been well-chronicled by the Intergovernmental Panel on Climate Change and others and form the building blocks of most bottom-up scenarios of GHG abatement, we know of no similar typology of consumer behaviour changes on goods and services. Analyses of diets and food are perhaps most common (Stehfest et al. 2009; Audsley et al. 2009; Garnett 2011; Brohmann and Barth 2011), but other assessments have looked at different suites of measures and behaviour shifts, such as reduction in purchases of clothing (Allwood et al. 2006; Carbon Trust 2011).

To explore what categories of behaviour changes are commonly discussed in the literature, we reviewed several recent scenarios that analysed behavioural measures and the resulting magnitudes of GHG reductions. Since our intent is to assess the impacts of an entire group of measures, we focused our review on studies that addressed more than one product category (Table 1).

⁵ Source: Author analysis of the data in the underlying MRIO model.

Table 1. Comparison of Bottom-up Consumption-based Scenarios

Scenario:	EU – European Commission (Brohmann and Barth 2011)	U.K. – London (BioRegional and London Sustainable Development Commission 2009)	U.K. – University of Surrey (Druckman and Jackson 2010)	U.K. – WRAP (Scott et al. 2009)	US – Michigan State and others (Dietz et al. 2009)	US – UC Berkeley (Jones and Kammen 2011)
Categories Addressed						
Food	X	X	X	X		X
Goods		X	X	X		
Services		X	X	X		
Construction		X	X	X		
Personal Transportation		X	X		X	X
Home Energy	X	X	X		X	X
GHG Reductions Due to Behaviour Shifts⁶						
Food, Goods, Services, Construction	N/A ⁷	~14% ⁸	~16%	10- 14% ⁹	N/A ⁷	4% (food only)
Personal Transport, Home Energy		~20%	~21%	N/A	N/A	16%
Total		~34%	~37%	10-14%	N/A	20%
Other Factors						
Geographic Focus	EU-27	London	U.K.	U.K.	US	US
Institution Focus		HH, Gov	HH	HH, Gov	HH	HH
Time scale	Through 2030	Through 2050	None	Through 2050	Through 2015	None
Quantified rebound	No	No	No	Yes	No	No

Based on this review, it is clear that analysts have not settled on a standard set of behaviour shifts. This complicates efforts to compare the assumptions and results of studies – some of which focus on nearly all forms of consumption, whereas others focus on a particular subset. In Table 1, we summarise the level of GHG-reductions that studies suggest is achievable via behavioural measures. Studies that looked at measures addressing food, goods, services, and construction yielded GHG reductions in the range of 14 to 16 per cent (before considering rebound) combined from these measures. Measures that address personal transport and home energy yielded GHG reductions of 16 to 21 per cent from these measures.

Of the scenarios reviewed in Table 1, the WRAP scenario for the U.K. (Scott et al. 2009) is the only scenario reviewed that both extends across the non-energy categories of consumer purchasing (e.g., food, goods, and services) and also includes consideration of how income freed up by reduced consumption might be redirected (i.e. the rebound effect). Including the rebound effect is important, because shifts in consumer behaviour (e.g. reduced purchasing of

⁶ At maximum implementation of measures considered, regardless of what year that implementation occurs.

⁷ Source did not report a total BAU against which to assess the impact of the measures assessed.

⁸ Approximated based on identification of consumption-based measures in the study's appendix. Reductions would likely be greater if the study did not also apply aggressive efficiency improvements in most sectors. Range reflects measures that only apply to goods (including food) and services (on the low end) to also including measures that address personal transportation and home energy (on the high end).

⁹ Depending on the degree of rebound.

a high-GHG good) would likely enable other purchases (Hertwich 2008; Girod et al. 2010; Ornetzeder et al. 2008). Because of this rebound effect, the GHG benefits could be muted, and economic impacts could also differ.¹⁰ We note that the WRAP scenario also finds GHG reductions from shifting behaviours associated with food, goods, services, and construction that are in line with the other studies reviewed, and so can be used to represent the scale of potential shifts to low-GHG consumption. For these reasons, we select the WRAP scenario as the set of behaviour changes to model for this analysis.

The WRAP scenario, released by the Waste & Resources Action Programme in 2009, charted the long-term (through 2050) GHG abatement potential behaviour change in the U.K., and was the most detailed accounting of the embodied GHGs in U.K. consumption at the time (Scott et al. 2009).¹¹ Among the specific behaviours considered were reduction in food waste, shifts in diet, using goods (such as clothing and home furnishings) longer, and shifting from goods to services for select goods (e.g. sharing services and rentals of high-end clothing, glass and tableware, household tools, personal vehicles). The strategies considered in the most aggressive variant of the WRAP scenario, used here, are listed in Table 2. The scenario found (after freed-up spending was redirected to low-GHG services, via the “rebound effect”) that aggressive implementation of these strategies could reduce the emissions associated with U.K. consumption by 10 per cent, compared to baseline emissions in 2050.

Table 2. Behaviour Changes included in WRAP Scenario ‘Beyond Best Practice’ Variant

Category	Measure
Food	All edible food waste is eliminated, reducing the need for food purchases Meat and dairy consumption declines 75% (with no replacement with other food)
Goods	Goods that are still working are no longer discarded; 90% of goods used to their full “technological lifespan” Durability of goods increases, reducing need for new goods by 40% Several goods are shared (rented) rather than owned personally: clothing, glassware and tableware, tools and equipment, vehicles, and recreational and audio-visual equipment (with rental rates varying by good) The GHG intensity of government procurement declines 90%
Services	Shift from goods to services (i.e., shared goods), per above
Construction	90% of homes slated for demolition are brought back into use, reducing the need for new builds ¹²

Modelling Impacts of Behaviours with an MRIO Model

To model the trade-related impacts of the list of behaviours identified, we used environmentally extended input-output (IO) techniques similar to those used in the original WRAP analysis. Instead of working with the exact model used in the WRAP study (which had a limited ability to distinguish world regions), we use an updated multi-regional Input-

¹⁰ The WRAP scenario does not, however, address another kind of rebound effect – that due to price effects. For example, if high-consumption countries were to reduce consumption of a particular good, the global price of this good could be expected to decline, enabling greater consumption of it by low-income countries who could then better afford it. We do not explicitly consider this possibility here, because our primary focus is not the GHG impacts of shifts to low-GHG consumption, but rather the resulting trade flows from low-income to high-consumption countries, which would not be affected by this indirect rebound effect.

¹¹ The study has since been published in the peer-reviewed literature as Barrett and Scott (2012).

¹² In the WRAP study, this was considered a supply- (production-) side measure, not demand- (behaviour-) side measure, but we list it here as a behaviour change since it is reducing the demand for new housing. However, following the WRAP definition, we do not consider it in the remainder of the analysis.

Output (MRIO) model that allows us to better identify the countries (and sectors) in which trade impacts could occur.¹³

IO models have become standard tools for assessing the distribution of an industry's product throughout the economy, including by country and economic sector (Miller and Blair 2009; Wiedmann et al. 2011). In recent years, these tools have been extended to cover global economies and focus on GHG impacts, leading to a number of assessments of the GHGs embodied in trade (Peters and Hertwich 2008; Hertwich and Peters 2009; Peters et al. 2011; Wiedmann 2008). The models are subject to several uncertainties, including those that arise from aggregating hundreds of individual sectors and regions into smaller, more manageable numbers; harmonising trade data across regions; and converting currencies into a common unit (Lenzen et al. 2010). These and other sources of uncertainty and sensitivity are discussed extensively in the literature (Lenzen et al. 2010; Weber 2008) and so are not described in detail here. However, in general, uncertainties are lowest at the level of entire economies (e.g., all emissions embodied in the U.K.'s consumption) and highest for particular trade flows between pairs of countries.

To model the shifts in behaviour, we obtained the raw data from the WRAP study authors (Scott et al. 2009) in terms of expenditures by category in both the baseline and "beyond best practice" (mitigation) scenarios.¹⁴ Table 3 displays the change in spending in each category. Note that reductions in spending in some sectors (e.g., bovine meat products, dairy products, clothing) are profound, and redirecting these savings leads to a large increase in spending on low-GHG recreational services.

We then apply these reductions in spending to our MRIO model for spending in our model's analysis year (2004), to estimate the scale of trade flows and GHGs targeted in the WRAP scenario. Although this approach obscures the many years it would take to achieve such societal shifts, as well as other trends that would affect emissions over time (such as changes in production technologies),¹⁵ this approach provides a simple estimate of the scale of trade flows (and emissions) targeted. Table 3 summarises actual (2004) mitigation (WRAP) scenario expenditures for the sectors affected, along with the fraction of final demand of each commodity that is satisfied by foreign production. Total final demand in the U.K. is assumed to remain unchanged, as all reductions in spending are assumed to be "rebounded" to recreational and other services.

¹³ The model is based on the GTAP 7 database and therefore has 113 world regions and a base year of 2004. It is based on one created at the Norwegian University of Science and Technology (Hertwich and Peters 2010), as used in the European Union's EUREAPA online tool (<http://www.oneplanetecconomynetwork.org/eureapa.html>).

¹⁴ For the purposes of the WRAP study, the authors used 123 disaggregated sectors, defined using the Standard Industrial Classification (SIC) system (Scott et al. 2009). Since the MRIO model we used is based on underlying data of the Global Trade and Analysis Project (GTAP, version 7), we then constructed a correspondence table between SIC sector codes to GTAP codes.

¹⁵ This method considers only the impact of shifting consumption relative to the baseline from the WRAP scenario, in order to explore the impact of these measures in isolation; any other background changes within the scenario, such as economic or population growth, are excluded.

Table 3. Final Demand, Trade Volumes, and WRAP Scenario Shifts

Consuming Sector ID (GTAP)	Consuming Sector Name (GTAP)	Final Demand ¹⁶ (2004), Million USD	Fraction of Final Demand Satisfied by Foreign Production (2004)	WRAP Scenario, Reduction Compared to Baseline (including Rebound)
1	Paddy rice	62	100%	-15%
4	Vegetables fruit nuts	12,208	57%	-1%
8	Crops nec	4,050	46%	0%
10	Animal products nec	1,156	23%	-21%
12	Wool silk-worm cocoons	47	98%	-9%
19	Bovine meat products	4,088	35%	-87%
20	Meat products nec	6,224	53%	-87%
21	Vegetable oils and fats	1,431	49%	-17%
22	Dairy products	14,505	24%	-87%
23	Processed rice	289	51%	-16%
24	Sugar	1,687	38%	-17%
25	Food products nec	82,432	23%	-33%
27	Textiles	26,433	42%	-84%
28	Wearing apparel	50,711	35%	-87%
29	Leather products	9,870	55%	-74%
30	Wood products	3,575	65%	-74%
31	Paper products publishing	32,048	24%	-32%
33	Chemical rubber plastic products	48,924	47%	-1%
34	Mineral products nec	6,406	32%	-78%
37	Metal products	15,297	34%	-78%
38	Motor vehicles and parts	92,783	59%	-92%
39	Transport equipment nec	12,285	40%	-25%
40	Electronic equipment	51,384	62%	-84%
41	Machinery and equipment nec	66,648	54%	-30%
42	Manufactures nec	57,629	34%	-65%
55	Recreational and other services	77,985	17%	+440%
All Others	All Others	1,296,104	17%	0%
Total		1,930,515	24%	0%

To implement the consumption shift in the MRIO model, we assume that any change in consumption occurs equally for domestic and foreign components of demand. In the case of the example above, if red meat expenditures are reduced by 87 per cent, we assume that demand for both domestic and imported red meat drops by 87 per cent. Within the MRIO, we track how a change in spending on a product affects every contributing producing sector from every region throughout the product's supply chain. In other words, an 87 per cent reduction in red meat consumption will not only reduce demand for cattle but also, in turn, reduce demand for energy, fertilisers, and pesticides needed to grow feed for cattle, regardless of where in the world those items are produced. An 87 per cent reduction in spending on red

¹⁶ Final demand is spending by households, government, business capital investment, and net changes to stocks.

meat therefore translates to an 87 per cent reduction in GHGs associated with red meat. We use the MRIO model to follow this through the entire supply chain, from country to country and sector to sector. Using this MRIO structure, we can estimate changes in each country's GDP (and greenhouse gas emissions) based on changes in consumption in the U.K. or in any other group of countries. For further details on construction of the underlying MRIO model, please see Hertwich and Peters (2010).

We analysed the impacts of shifting consumption in the U.K. on four country groupings:

- *The U.K.* itself, to look at domestic impacts of the behaviour changes;
- *High-income* (outside the U.K.);
- *Lower-income*;
- *Least Developed Countries (LDCs)*, or world's poorest countries, which are a subset of the lower-income countries.¹⁷

Table 4 provides some descriptive statistics of the regions analysed. Note that 76 per cent of the U.K.'s consumption is satisfied by domestic production.

Table 4. Descriptive Statistics of Regions Analysed (2004)

Region	Population	GDP ¹⁸ (2004 US \$)	GDP/Capita (2004 US \$)	Value Added for U.K. Consumption (2004 US \$)	Value Added as Fraction of U.K. Consumption
U.K.	60,000	2,124,000	35,400	1,461,000	76%
High-income (ex U.K.)	1,192,000	30,598,000	31,642	368,000	19%
Lower-income I	5,371,000	8,248,000	1,536	102,000	6%
LDCs ¹⁷	374,000	114,000	310	2,000	<1%
Total (World)	6,398,000	40,970,000	6,400	1,931,000	100%

In this table, we report the distribution of *value added* in support of U.K. consumption. Value added is the difference between the value of a good or service and the other, intermediate goods or services used to produce it and is created primarily via human labour and capital equipment. Since a country's GDP is the sum of all value added in the country,¹⁹ a change in value added would directly affect GDP. For this reason, and because GDP is a more widely used term, we will report results in terms of changes in a country's GDP.

3. RESULTS

The WRAP scenario involves adopting a group of low-GHG behaviours, such as diet shift, reduced purchasing of clothing and other household items, and a transition to sharing a large number of goods, including vehicles (Table 2). Shifting consumption from these types of goods to the alternatives, and considering the rebound effect, leads to considerable changes in spending patterns for about one-third of total U.K. final demand (Table 3). The original WRAP analysis (Scott et al. 2009) found that shifting consumption in this manner would lead

¹⁷ The MRIO model used (Hertwich and Peters 2010) includes the following LDCs individually: Bangladesh, Cambodia, Ethiopia, Lao People's Democratic Republic, Madagascar, Malawi, Mozambique, Myanmar, Senegal, Tanzania, Uganda, and Zambia. Together these LDCs represent about half of the GDP of all UN-listed LDCs (per the World Bank's development indicators database).

¹⁸ GDP here is on a market exchange rate (MER) basis for the year 2004.

¹⁹ After adding taxes and adjusting for any subsidies not reflected in the purchase price of a good.

to a reduction in GHGs associated with consumption of about 10 per cent.²⁰ We find here that these spending shifts in the U.K. would yield starkly different economic impacts in other world regions.

As shows in Table 5, the WRAP scenario could be expected to lead to an *increase* in GDP in the U.K. This is because under the scenario, consumer purchases shift from goods, for which considerable value is imported (e.g. vehicles, where an average of 59 per cent of the value is imported), to services, where most of the value is produced domestically (e.g. recreational and other services, where only 17 per cent of the value is imported). Since the U.K. produces its own services to a much greater extent than it produces its own food or goods, shifting spending from food and goods to services is a net benefit to the U.K.'s economy, even as it is a detriment to the countries that previously were providing the food and goods.

Table 5. Change in GDP in U.K. and World Regions as a Result of the WRAP Scenario

Region	Change in GDP
U.K.	4.6%
High-income	-0.2%
Lower-income	-0.3%
LDCs	-0.7%

The WRAP scenario directs a greater share of spending to the U.K., but this comes at the expense of trading partners. In particular, Table 5 shows that high-income countries (outside the U.K.) would experience a 0.2 per cent decline in GDP, lower-income countries would experience a 0.3 per cent decline in GDP, and Least Developed Countries (LDCs) would experience a 0.7 per cent decline in GDP. This trend suggests that adopting low-GHG behaviours in the U.K. could lead to economic decline in trading partners, and that the decline could be proportionally worse in lower-income countries, especially LDCs.

This finding raises questions about whether the WRAP scenario would contribute to, or detract from, a key goal of sustainable development: poverty alleviation. In particular, putting the nearly 1 per cent decline in GDP of LDCs in context is difficult. Is a 1 per cent decline in GDP in these countries cause for concern? As was displayed in Table 4, LDCs already have (by far) the lowest per-capita incomes, less than one-hundredth of per-capita incomes in the U.K. While a 1 per cent decline may not seem large, it represents a further setback to what is already a gigantic disparity in livelihoods.

Furthermore, this nearly 1 per cent decline in per-capita incomes in LDCs is only due to a shift in consumption in a single country: the U.K. Discussions of low-GHG consumption are also advancing in Europe (Brohmann and Barth 2011) and, to a lesser extent, also in North America (Jones and Kammen 2011; Oregon Global Warming Commission 2011; Timmer et al. 2009) and other high-income countries. If these other countries also adopted the same policies as the WRAP scenario (assuming the same percentage reductions in consumption by sector as in Table 3, the impact on developing countries could be considerably greater: up to a 4.5 per cent decline in lower-income country GDP and up to 5.7 per cent in LDCs, as displayed in Table 6.

²⁰ One might wonder why the WRAP scenario did not yield even greater reductions in GHGs given that it targets roughly one-third of the U.K.'s economy (Table 3). Of the third of the economy addressed, about half of the spending is shifted, or roughly 18 per cent. If these activities were of average GHG intensity (per dollar) and there was no rebound, then the net reduction would be 18 per cent. However, the net reduction is less, because although the activities shifted are somewhat higher-than-average GHG-intensity, the low-GHG services are still about half the average GHG-intensity.

Table 6. Sensitivity Analysis: If Other the EU-27 and other High-Income Countries also Adopted WRAP Scenario

Region Affected	Change in GDP due to Switch to Low-GHG Consumption (WRAP scenario) in:		
	U.K.	EU-27	High-Income
U.K.	4.6%	3.3%	2.8%
High Income	-0.2%	0.2%	1.0%
Lower Income	-0.3%	-1.5%	-4.5%
LDCs	-0.7%	-3.4%	-5.7%

These findings raise a flag of caution: actions or policies that reduce high-income-country consumption of goods may have disproportionate negative impacts on lower-income countries. Sustainable development (and climate mitigation) may require shifts in consumption (and corresponding shifts in technologies and processes that produce goods and services), but it also requires giant strides in global equity, so all people have access to basic security, human rights and social benefits (Sathaye et al. 2007). Individual actions need not necessarily pursue both environmental and development goals simultaneously, but taken all together, policies and behaviours will need to advance both. Based on our preliminary analysis here, low-GHG behaviours in high-income countries (at least as defined in the WRAP scenario) appear to do little to advance global economic equity.

In principle, other policy measures that reduce imports, such as border carbon adjustments, which would levy fees at national borders based on carbon content, could have similar effects on low-income countries. However, border carbon measures are more commonly discussed for energy-intensive raw materials such as cement, concrete, and steel, and less so for consumer goods, where the adjustments may be less effective or practical (Carbon Trust 2010b; Weber and Peters 2009). For studies of the development and poverty impacts of border carbon adjustments and other tariffs, see Hertel et al (2009), Anderson et al (2006), and ICTSD (2011).

The findings displayed in Table 6 are the result of the broad suite of low-GHG behaviours defined in the U.K.'s WRAP scenario (Table 2). However, trade patterns are not the same for all products. Table 7 shows individual results for five distinct types of consumption shifts: diet shift (reduced meat and dairy consumption); food waste reduction (all edible food waste eliminated); clothing and textiles (longer useful lifespans and shift to rental of high-end garments); other manufactured goods (goods reach their full "technological lifespan", many are shared rather than personally owned); and vehicles (widespread shift to shared, rather than owned, vehicles). From this table, we see that impacts on lower-income countries are driven most strongly by reduction in consumption of clothing and other manufactured goods, and the impacts on LDCs are driven overwhelmingly by reductions in clothing. By contrast, in general, diet shift, food waste reduction, and reduced purchase of vehicles have fewer impacts on lower-income countries, because (at present) high-income countries do not rely as strongly on lower-income countries to produce food and vehicles.²¹ These findings suggest that of the

²¹ One might wonder whether these findings are perhaps driven not by the intensity of trade in these products with developing countries but instead simply by the magnitude of shift in spending. The shifts in spending for diet shift, food waste reduction, clothing and textiles, other goods, and vehicles were \$115 million, \$96 million, \$152 million, \$209 million, and \$167 million, respectively. These vary by less than a factor of two, much less variation than the impacts in Table 7, suggesting that the magnitude of the shift is less of a factor than the trade intensity. For example, the impact of the shift in clothing and textiles has about 50 times more impact on LDCs than diet shift, but the shift in spending is only 30 per cent more.

consumption shifts studied, reduced consumption of clothing and manufactured goods in high-income countries is likely to have the strongest negative impact on lower-income countries, at least given recent patterns of global trade and production.²² Of course, these findings are averages for relatively broad product groups, and the impacts for any individual product could vary, e.g. for particular foods grown in poor countries and imported into high-income countries (Müller 2007).

Table 7. Sensitivity Analysis if U.K. Adopted Individual Low-GHG Measures

Region Affected	Change in GDP in affected region due to shifts in U.K. consumption of: ²³					
	WRAP Scenario (Total)	Diet Shift	Food Waste Reduction	Clothing and Textiles	Other Manufactured Goods	Vehicles
U.K.	4.60%	0.21%	0.08%	0.79%	1.81%	1.74%
High Income	-0.24%	-0.01%	-0.00%	-0.02%	-0.09%	-0.11%
Lower Income I	-0.29%	-0.01%	-0.01%	-0.12%	-0.12%	-0.03%
LDCs	-0.72%	-0.01%	-0.01%	-0.67%	-0.01%	-0.00%

In the next section, we will explore options for addressing development and poverty in the context of developed-world consumption. But first, we discuss some limitations of this analysis.

Limitations of Analysis

One of the most significant limitations of our analysis is that we do not explore the dynamic effects of the world economy in response to the WRAP scenario's hypothetical shift in consumption. Such a shift in demand could be expected to lead to other, indirect adjustments in prices, supply, and demand of goods and services. For example, reduced consumption of certain items (e.g. clothing) would, based on economic theory, be expected to reduce the prices of such items. On one hand, decreasing prices would further reduce the value of trade to lower-income, producer countries. On the other hand, reduced global prices could increase the purchasing power of consumers in the low-income countries, who may then be better able to afford the products and therefore buy more of them (Schettkat 2011; Alcott 2008). We were not able to assess the relative impact of these two factors.

We also assume that the global economic structure remains as it was in 2004. Our results could be affected if the production structure changed over time, or if changes to energy supplies or production practices were substantially different at the margin than at 2004 average rates.

Broadly speaking, we assume, as do nearly all MRIO-based analyses, that demand (consumption) relates linearly to emissions and economic activity. While this assumption is valid for static analyses (e.g., consumption-based GHG inventories) that simply attribute responsibility for emissions and economic activity to particular categories and regions of demand, the assumptions may not hold for assessing the full impacts of *changes* in demand (or other inputs) such as that modelled here (Feng 2009; Jensen 1980; Turner et al. 2011). Assessing how a shift in demand could translate into a new global equilibrium (and associated emissions and economic implications) would require a computable general equilibrium (CGE) model or other analytical methods to assess changes at the *margin*. Due to the

²² The model used is based on trade and production patterns in 2004.

²³ All results here include the effects of redirecting the spending to low-GHG services.

complexities, this additional analysis is beyond the scope of this study, as it has been for nearly all prior such assessments of shifts to low-GHG consumption. Furthermore, CGE models are subject to their own limitations and uncertainties in assessing changes in trade, including uncertainties in the very parameters (called “Armington elasticities”) that control how much of a country’s consumption will be fulfilled by production in different countries (Ackerman and Gallagher 2008). For these reasons, we believe our simplified I-O approach here is reasonable for a first-order approximation of the trade-related impacts of low-GHG consumption. All in all, our analysis is but one snapshot of a potential problem – one using a very similar MRIO model (Hertwich and Peters 2010) as is often used for assessments of consumption – and further perspectives and analyses would be beneficial.

Lastly, we note that the role of trade in development is not simple. In general, increased trade leads to increased (average) per capita incomes (Frankel and Romer 1999; Anderson and Martin 2006; Hertel and Keeney 2006; Irwin and Terviö 2002).²⁴ Due to the benefits, trade (and improving trade conditions) is a central pillar of major efforts (e.g. in the UN) to address poverty and development in poor countries (UNCTAD 2010), and so we consider trade here as a viable vehicle to deliver development (and GHG) benefits. However, increased average incomes do not necessarily lead to improvements at the lowest levels of society, since new income may flow disproportionately to middle- and higher-income populations. The impact of trade on income distribution has varied considerably between countries (White and Anderson 2001; Rodrik 2001; Ravallion 2006), and analysts disagree on whether increases in trade have, in general, been a positive (Dollar and Kraay 2004) or at-best-neutral force for poverty reduction (Ravallion 2006). Clearly, increasing trade volumes alone is a blunt instrument for raising livelihoods in low-income countries; complementary efforts are needed to ensure that trade provides broad economic and social benefits, as well as to address additional issues, such as substandard labour practices.

4. DISCUSSION: OPTIONS FOR ADDRESSING DEVELOPMENT IN SUSTAINABLE CONSUMPTION

Our analysis demonstrates that low-GHG behaviour changes in high-income countries may have disproportionate economic impacts on low-income countries, especially LDCs. What does this suggest for efforts to bring about low-GHG consumption in high-income countries? On one hand, some have argued that reductions in consumption in high-income countries are essential to avoid the worst impacts of climate change (Jackson 2009), implying that entirely different means of economic development in poor countries may be needed. From this perspective, a reduction in GDP in LDCs of 5 or 6 per cent (Table 6), on the order of one year of GDP growth, may be a small price to pay compared with the climate-related damages that may be avoided.

On the other hand, trade is a significant component of GDP in poor countries, and can be an important mechanism to increase global equity (Hertel et al. 2009; UNCTAD 2010). Furthermore, “sustainable consumption” was originally envisioned (in *Agenda 21*) as a means to help reduce poverty. In our view, it is therefore instructive to explore opportunities to use trade for both GHG and development benefit. The means to do so, however, are not obvious. In the remainder of this paper, we pose and explore possible new measures of low-GHG consumption that could bring both GHG and development benefits. They are:

²⁴ More specifically, Frankel and Romer (1999) found that a one percentage point increase in the ratio of trade to total country GDP increases per-capita income by half a percent.

- **Purchasing from poor and low-GHG-intensity countries.** Some countries may be able to produce certain goods with much lower GHGs than other countries. If these countries were also poor countries with high development needs, there may be an opportunity to develop purchasing practices or trade policies to support trade with these countries.
- **Importing higher-cost, higher-quality, and value-added goods.** Importing higher-cost, higher-quality goods could have both GHG and development benefits if these goods both last longer (meaning fewer new goods are needed) and cost more, where more of the value is retained by the producing country.
- **Lowering the GHG intensity of production in poor countries.** Though not a “consumption” measure per se, transitioning technologies or processes used to produce goods in developing countries – perhaps with technology transfer or finance from high-consuming, industrialised country trading partners – would reduce the GHG-intensity of these goods and bring economic benefits.

Below we discuss each of these potential remedies in more detail.

Purchase from Poor and Low-GHG Countries

So far, most discussions of low-GHG consumption focus on reducing purchases that have, on average, high GHG impacts. For example, extending the useful life of clothing, if it leads to less production of new clothing, could reduce GHG emissions. However, within a given product category, items may have varying carbon footprints depending on how they are designed and where they are produced: sewing clothing with equipment powered by hydroelectricity would be associated with fewer GHG emissions than if powered by coal-fired electricity. Similarly, if the GHG-intensity of production varied systematically from country to country, then purchasing a good from one country instead of another could lead to GHG reductions.

Accordingly, considering country of origin in purchasing decisions may be a way to bring both GHG and development benefits. For example, in addition to reducing consumption of clothes, researchers and consumers could assess whether the goods could be sourced from countries with much lower emissions and higher development benefit per item.

Significant research would be needed to identify products with low-GHG production practices, (including the embodied emissions of intermediate goods and materials) and high development benefits. Though analysts have carried out country- and product-specific analyses of GHG impacts based on input-output modelling (Carbon Trust 2011), these analyses generally contain very little (if any) data on GHG intensity on a *functional* instead of *monetary* basis. For example, GTAP-based MRIO models (like those used in this study as well as Carbon Trust 2011) produce estimates of emissions per *dollar* of trade. However, higher per-dollar emissions intensities do not necessarily imply higher emissions per *functional unit*. For example, if a shirt from one region cost half as much to produce as in another region, but released the same quantity of GHGs, the emissions intensity (per dollar) would be twice that of the other region, even as the same GHGs were associated with each unit. In such a case, the difference in emissions intensities would reflect a difference in production costs, not in actual production practices or emissions.²⁵ The difference between

²⁵ Erickson et al. (2011) found that the average emissions intensity of clothing imported to the U.S. in 2005 was 0.4 kg CO₂e/\$ from Mexico, 2 kg CO₂e/\$ from India and China, and 1 kg CO₂e/\$ averaged over all countries that imported clothing to the U.S. The average value of a boy or men’s knit cotton shirt imported to the U.S. in 2005

monetary and functional units is an important gap in the input-output literature (Girod and de Haan 2009)

Furthermore, most MRIO-based analyses look at the average GHG intensity of a given product. However, assessing changes in production location requires looking not at the *average* GHG intensity but at the *marginal* sources of production and energy. For example, switching production from one country to another will lead to reduced activity and energy demands in one country and increased demands in another. The sources that are taken offline in the “losing” country may be very different than those brought online to fulfil production in the alternative country. For example, south Asia produces significant quantities of electricity using low-GHG hydropower, but most new electricity generation capacity in recent years has been from fossil fuels, suggesting that new electricity demand is likely to be met not with hydropower (for which supply is more constrained) but with fossil fuels.²⁶ Accordingly, assessing the GHG implications of a shift in production from one country to another is not as simple as comparing current average practices in one country with those in another, but instead requires looking at what the marginal practices and energy sources would be.

While the development benefits of trade are not assured, experience has provided substantial lessons on which countries face significant development needs and how to increase the benefits of trade. For example, research surrounding the World Trade Organisation’s Doha round of trade negotiations has suggested that removing tariffs and other trade barriers in both higher-income (consumer) and developing countries can bring significant development benefits (Hertel et al. 2009; UNCTAD 2010). Other mechanisms to increase the development benefits of trade include technical assistance on accessing markets and technology transfer to enable trade diversification (Gueye et al. 2009; UNCTAD 2010).

The feasibility of preferential product purchasing would be determined both by the availability of policy tools as well as consumer willingness to seek out goods meeting these emissions and development criteria. Governments already enact policies designed to favour imports from certain countries in the forms of lower tariffs or even removal of all duties, suggesting that tariffs (and, potentially also quotas) could be revisited, considering both emissions intensity and development needs. However, many technical, administrative, and legal hurdles may exist, and their effectiveness is, in many cases, limited (Monkelbaan 2011; UNCTAD 2010). Consumer interest shows some promise for voluntarily altering purchasing behaviour to reduce GHGs (Carbon Trust 2010a), though many barriers exist there too, from how to provide reliable and meaningful information, to lack of widespread willingness to substantially alter behaviour.

Import Higher-Cost, Higher-Quality, and Value-Added Goods

Several scenarios of low-GHG consumption include measures that reduce purchases of new goods, often under the assumption that goods last longer or are used to their full “useful life”. In this analysis (based on the WRAP scenario), we assume that decreased purchases of new items leads to equivalent reductions in trade and GHGs. This is equivalent to assuming that the prices (per unit) of these goods would remain unchanged. However, consumer purchase of *higher-cost* goods could yield both development and GHG benefits. For example, all other issues aside, if clothes that lasted twice as long cost twice as much, then the value of the trade

was \$3.33 from China, \$5.02 from Mexico, \$6.48 from Canada, and \$4.91 averaged over all countries importing to the U.S. (UN Statistics Division 2011). This suggests that price differences may be a significant reason for the differences in emissions intensities between China and other regions.

²⁶ Source: http://www.iea.org/stats/pdf_graphs/35ELEC.pdf.

flows could be maintained, via increased quality, even as the embodied emissions (per functional unit) would be reduced substantially (Allwood et al. 2006). However, it is not immediately clear what would be needed to produce more durable products – is it, for example, introduction of styles (e.g. for clothing) that consumers can accept for longer periods, or rather the durability of underlying materials and construction? In either case, for more durable products to provide a development benefit to producing countries, those countries must be able to capture the added value themselves. Otherwise, if the increased quality comes from value added elsewhere, then the development benefits may not exist. Further research is needed to determine how poor countries could capture the benefits of the added, higher value, including whether these countries could invest in any extra expertise, equipment, and/or land needed to make the higher-quality goods, including through support from high-income countries via technology transfer of manufacturing equipment and technical assistance .

Lower the GHG-Intensity of Production in Poor Countries

Our discussion has focused on how reductions or shifts in purchasing could affect GHG emissions associated with consumption. However, reducing the emissions intensity of the *production* of those goods would also affect the emissions associated with their *consumption*.

For example, reducing the GHG-intensity of steel production in developing countries – say, through projects that generate electricity from waste gases at steel mills – would reduce the GHGs associated with steel-intensive products, such as vehicles or appliances. Mechanisms or finance from consumer countries that helped implement such measures in producer countries could thus help reduce the emissions embodied in traded goods.

For example, as part of the United Nations Framework Convention on Climate Change (UNFCCC) negotiations, countries have agreed to establish a Green Climate Fund to support GHG abatement in developing countries, including through technology transfer (UNFCCC 2011; UNFCCC 2011b), though the details are far from final. Discussions are also advancing, particularly in Europe, about how to orient the Clean Development Mechanism (CDM) to focus on Least Developed Countries after 2012, providing another means to aid in emission reduction and development in poor countries. Other possibilities also exist, such as sectoral crediting (Schneider and Cames 2009) that could use carbon offset markets to achieve reductions in particular industry sectors in particular countries.

Summary

Below we consider how these three options might fare against two common objectives – reducing emissions and supporting the incomes of poor countries –as well as their feasibility (from a policy perspective), and further research needed to address key knowledge deficiencies.

Table 8. Assessment of Alternative Options for Consideration of Development Impacts of Shifts in Consumption

	Potential Effectiveness at Reducing Emissions	Potential Effectiveness at Supporting Poor Countries	Feasibility	Research Needs
Consider country of origin in sourcing products	Difficult to assess, as relatively little evidence exists to compare life-cycle emissions of major goods by country of origin	Trade does tend to lead to increasing average incomes, but income distribution and other social factors (e.g., child labour) would remain a concern	Somewhat possible on an individual basis, and through tariff rates; trade laws may limit policy-makers' options, however	Methods to compare emissions per unit on a physical basis, comparing like for like products and marginal practices
Import Higher Cost, Quality, and Value-added Goods	If more-durable goods don't require substantially more GHGs and reduce purchases of new goods, then could be significant	Higher price could directly translate to greater value-added and incomes, though research to date is mixed	Though counter to recent trends, switch to higher-quality goods could be cost-neutral and have other benefits to consumers	Studies on production requirements, purchasing behaviours and impacts of longer-lived goods
Lower the GHG intensity of production in poor countries	Directly targets the technologies or processes that emit GHGs	Highly variable by project, but can in theory enable cleaner production and capital investments in poor communities	Slow-moving topic in UNFCCC, and may not be targeted so specifically to particular industries	Research on mechanisms and feasibility of international carbon finance

Unfortunately, none of the options above clearly excels at all of the objectives, and large uncertainties remain, both in effectiveness and feasibility. Further research would help in all three areas.

One option that shows promise is to consider country of origin in sourcing products. This option would seem to be the most direct means of supporting poor countries, and it aligns well with the United Nations' focus on improving trade volumes and conditions with Least Developed Countries (UNCTAD 2010). Yet the potential effectiveness at reducing emissions is highly unknown, since robust methods to compare emissions per unit of major goods by country of origin are elusive or, at best, still emerging.

In the next section, we conduct an initial exploration of the potential scale of reducing emissions due to shifting trade patterns for clothing.

5. PRODUCT FOCUS: CLOTHING

As discussed above, shifting the supply of a product from one country (or set of countries) to another could potentially bring both emissions and development benefits. However, numerous questions remain about how to quantify these benefits. For example, are existing data robust enough to assess the GHG benefits of a shift in trade, and how can such an analysis meaningfully define development benefits? Fully answering these questions is beyond the scope of this analysis, but here we offer a glimpse into the question by considering one broad product category: clothing. We focus on clothing because a significant fraction is imported to the U.K. from other countries; it is a product for which several consumer behaviour-changes have been proposed (e.g. extending the useful life, renting of high-end clothing); it represents

a sizable (~3 per cent) fraction of the U.K.'s consumption-based GHG inventory; and emissions associated with transporting the clothing are likely minimal, since clothing is often shipped by sea, a very low-GHG shipping mode (Weber and Matthews 2008), meaning shifts in the location of production would not likely substantially impact total emissions associated with the goods.

To conduct the analysis, we use the same MRIO model as in prior sections of this paper, with one addition: we convert the trade values of clothing to a functional unit of kilogram (Girod and de Haan 2010) using data from the UN on average prices per kilogram of trade between the U.K. and supplier countries (UN Statistics Division 2011).²⁷ In the underlying MRIO, calculations are performed on a per-dollar basis, which is standard practice for input-output models (Miller and Blair 2009). However, comparing items instead on a per-kilogram basis helps eliminate any bias in the difference of per-dollar emissions intensities that may arise to differences in the value of the respective currencies (and, by extension, the standard of living of different countries).²⁸ If we had not made this correction, our calculations of emissions-intensity would artificially be biased against countries with very low prices (which may also tend to be poorer countries), since these low prices would depress the denominator, thus raising their overall GHG-per-dollar intensities. Use of a kilogram also introduces biases, however – for example, against lighter clothing that would otherwise provide the same function as a heavier item, such as a lightweight rain jacket that may provide the same (or greater) function as a heavier alternative.

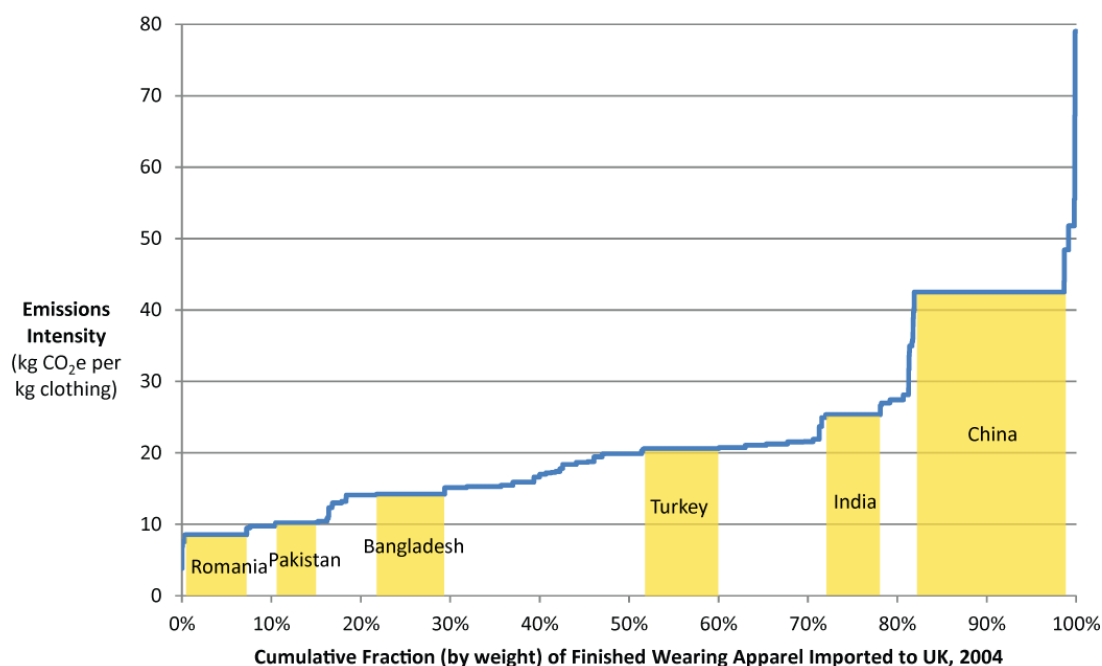
Comparing GHG-Intensity across Countries

Figure 1 below shows the estimated distribution of GHG-intensity of clothing imported to the U.K. in 2004, by country. As the figure indicates, the median GHG-intensity of clothing (that at the 50th percentile) is approximately 20 kg of CO₂e per kilogram of clothing. This finding is roughly consistent with other life-cycle studies of clothing, which have found clothing production to have a GHG intensity of 12 to 24 kg CO₂e per kg (Girod and de Haan 2010; Carbon Trust 2011; Steinberger et al. 2009). However our results indicate that the GHG intensity of clothing production could vary by more than a factor of four depending on producing country, with some countries (e.g., China) producing at more than 40 kg CO₂e/kg, and some (e.g., Romania and Pakistan) producing at about 10 kg CO₂e/kg.

²⁷ Arguably, the function of clothing is to both cover and protect (e.g., from weather) a person, both functions for which the weight of the clothing is an approximate, if highly imperfect, unit. Even better would be to specify particular items, e.g. a t-shirt, a pair of shoes, or a rain jacket, and such analyses have been conducted by other analysts using process-based LCA. However, since MRIO results are for entire sectors, a standard unit is needed across the entire sector (a t-shirt and a pair of shoes are, alas, different units.)

²⁸ Our MRIO is based on GTAP, which operates on a market exchange rate (MER), not purchasing power parity (PPP) basis.

Figure 1. Estimated Average Emissions Intensity of U.K. Clothing Imports by Country, 2004 (with labelling of top countries collectively representing half of all imports)



Source: Author calculations from MRIO model and UN trade data.

What causes these large differences in estimates, and are they plausible? In general, uncertainties in MRIO analyses increase as one moves from a country's entire consumption to particular categories (e.g. imported "wearing apparel", as in Figure 1), though quantification of uncertainties, especially for individual sectors, is very rare in the MRIO literature (Lenzen et al. 2010). Using a similar MRIO as we employ here, Lenzen et al (2010) found that uncertainty in CO₂ emissions in *all* imports into the U.K. in 2004 was about 7 per cent (at one standard deviation), so uncertainties for emissions within particular sector and importing country combinations (as in Figure 1) would be much higher.

At least one factor supports the general trend in Figure 1: the GHG intensity of electricity. For example, the IEA reports that electricity generation in Romania and Pakistan in 2004 (among the least GHG-intensive clothing producers) averaged about 0.4 tCO₂e/Mwh, about half that of China (0.8 tCO₂e/Mwh), one of the most GHG-intensive clothing producers (IEA 2010). In our estimates, electricity generated in China comprises about 18 kg CO₂e per kg of China's clothing production. So, even if China's electricity were half as GHG-intensive (as it is in Romania or Pakistan), China's clothing would still be about 34 kg CO₂e / kg, still much higher than most other countries. This example demonstrates that the GHG-intensity of electricity can explain only part of the difference.

Other factors besides energy supply could also be at play. Countries could be producing different items, or using different materials. For example, about 2 kg CO₂e per kg of China's clothing emissions are emitted by cattle (which presumably are raised for leather), and China does produce a higher fraction of leather goods (e.g. about 6 per cent of exports to the U.K. by weight) than do other regions (e.g. less than 1 per cent of Romania's exports to the U.K.) (UN Statistics Division 2011).

Other potential sources of differences include:

- Uncertainties in the underlying GTAP-based MRIO model – which increase at the level of individual product categories from particular countries, and which may arise either due to underlying data errors (e.g. GHG, trade, or input-output data for particular countries) or systematic errors (e.g. due to conversion of prices or sector classification schemes between countries) (Lenzen et al. 2010).
- Additional variations in the products made – and the materials used. For example, imports from Romania are dominated by women’s clothing, whereas imports from China are much more diverse (UN Statistics Division 2011), though it is unclear exactly what types of clothing would be more GHG-intensive to produce.
- Variations in the production technologies and practices used in each region, such as greater or less reliance on hand labour versus mechanised equipment.

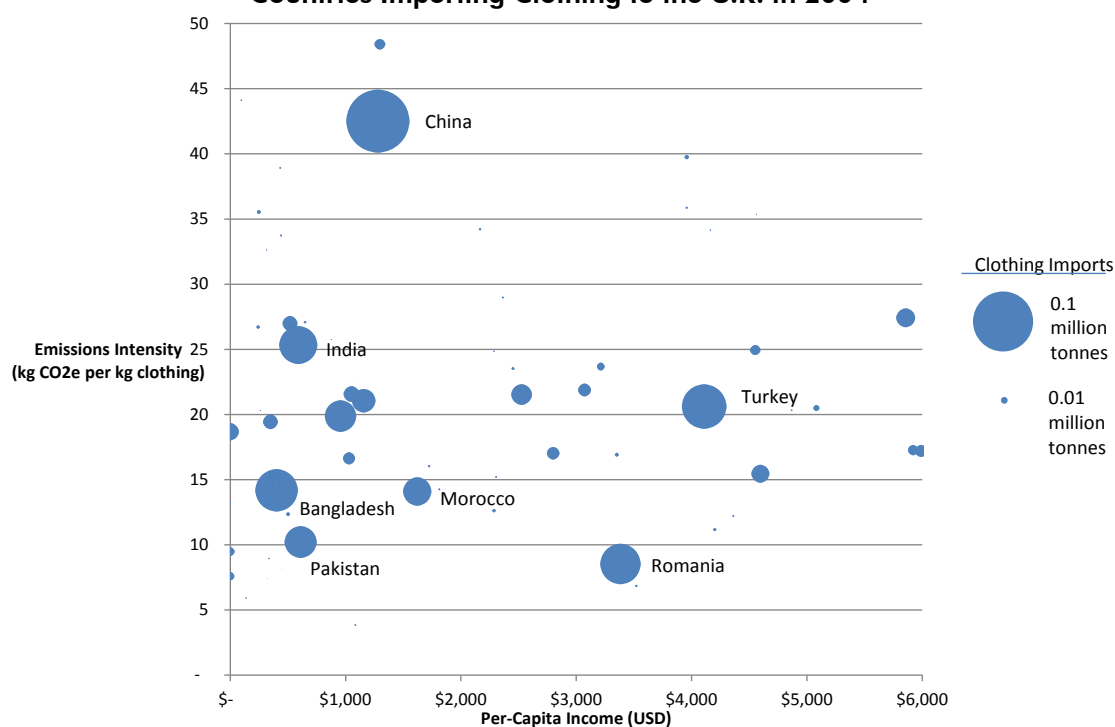
Despite these uncertainties and limitations, the broad initial finding that the GHG-intensity of clothing production can vary significantly by country of production seems highly plausible.²⁹ This suggests that the opportunity may exist to employ country-of-origin as a tactic for reducing the GHGs associated with consumption. Indeed, if GHGs associated with some clothing items could be reduced by a factor of four or more, that shift could have an even greater impact than some other strategies, such as durability, that are currently prominent in discussions of low-GHG behaviours.

Furthermore, purchasing from some countries (instead of others) would seem, to first order, to also provide the opportunity for development benefits. Figure 2 displays the GHG-intensity of clothing sourced from countries with average incomes (measured coarsely here as GDP/capita³⁰) that are below the world average of about \$6,000 (as was displayed above in Table 4). Shifting clothing production from areas with higher incomes and higher GHGs to countries with below-average GHG-intensity and below-average incomes, such as Bangladesh, Pakistan, Morocco, or Romania, would, to first order, provide both GHG and development benefits.

²⁹ Variation in GHG intensities by up to a factor of four globally is not implausible, at least as gauged from studies of other products. For example, the IEA reports that the GHG intensity of paper production varies by approximately a factor of four between the most and least-intensive countries (IEA 2008).

³⁰ On a market exchange rate (MER) basis.

Figure 2. GHG Intensity, Per-capita Income, and Trade Volumes of Low-income Countries Importing Clothing to the U.K. in 2004



Source: Author calculations from MRIO model.

For example, Figure 1 and Figure 2 suggest that if the approximately 100,000 tonnes of clothing currently made in China for the U.K. was instead made in a lower-GHG country such as Bangladesh, GHG emissions could be reduced by nearly 3 million tonnes CO₂e, or about 10 per cent of all emissions associated with U.K. consumption of clothing.

Priorities for Further Research on Shifting Location of Production

Of course, the actual effects of a shift in production location are not nearly as simple as this example, from either a GHG or development perspective, for several reasons. To adequately assess a shift in GHGs, further information would be needed on:

- **Whether equivalent products are made in each region.** Differences in what countries are currently producing could explain some unknown fraction of the difference in GHG intensities. Furthermore, a kilogram may not be the appropriate unit of comparison, as the weight of the item is only a rough proxy for the function of clothing.
- **Marginal energy sources, production practices, and sources of intermediate goods.** Assessing the GHG implications of shifts in location of production requires assessing the marginal, not the average, practices in each region. Significant differences could exist between average and marginal practices for energy, production practices (if new technologies were replacing old technologies, for example) or for intermediate goods (such as cotton sources used).

To assess development benefits, more information on the following would be helpful:

- **Relative reliance on the factor inputs of capital and labour.** In our analysis, we have simply assumed that an increase in GDP translates into increased development

benefits, but effects would differ depending on to what extent the changes in trade are met via labour, capital, or other factors (such as profits).

- **Distribution of income within the labour pool, and other social impacts.** Even as increased trade may raise average incomes, it may not be distributed equitably. It may also be important to investigate and discuss complementary mechanisms to address questionable social practices (e.g., child labour).
- **How income translates to livelihoods and development benefits.** Better metrics of development benefits could help support this analysis.

Other researchers, too, have been working to chart out research directions on the role of trade and emissions in human development, further suggesting the opportunities for research on future patterns of consumption and production that support human development and global climate (Steinberger et al. 2012).

6. CONCLUSIONS

A growing body of research shows how shifts in consumer behaviour could lead to reductions in greenhouse gases. By buying less “stuff” and fewer high-GHG items (e.g., red meat), and redirecting any spending to low-GHG alternatives, consumers could help contribute to reduced GHGs. (Low-GHG behaviour is also possible in the realms of personal transport and home energy, but these were not the focus of this paper.) Altogether, purchase of low-GHG goods and services could reduce emissions associated with consumption in high-income countries by at least 10 per cent, and likely more. Given the pressing need to reduce global GHGs, this could be a welcome and necessary contribution to efforts to limit global warming.

Our paper analysed the potential economic impacts of low-GHG consumption strategies recently discussed in the U.K. and found that taken together, they would result in a dramatic shift in spending in roughly a fifth of the U.K.’s economy, with fewer purchases of goods and greater purchases of low-GHG recreation and entertainment. We found that this shift would benefit the U.K.’s economy, because a higher fraction of services are produced domestically than are goods. However, it would also have a disproportionate negative impact on low-income countries, especially LDCs, which could experience GDP losses of nearly 1 per cent due to the spending shift in the U.K. and greater than 5 per cent if all high-income countries adopted similar measures. These findings raise a flag of caution about how to pursue low-GHG consumption in high-consumption countries like the U.K., U.S., Japan, Canada, and much of Europe. Trade helps global development, and measures that reduce trade – whether under the banner of low-GHG or “sustainable” consumption or other efforts such as the trend towards local purchasing – can disproportionately affect poorer countries that critically depend on that income.

Some have argued that reductions in consumption in high-income countries may be essential to avoid the worst impacts of climate change, and that low-income countries may need to rely less on trade with high-income countries – instead increasing self-reliance or trade with other developing countries.

We believe these strategies should still be pursued, but further work is needed to find ways to produce both GHG and development benefits through trade between high-income and low-income countries. For example, high-income countries could preferentially source products from low-GHG and low-income regions. Our preliminary calculation for clothing, using a multiregional input-output model, found that the GHG intensity of clothing production can vary by a factor of four or more. If true, this suggests that switching the location of production

could be as big or bigger of a GHG-reduction measure as other commonly discussed measures, such as doubling the useful life of clothing. Still, our calculation is subject to significant uncertainty, as the multiregional input-output model is a very coarse tool for assessing the GHG-intensity of particular products.

Shifts to lower-GHG consumption may well be needed to avert the worst impacts of climate change. In general, such shifts in consumer behaviour have not been well integrated into mainstream assessments of how to reduce global GHGs. As interest in behavioural measures, consumption, and lifestyles grows (and as other measures that may affect trade, such as border carbon adjustments, gain favour), analysts and policymakers should take care to explore measures that could have benefits both for the climate and for global development.

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