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THE ROLE OF INFORMATION DISCLOSURE IN CLIMATE MITIGATION POLICY

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Information disclosure policies represent an additional policy mechanism that can be used to foster reductions in greenhouse gas emissions. These informational efforts could be either mandatory or voluntary, but in each case government regulation could play a productive role by establishing common structures for the information and providing criteria to ensure the accuracy and credibility of the information. Unlike most previous uses of environmental information disclosure, such as the Toxic Release Inventory and pesticide warnings, carbon footprint labeling does not communicate information about immediate private benefits. While considerable insight can be gleaned by examining the principles for effective warnings generally, additional research would further our understanding of how to best design a successful information effort directed at varied future environmental benefits. Care is needed as green labeling may distort consumer decisions if undue prominence is given to environmental consequences as compared to other valued attributes, such as safety.

Keywords: Information disclosure; carbon labels; greenhouse gas mitigation; green labeling; warnings.

1. Introduction

1.1. *Why the excitement (or lack thereof) for information disclosure policies?*

This paper examines the potential role of information disclosure in reducing greenhouse gas emissions. Carbon disclosure is now becoming part of the regulatory landscape in the U.S. as large emitters are being required to disclose their annual emissions to the U.S. Environmental Protection Agency (EPA) under the Greenhouse

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[1]See http://epa.gov/climatechange/emissions/ghgdata/.

Gas Reporting Program.[1] At the same time, information disclosure is increasingly becoming part of the private quasi-regulatory landscape as firms voluntarily disclose their carbon emissions through the Carbon Disclosure Project or prepare "carbon footprint" labels for their products. While these disclosure policies are mostly too new to evaluate empirically, previous theoretical and empirical studies of existing environmental information disclosure policies may provide insights into what works, what does not and at what cost. Thus, we examine the existing literature to look for lessons learned as well as gaps in our knowledge about how carbon disclosure policies are likely to work.

About 30 years ago, information disclosure was not in the environmental regulator's toolkit as an emissions reduction strategy. Instead, command-and-control regulation and the emerging market-based approaches of emission fees and marketable permits were viewed as the appropriate government responses to pollution externalities. However, several important developments in the 1980s led to a third potential tool for reducing pollution — information disclosure. Most visibly, disclosure of toxic emissions under the Congressionally mandated toxic release inventory (TRI) not only provided the public with new information as a "Community Right-to-Know Law," but it ultimately had a significant impact on firm-level emissions. The TRI program led to the adoption of other similar information disclosure laws in the U.S. and globally. In fact, EPA made information disclosure policies a key part of their mission in the 1990s,[2] and the World Bank experimented with and touted information disclosure policies in the developing world (see Dasgupta *et al.*, 2006). This growing trend led to Tietenberg's (1998) characterization of information disclosure as being the third wave of environmental regulation. Information disclosure programs appeal to regulators because they have been shown to be effective in reducing pollution, are oftentimes politically more feasible than new regulations (or legislation), and are thought to cost the government less than drafting and implementing new regulatory standards (Cohen, 2001).

At the same time, at the product level, growing consumer interest in "green products" led many companies to develop and market products with environmental attributes. For example, EPA reported that the number of new products being marketed with green claims increased from 1.1% in 1986 to 12.6% in 1991 (EPA, 1993). More recently, carbon labeling of products is gaining considerable interest with pilot programs being implemented in countries such as the U.K., Switzerland and Japan, and there are proposals to expand and standardize such programs globally (Vandenbergh and Cohen, 2010; Vandenbergh *et al.*, 2011).

While this paper focuses primarily on policy-relevant questions, we do not limit the discussion to *mandatory* or *government* information disclosure policies. Many *voluntary* disclosure mechanisms exist — often with direct or indirect government involvement. For example, the Department of Energy's Greenhouse Gas Registry was a voluntary reporting protocol that provided companies with a government-sponsored

[2]See Beierle (2003) for a discussion of the EPA policy and several programs implemented following the success of TRI. Another area in which disclosure has been used and studied is safe drinking water (Bennear and Olmstead, 2008).

reporting framework. In addition to government regulation, however, there are many private information disclosure programs that take on a quasi-regulatory posture. For example, rating organizations might monitor company performance based on a combination of mandatory and/or voluntary disclosures and provide a third-party assessment. In product labeling, there are many privately sponsored schemes, often competing within the same product category.

While the focus of this paper is largely on facility-, firm- or product-level disclosure, these mechanisms should be viewed as a subset of a broader range of potential informational policies. Public education campaigns have played a prominent role in anti-drug policies, and there are formal education requirements that must be met before becoming a licensed pesticide applicator[3] or being allowed to drive a car. Utilization of informational approaches in the context of climate change policies may lead to firm-level disclosures or labeling policies, but other informational interventions also may be useful and should be considered if disclosure approaches alone are inadequate due to lack of consumer or public knowledge and understanding of complex climate information.

Irrespective of whether information disclosure is mandatory or voluntary, the key question remains whether environmental information disclosure is an effective complement to, or a substitute for, traditional forms of regulation. Information disclosure itself is unlikely to lead to full internalization of the externalities and may not even pass a cost–benefit test in some circumstances (Cohen and Santhakumar, 2007). For example, it is possible that shedding light on one product attribute or one pollutant will focus public or consumer attention toward a social ill that is less important than another that has no such disclosure program. There are, for example, many attributes of products that consumers may find difficult to monitor, including safety, reliability, and environmental externalities. Highlighting one of these dimensions may lead to inordinate attention to the highlighted attribute relative to other difficult to monitor attributes. Nevertheless, if crafted properly, information disclosure can be an important addition to the policy landscape. Perhaps equally important, however, is the question of the mechanisms by which emission reductions are observed following information disclosure. Understanding these mechanisms will help policy makers choose which industries, product categories and disclosure policies to adopt as well as how to structure them.

Finally, the question arises as to whether the lessons learned from prior information disclosure programs apply to carbon disclosure. Unlike many pollutants or products that have been labeled, there is not a pure "private" component to the benefits of greenhouse gas emission reductions — with the possible exception of an altruistic component. It is unlikely that consumers will alter their consumption decisions in response to information about external benefits to society as much as they might alter purchase and usage decisions when confronted with information about personal

[3]See http://www.epa.gov/oppfead1/safety/applicators/ctprogs.htm.

benefits in terms of financial savings or reduced health risks. Thus, there is a need for caution in assessing whether and to what extent we can transfer the findings from previous studies to carbon disclosure and labeling policies. To begin to answer these questions requires an understanding of both the theory and evidence on information disclosure to date.

2. Theory of Information Disclosure

To set the stage for the rest of the paper, we briefly review the underlying theory of information disclosure. We consider two questions: first, why and under what circumstances does information disclosure lead to voluntary firm reductions in emissions? Second, why do some firms voluntarily disclose their emissions? We consider each question in turn.

2.1. *Why do firms voluntarily adopt environmental measures beyond legal requirements?*

Konar and Cohen (2000) developed a simple model to explain firm voluntary pollution reductions in the face of mandatory information disclosure (see also Karkkainen, 2001; Schatz, 2008). The model assumes profit maximization and posits that firm-level emissions vary because of firm-specific factors that affect both the "ability" and "incentive" to reduce pollution. The incentive to reduce pollution may be due to external pressures such as community or public interest groups that might bring about negative publicity, sue for tort damages caused by environmental hazards or challenge the company on other issues (e.g., zoning board rulings); employees who might be concerned about the health of their workplace environment or the reputation of their employer; or consumers who might base some purchase decisions on a firm's environmental record. Another potential source of pressure is from investors who may use pollution as a signal of the firm's productive efficiency — or may anticipate increased costs due to some of the consumer, employee or public pressures described above. Finally, even though these emissions are legal, Konar and Cohen (2000) noted that firms/industries that are highly regulated might face increased government scrutiny when they are shown to be relatively high emitters of legal pollution (Chatterji and Toffel, 2010). Mediating these external pressures is the firm's ability — i.e., the cost of reducing emissions, which might vary by age of plant or location, and the firm's financial status.

This model leads to predictions about which firms are most likely to reduce emissions in response to information disclosure policies. To the extent that environmental reputation matters and stakeholder pressures are important, firms with the "most to lose" from a negative environmental reputation have a greater incentive to improve their environmental performance compared to others. Of course, the cost of pollution reductions and financial ability will also be an important factor in a firm's cost–benefit calculus. Note that factors such as which firms have the most to lose from

negative publicity or a firm's financial ability to reduce pollution may have little to do with efficient pollution reduction — i.e., there is no reason to believe that information disclosure policies will lead to least cost — or efficient — reductions in pollution. Which firms have the most to lose or the most to gain from voluntary pollution reductions? The evidence is somewhat weak on this account — an issue we turn to in the next section.

Similar types of profit-related factors often come into play with respect to product labeling efforts. Firms may be able to boost product demand and corporate profits through a voluntary "green labeling" program that touts the environmental benefits or limited environmental harm from its products. Similarly, to the extent product demand is affected by green labels, mandatory labeling will provide an incentive for firms to improve their environmental performance to the extent increased sales revenue outweighs any additional cost of emission reductions.

2.2. *Why do firms voluntarily disclose emissions?*

Throughout, we assume firms are rational profit maximizers. As such, in deciding whether or not to voluntarily disclose company-wide or product-level environmental performance, firms judge their private costs against their perceived benefits. Costs would include both the opportunity costs associated with testing and labeling as well as any resulting negative impact on revenue (either through higher prices or negative information affecting sales). Benefits from disclosing relatively good information would include the potential for greater sales, favorable treatment by regulators or other stakeholders, etc. Generally, the economics of information literature predicts that firms will voluntarily disclose only positive information (either absolute or relative to their competitors) — whether at the firm or product level. However, if one firm can credibly claim to be of higher quality on a particular product attribute, this provides an incentive for competing firms (other than the lowest-quality firm) to reveal their quality on that attribute as well (Viscusi, 1978; Ippolito and Mathios, 1990). As the highest-quality firms reveal their quality level, doing so will affect the incentives of other firms to do likewise to the extent that consumers revise their quality assessments downward for the firms that have not yet been identified. This type of outcome will occur if consumers can assess the average quality level for the industry. Once the above-average firms have certified their quality level, consumers will lower their quality assessment for the currently uncertified firms based on the now lower average quality for these firms. This process usually increases the incentive of the higher-quality remaining firms to certify their quality level, leading to greater unraveling in the market. Key factors that foster broad voluntary quality certification are having low costs of quality certification and having available a credible mechanism for certifying quality level. Government policies potentially can assist on each of these dimensions.

Kim and Lyon (2011) modeled firm behavior in a manner that considers the costs and benefits of voluntarily investing in carbon emission reductions and/or disclosing

carbon emissions when faced with the potential of earning early reduction credits under a future where carbon is regulated (priced). Their basic findings are that firms are more likely to participate in the voluntary disclosure program when they (a) have a lower marginal abatement cost and (b) face a greater threat of future state regulation. An important twist to this model is the possibility that firms can selectively disclose information. Lyon and Maxwell (2010) considered this explicitly in their model of "greenwashing",[4] where firms are subject to scrutiny and NGO pressure if their disclosures are misleading. Recognizing that large firms have mixed environmental records (e.g., numerous facilities, accidental discharges, etc.), they show that some of the least polluting firms are also least likely to disclose — for fear of public backlash for greenwashing. By examining environmental quality as a complex multidimensional attribute, their findings provide an important caveat to those of Viscusi (1978) and Ippolito and Mathios (1990). They also found that activist pressure is likely to induce some of the most polluting firms to disclose. Their finding is reminiscent of what happened with green marketing claims in the early 1990s after some of the largest consumer product companies were charged with making false environmental marketing claims and subsequently stopped making such claims altogether for fear of hurting their overall corporate reputation.

3. Information Disclosure at the Facility or Firm Level

Does information disclosure provide an incentive for firms to voluntarily reduce pollution? As noted above, the TRI program was initiated in the mid-1980s. It is one of the earliest mandatory environmental information disclosure programs as well as the most studied. Hamilton (1995) reported that publicly traded firms, on average, suffered significant reductions in stock returns on the day that TRI information was first released to the public — although the distribution of abnormal returns varied considerably across firms.[5] Following this result, Konar and Cohen (1997) found that firms with significant stock price hits on the first release date were the firms whose TRI emissions were reduced the most in the first two years following the first disclosure. In the aggregate, TRI emissions were reduced considerably and continue to decline.[6]

[4]Lyon and Maxwell (2010, p. 9) define greenwashing as being "…fundamentally about misleading consumers and investors by telling the truth, but not the whole truth. This suggests a model in which the firm discloses verifiable information, but may choose to withhold facts that do not reflect favorably on it, thereby persuading outsiders that the firm's performance is better than it is in reality."

[5]Of course, the fact that stock prices were affected does not necessarily mean that investors care about TRI emissions themselves — instead, the reason investors care are likely to be directly related to expected firm profitability. Thus, if TRI is correlated with inefficient production, expected future regulatory action, zoning restrictions, etc., these are all mechanisms through which rational investors might reevaluate firm valuation.

[6]For example, Konar and Cohen (1997) found that TRI per dollar revenue for publicly traded firms declined by 11.9% when comparing 1988–1990 to 1991–1993 levels. Interestingly, the decline for the top 40 firms whose stock declines were highest upon the first release of TRI data was more than twice this level, 27.9%. Konar and Cohen (2001) provided evidence that publicly traded firms derived intangible asset value from voluntarily reducing TRI emissions. Even the most recent EPA TRI report shows continued aggregate national declines in TRI emissions, see http://www.epa.gov/tri/tridata/tri09/nationalanalysis/overview/2009TRINAOverviewfinal.pdf.

Will facility-level carbon disclosures bring about similar reductions in carbon emissions? Unlike TRI, where the local residents nearby a polluting facility might directly bear the costs of higher levels of pollution, carbon emissions have a global impact and do not necessarily affect local communities any more than a carbon emitting factory thousands of miles away. The intensity of the preferences of local residents affected by pollution will likely be greater than in the carbon emissions case. Moreover, TRI disclosures may also be a signal of prospective regulatory costs, and this expectation may not be as pronounced for less well-established greenhouse gas policies. Of course, as discussed in the theory section, there are other reasons why pressure might be brought to bear on facilities — including pressure from NGOs or environmentally concerned consumers — none of which are necessarily local. Recently, Beatty and Shimshack (2010) examined the stock price reaction to an announcement by an environmental group that rated companies based on their responsiveness to climate change concerns. They found significant negative stock price effects for poorly rated firms — consistent with previous studies on TRI. However, we do not yet know whether these stock price effects will translate into greenhouse gas emission reductions.

Despite these early signs of success, there are numerous signs of caution about the impact of information disclosure. Subsequent studies of TRI suggest that reductions varied considerably by location, and that some of the reported decrease in emissions might be due to firms changing their reporting procedures or by substituting non-TRI chemicals that were not necessarily less toxic (Bui, 2005; Graham and Miller, 2001). Although we are unaware of any empirical evidence regarding substitution and reporting effects, it is also plausible to assume that some reductions might have occurred through offshoring. While the jury is still out about the effectiveness of TRI and other similar programs, much can be learned from the studies conducted to date.

The fact that TRI emissions reductions were not uniformly distributed across firms raises important questions about the mechanisms by which these programs induce firms to voluntarily reduce emissions beyond any legal requirement. While some studies have sorted out some or all of these potential mechanisms, in other cases it is difficult to attribute impacts directly. We summarize the evidence below.

Environmental group pressure appears to have some impact — although not always. For example, Konar and Cohen (2000) directly controlled for negative advertising by various environmental groups following release of TRI information and found that some of these negative messages had an impact on emissions. Although they do not provide direct evidence on the exact mechanism, several studies have shown that firms identified as being "worst in class" in their industry subsequently reduced emissions most (Konar and Cohen, 2000; Chatterji and Toffel, 2010).

Evidence on consumer pressure is mixed. Konar and Cohen (2000) used advertising expenditures as a proxy for consumer pressure and failed to find any impact on TRI emission reductions. Similarly, Beatty and Shimshack (2010) examined the impacts of a third-party rating of firm responsiveness to climate change concerns and found that

advertising expenditures did not help explain negative stock price returns. On the other hand, Delmas *et al.* (2010) found that investor-owned utilities were more responsive to mandatory disclosures when they sell more to residential customers.

Similarly, evidence on "government pressure" is somewhat mixed. There is some evidence suggesting that firms are more likely to voluntarily reduce emissions when they are otherwise subject to government regulatory pressures or the threat of future regulation in other environmental realms. Konar and Cohen (2000) found that an increased number of fines were associated with larger emission reductions (although they found the opposite effect with respect to the level of fines). Maxwell *et al.* (2000) found that facilities located in states with higher levels of environmental activism were more likely to reduce TRI emissions — consistent with their model of regulatory preemption.

4. Carbon Product Labels[7]

4.1. *Objectives of labels*

Labels and warnings have served a major role in a variety of consumer and industrial contexts and potentially could be a useful component of climate change policies. Although companies can provide labels voluntarily, few firms did so until long after warnings were required for very dangerous products. The first warning labeling laws in the U.S. were for a small group of highly dangerous chemicals such as sulfuric acid, with warning requirements for prescription drugs following. Beginning in 1966, federal legislation has required that cigarettes bear on-product warnings following specific wording and format. Cigarette warnings were the first warnings for a product that posed dangers when used in a way that the manufacturer intended. In the 1980s, OSHA imposed the first labeling requirements for workplace chemical hazards. Labels for consumer products have since proliferated including labels for flammable materials, potentially dangerous household chemicals, alcoholic beverages, nutrition information, lawn mowers, organic produce and a wide range of other products.

What is distinctive about carbon labeling policies is that the focus is on externalities rather than the benefits and costs to the individual. Admonitions against driving after excessive drinking of alcoholic beverages do include an externality component, as do alcohol and cigarette warnings about potential birth defects if these products are used by pregnant women. Even for birth defects, the externalities involved are not remote as there is likely to be a fairly substantial personal stake in the adverse effects of risky behavior on one's children. Pesticide warnings alert consumers to both personal harm and environmental danger. But in these instances there is a private benefit and cost component as well, and the risks affecting others are generally near term, which lead to identifiable harms, and can be averted through a single person's proper care. The hazards

[7]Unless indicated otherwise, the evidence supporting the empirical results discussed in this section is drawn from Viscusi and Magat (1987) and Magat and Viscusi (1992). For a review of the history of warnings, see Viscusi (2002).

of climate change are quite different. The climate change externalities of any individual's decisions will not affect the consumer will probably not be apparent until many decades after the consumption decision, and will not be perceptibly affected by anything the consumer does. As a consequence, the task for carbon labeling is more daunting than in other labeling contexts. Nevertheless, carbon labeling is not the first instance where labeling has been applied to a diffuse externality for which restraint by any particular individual will have no perceptible impact. For example, there is evidence that dolphin-safe tuna labels had a significant impact on product choice (Teisl *et al.*, 2002).

Because of the presence of externalities in the carbon labeling situation, social norms may come into play.[8] Driving a Prius may serve as a form of conspicuous conservation, fostering the reputation of the driver of this hybrid vehicle (Griskevicius *et al.*, 2010). Similarly, the presence of solar panels for one's house creates a visible commitment to the environment, whereas the installation of a multi-zone highly efficient air conditioning and heating system does not. Visible environmentally responsible actions by one's neighbors also may establish a social norm and encourage similar behaviors by others. The importance of social norms for environmental actions also appears to be especially pronounced for those who are acting responsibly, as they are often particularly disturbed by the failure of others to conform (Viscusi *et al.*, 2011).

If the policy objective is to influence decentralized decisions that cannot be readily monitored or controlled, then informational policies provide a mechanism for fostering the desired behavior. As with facility or firm-level disclosure policies, labeling policies also may be a more politically viable policy option, given the greater challenges facing the adoption of efforts such as cap-and-trade policies. For warnings pertaining to private risks, there is also the impetus that tort liability provides for conveying warnings. But there are no comparable legal requirements for warnings with respect to climate change externalities. As a consequence, government regulation and private actions by firms must play a greater role.

Labeling policies have two potential functions. First, they could affect the discrete choice of which activities or products to choose. Should the consumer buy a hybrid car, an energy efficient house or take an international plane flight? Second, labels and warnings can be used to influence precautions and how people use products. Not idling one's car and keeping the thermostat at a temperature that leads to less energy use are examples of behavioral changes that also can be the focus of informational efforts and be part of climate change policies. If information will not potentially alter either the

[8]The "norm activation theory" in the social psychology literature has dealt with similar issues and there is a lengthy literature focused on environmental norms (see, for example, Stern *et al.*, 1999). This literature argues that for norms to develop, there needs to be both an "awareness of consequences" and "acceptance of responsibility" — which includes an understanding that individual action will help alleviate the problem. In the context of environmental norms, Stern *et al.* (1999) recognized that in addition to the need for an awareness of the externality (in our case the impact of carbon emissions on climate change), there is a need to overcome the free rider nature of pollution. Since group action can alleviate the impact of an externality, it is through social norms and group obligations that individuals can rationalize their way out of this free rider problem.

activity/product choice decision or induce any behavioral changes, then the information has no economic value to the consumer from a decision standpoint. It should also be noted that not all behavioral changes are necessarily beneficial. A consumer could potentially offset environmentally protective actions by being more lax in other ways. This danger is particularly great if consumers overestimate the impact of their protective behaviors. Having bought a Prius, for example, I might potentially drive more miles, reducing the extent of the environmental improvement.

Irrespective of whether information is intended to alter discrete choices or behavior given this choice, the principles derived from studies in the hazard warnings literature are applicable. To be effective, warnings must provide new information in a convincing manner. Warnings that simply remind consumers of what they already know or which attempt to browbeat consumers into changing their behavior have not proven to be effective. Carbon labeling policies that provide information about the carbon content of different products will likely be effective, whereas general admonitions about the dangers of climate change may not.

To maintain the credibility of warnings efforts, the information provided should be accurate and honest. In the case of private risks, the objective is to provide unbiased information that, if credible, will lead Bayesian consumers to update their risk assessments to form more accurate risk beliefs. Whether the objective is to foster accurate probability assessments, an understanding of the consequences of the possible harms, or some other concerns, we assume the responsibility, of those designing warnings, is to provide accurate information so as not to undermine the credibility of warnings efforts generally. Thus, even though promoting consumer behavior to reduce the consumer's carbon footprint is a worthy cause, the labeling effort should not distort the environmental consequences of the product in order to advance that objective.

4.2. *Criteria for effective labels*

The literature on hazard warnings has developed a series of insights that provide useful guidance for the design of labels generally. These insights are applicable to carbon footprint labels as the guidance pertains primarily to general issues such as how to convey information effectively rather than whether the label involves environmental externalities. These insights have been derived based on observation of actual experience with labels as well as controlled experimental studies. Similar kinds of scientific research can be used to refine the insights for the design of carbon footprint labeling approaches, but thus far there does not appear to be comparable research on carbon labels.

To be effective, the consumer must receive the information, process the information, believe the information and use it to update beliefs that potentially can influence decisions regarding the product. On-product labels consequently have the strength that including the label as part of the product ensures that the consumer will receive the information. Similarly, point-of-purchase displays with comparative information

across products can be effective since they provide comparative information at the time of the consumer's purchase decision. In contrast, postings on the Internet or in news media may not be received.[9] Even if the information is included on the product, it must still be read. To promote the reading of the warnings information, often it is useful to incorporate the warning in a context that will engage the consumer in the normal course of purchasing or using the product, such as when reading instructions for use. Another frequent approach is to have a standard location and format for providing the information of interest, as in the case of the listing of nutritional information.

The content of the label also matters. Thus, the substantive information being conveyed is important as the amount of information and whether a broad audience can understand it. Both from the standpoint of space constraints and consumer information processing, labels should be parsimonious. Consumers generally cannot reliably process more than four to five pieces of information from a label. Too much information leads to problems of label clutter, which results in consumers not processing the main message from the label and either focusing on less important matters or simply being overwhelmed and not attending to the label at all. Substantive issues pertaining to content also include how the information is framed as, for example, this product is better for the environment than other products or this product is worse for the environment than other products.[10] Experimental studies suggest that the negative framing may be more effective when households have only a modest interest in the environment (Grankvist *et al.*, 2004).

Format issues also enter into determining the efficacy of the label. The print size must be sufficiently large to be readable. Extremely large typefaces are not more effective and simply take up more of the available space on the label, decreasing the amount of other useful information that can be provided. Whereas economists generally support the freedom of individuals and firms to make different decisions, in the case of warnings the presence of diversity is a negative rather than a positive attribute. Standardization in the warnings vocabulary is desirable so that human hazard signal words such as danger, caution and warning have the same meaning for different products. As carbon footprint labels develop, uniformity in the index used to indicate the magnitude of the carbon footprint from the product is desirable. Perhaps in part because of the ability of standardized labels to be more easily processed by consumers, the Energy Star label has been much more effective than various private labeling systems for energy efficiency (Banerjee and Solomon, 2003). Similarly, uniformity is desirable from the standpoint of format so that the use of boxed warnings or bold print for some pharmaceutical products has the same meaning across product groups. In

[9]New technology and media may be changing this somewhat. For example, "Good Guide" (www.goodguide.com) is a mobile application that allows consumers to check product ratings on various dimensions while shopping even without product labels. If similar products are introduced by ratings organizations that focus on companies, this might begin to blur the distinction between product labels and corporate-level information.

[10]Note that such general claims might run afoul of Federal Trade Commission "Guide for the Use of Environmental Marketing Claims." See 16 CFR Part 260.

much the same way, carbon footprint labels should have a consistent mechanism for communicating the environmental harm. At present, there is no consistency as, for example, gas and electric public utilities often use quite different formats for communicating energy usage and possible environmental consequences.

The mechanism by which the informational effort is intended to induce its effect is also a key concern. Viscusi *et al.* (2011) found empirical evidence in support of three different mechanisms by which environmental policies could foster behaviors that are protective of the environment. First, the protective behavior may be attractive if the person has a self-interest in the behavior due, for example, to financial benefits or personal concerns for the environment. Second, people may develop personal norms that they find attractive for their behavior and which they believe others should adopt as well. Third, there may be external norms imposed by others in the form of either a societal reference point for appropriate behavior or pressure to adopt the environmentally responsible behavior. Thus, the adoption of personal norms by part of the population may either lead to pro-environmental social pressures on others or may provide a reference point for appropriate behavior that in turn will affect decisions by others. In thinking about the mechanism by which labeling will be effective, it is useful to inquire whether the appeal is to private self-interest, or whether it is an attempt to establish a social norm. The influence of these mechanisms is likely to be dependent not only on the labeling information but also on how prevalent and visible is the responsible behavior by a particular household and/or the average household in the target community.

Finally, the use of labeling should be selective. In situations in which the use of labels is ubiquitous, then consumers will suffer from problems of information overload. At present, most warning labels are for products that are either dangerous in some respect or for which there is the potential for failing to reap the full benefits from the product by, for example, not understanding which breakfast cereal is most nutritious. If every product category has a carbon footprint label and is, in effect, stamped as being potentially harmful to the environment, then it will be more difficult for consumers to make the judgment about when it is important to be concerned about the carbon footprint and when it is not. Thus, it might be more effective to label only product categories that have significant carbon footprints and that have enough variability in current or future carbon footprints to provide consumers with meaningful choices (and firms with meaningful incentives to reduce the carbon footprint of their products).

4.3. *An example of the EPA-DOT fuel economy label*

Figure 1 provides an example of a recent warning label that will go into effect in 2013, which is the EPA-DOT label for flexible-fuel vehicles that use gasoline–ethanol (E85). The best tests of efficacy of this label as opposed to other approaches that might be used, would be actual field experiments using this label or other labels to identify their effect. Alternatively, one can use an experimental design as in Viscusi and Magat

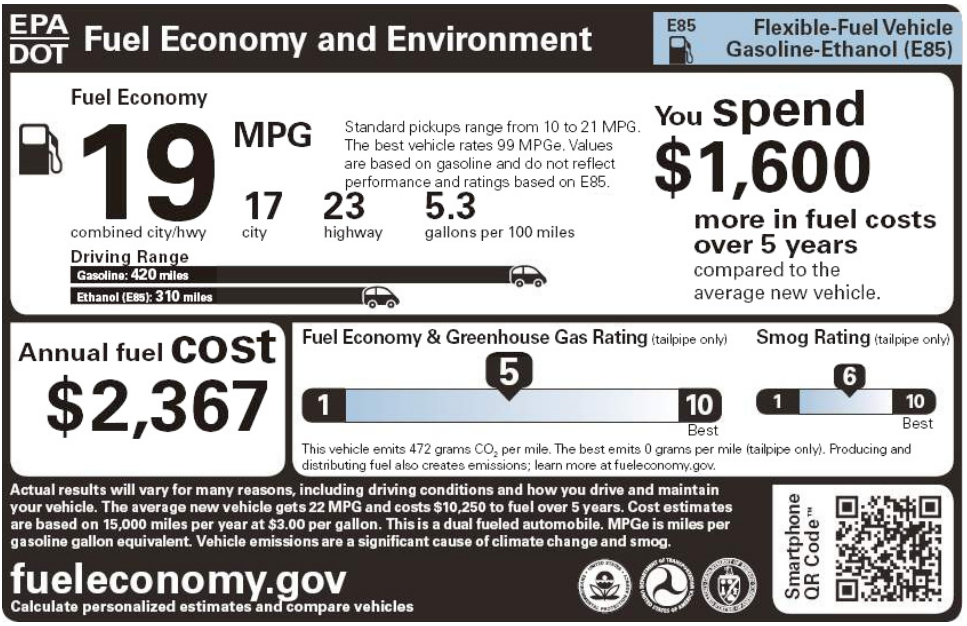

Figure 1. EPA-DOT motor-vehicle label combining fuel economy and environmental consequences.

(1987) and Magat and Viscusi (1992) to evaluate the effect of different labels on the information that is processed and how it will affect planned consumer decisions.

The dominant focus of the label is on various financial aspects regarding energy usage, where some of this information may have environmental ramifications as well. The energy usage information is provided in multiple, somewhat redundant ways including overall mpg, mpg in city and highway, gallons per 100 miles, driving range, annual fuel cost and marginal fuel cost over the next five years. The main takeaway from this label is that the main concern should be about pocketbook issues, not environmental externalities.

The most prominent information is the mpg figure for combined city/highway driving. However, we see in the fine print that this figure is based on gasoline not ethanol (E85), which will perform less well. There is some redundancy as the label also provides information about the number of gallons per 100 miles. The driving range information also is presumably useful, as we see that ethanol (E85) will get the car about three-fourths as far as will a comparable amount of gasoline. Consumers using ethanol (E85) consequently will have to do the math to figure out that their mpg will probably be about 14 overall. Posting the relative performance of ethanol (E85) at the pump where consumers purchase gasoline will assist them in making more informed choices about which type of fuel to use.

Next in prominence on the label is the fuel cost information. The label tells the consumer comparative information about the additional spending in fuel costs over five

years compared to the average new vehicle as well as the annual fuel costs. Thus, the label cuts across two different time horizons, complicating the comparisons. In fine print below, we see that these estimates are based on 15,000 miles per year and $3 per gallon.

While the fuel economy and gasoline cost information are extensions of relatively long-term labeling approaches to inform consumers of the energy efficiency of their vehicles, the information about environmental effects is new. The carbon footprint information in the panel includes both a fuel economy and greenhouse gas rating, which is accorded a larger-sized scale than the smog rating. Presumably, even if consumers do not know the difference in the importance of greenhouse gases and smog, which many surely do not, the size of the scale may be suggestive that greenhouse gases matter more than smog. Or consumers might think that the size of the scale does not indicate importance but is a consequence of the graphic design. In particular, the scale heading of "Fuel Economy & Greenhouse Gas Rating (tailpipe only)" takes up more space than does "Smog Rating (tailpipe only)," and perhaps the length of the scales had to be adjusted accordingly. On each of the scales the cars get a rating on a 10-point scale. It is unclear whether this is a cardinal scale (e.g., a score of 1 has 10 times as much greenhouse gas emissions as a score of 10) or an ordinal scale (e.g., a score of 1 implies more greenhouse gas emissions than a score of 10 but how much more is undefined). Similar issues arise with respect to the smog rating scale. Below the scales we find that this vehicle emits 472 g CO_2 per mile, which is not as good as zero, but is this bad? Unlike conventional warnings contexts, it is difficult for consumers to get a sense of the magnitude of the harms that will result from not taking more environmentally responsible behavior.

Complications arise with respect to comparing scores on these two scales as well. If Car A has a greenhouse gas score of 5 and a smog rating of 7, while Car B has a smog rating of 9 and a greenhouse gas rating of 4, which car is better for the environment? And what weight should the consumer place on the many pieces of information provided, most notably the fuel economy and environment information? Fortunately, fuel economy is negatively correlated with environmental harm so that fostering choice of more fuel efficient vehicles will enhance environmental quality.

Finally, note that this label is selectively targeted at fuel efficiency and environmental externalities. If, for example, the prominence of the label leads consumers to disregard other difficult to observe concerns, such as safety, then the quality of consumer decisions may not be improved. Similarly, while fuel economy ratings provide a meaningful measure of vehicle operating costs for any given level of reliability, if a vehicle has a higher rate of repairs the operating cost will be increased. Ideally, consumers should receive information on multiple product attributes, particularly those that are difficult to observe and may be important.

4.4. *Evidence on consumer willingness to pay for environmental amenities*

Labels indicating the effect of the product on the environment can potentially affect consumer choice to the extent that they are willing to pay more for more

environmentally responsible products. Principal contexts in which labels have been used to communicate environmental benefits as well as financial costs are for green energy, appliances and buildings. Considering the performance in these areas provides some indication of the likely degree of success of carbon labeling approaches.

Energy efficiency of appliances has long been a focus of various consumer ratings and government programs. As one might expect from their shorter time horizons and the durable goods nature of appliances, households that rent tend to have less efficient appliances than do homeowners after controlling for income and other factors (Davis, 2010). A choice-based conjoint study in Switzerland found that the EU eco-labeling of washing machines could potentially be effective, but that the system permitted too few variations in relative performance (Sammer and Wüstenhagen, 2006). There may be a similar shortcoming in the U.S. If the great majority of appliances are accorded an Energy Star rating, there is little distinction across different appliances in their relative performance. Even though the Energy Star program appears to be effective in stimulating consumer concern with both private energy savings and environmental costs (Ward *et al.*, 2011), the program potentially could enhance its effectiveness with more gradations in performance ratings.

While building codes that require energy-efficient buildings may be effective (Jacobsen and Kotchen, 2010), voluntary approaches that utilize energy labeling may be useful as well. The home energy label implemented by the European Union includes both energy cost savings information as well as environmental CO_2 impacts, each of which provides current and potential performance measures. The labeling system has not been widely adopted because of largely adverse publicity and negative sentiment toward the labels. For those homes that were labeled, Brounen and Kok (2011) found that energy cost savings communicated by the labels were capitalized into the value of the homes. However, the capitalized gains are sometimes modest, as Dastrup *et al.* (2011) found only a small premium for solar panels on homes in San Diego and Sacramento. Similarly, Eichholtz *et al.* (2010) studied green buildings in the commercial real estate market and found that while price premiums were clearly related to energy efficiency, there also appeared to be an additional intangible value placed on buildings with an Energy Star or LEAD certification.

The study by Banfi *et al.* (2008) utilized a stated preference model to elicit Swiss households' willingness to pay for greater energy efficiency in residential buildings. Consumers exhibited substantial willingness to pay for greater energy efficiency. While the valuations may include consideration of environmental benefits, the experimental design focused on energy-related components, such as installation of enhanced windows coated with triple glazing and with no experimental variation in the environmental effects.

The above studies largely comingle the private pecuniary benefits of reduced energy consumption with the public (or altruistic) benefits of greener energy. In contrast, a series of studies have attempted to sort out the pure pecuniary from altruistic rationales. For example, Clark *et al.* (2003) found that altruism toward the environment is a chief

reason why consumers participate in green electricity programs that purchase higher priced energy from wind or solar. Borchers *et al.* (2007) found that stated willingness to pay for green energy was positive, with some variations in willingness to pay by source of energy as solar energy had the highest value and biomass had the lowest value. Menges *et al.* (2005) found both altruism and warm glow effects to be at work in affecting people's stated willingness to pay a premium for green energy. Finally, Zarnikau (2003) found that more information about green power and energy resource issues boosts consumers' stated willingness to pay for green energy.

Aside from energy, there are also a few examples where consumers have demonstrated their willingness-to-pay for environmental amenities beyond any private pecuniary value. The most notable example in the real world is the labeling of dolphin-safe tuna (Teisl *et al.*, 2002). More recently, Michaud *et al.* (2012) conducted a random discrete choice experiment in Grenoble, France, where consumers faced actual purchase decisions of roses. Irrespective of price, the "low-carbon" rose was chosen 79% of the time compared to a "higher-carbon" rose. Moreover, consumers were found to be willing to pay a significant price premium for the low-carbon rose. Since a low-carbon rose has no direct consumer health benefits, it would be reasonable to attribute this demand to altruism (or perhaps to the warm glow of bringing carbon-friendly roses to a loved one).

5. Unintended Consequences of Information Policies

Like all regulatory policies, information disclosure must be designed with care to minimize unintended consequences. We highlight three potential unintended consequences that apply to both firm-level and product-level disclosure: (1) reducing competition or innovation, (2) shifting (instead of reducing) emissions and (3) costly emission reductions.

5.1. *Reducing emissions competition or innovation*

Disclosure programs or labels that use a threshold and/or rating system run the risk of stifling innovation. For example, once a firm meets the Energy Star label requirements, it has little incentive to exceed that level. Similarly, firms that are far below the Energy Star threshold might have little incentive to improve knowing that they will never reach that certification level. Partial solutions to this problem include continuous updating of the threshold, multiple rating levels, competing labels and a continuous emissions measure.

5.2. *Shifting (instead of reducing) emissions*

Political discussions over domestic climate legislation have almost always focused upon the concern about "leakage" — that firms will simply outsource and/or shift production overseas to avoid a carbon tax or cap. Remedies almost inevitably result in

subsidies or trade barriers for certain industries. While the concern is no different here, the potential solution might be less damaging. The solution appears to partially rely upon appropriately defined boundaries of the firm and/or product — i.e., to include the entire life cycle of production regardless of where the input was produced or transported from (Vandenbergh and Cohen, 2010). The problem may be more complex than simply focusing on production, however, as studies have shown that for many products, a significant portion of carbon emissions occur during consumer use. Note that in the fuel economy example discussed earlier, all of the carbon information is based on use — thus, this particular label ignores the production stage. Of course, balancing the cost and benefits of precision might warrant such choices — but they will ultimately need to be made on a product-by-product category basis.

A related concern with product labels is the "rebound effect" of offsetting behavior — that consumers will offset their climate-friendly choice in one domain (e.g., purchase decision) by making other "dirty" choices elsewhere (e.g., use the product more). This has been tested in the context of residential purchase of green energy and the evidence suggests that while there is some offsetting behavior, its impact (at least in this case) is small (Jacobsen *et al.*, 2012). Moreover, it is quite possible that the effect would go the other way — heightened awareness and habits of purchasing carbon-friendly products might increase consumer propensity to reduce their carbon footprint elsewhere in their life choices. This remains an important topic for future research.

5.3. *Costly emission reductions*

While information disclosure policies are "market-based" solutions to the extent that they rely upon market forces to internalize externalities, unlike emission fees or marketable permits, they are not necessarily designed to provide least cost solutions and in some cases might even induce emission reductions that would not pass a social benefit–cost test (Cohen and Santhakumar, 2007). In fact, Delmas *et al.* (2010) found electric utilities that reduced emissions most following an information disclosure program were those who used the cleanest fuel mix.

6. Concluding Remarks and Research Challenges

In theory, more information is better as it provides consumers and stakeholders with the ability to make more informed choices. Yet, unless carefully designed, information policies might have little effect on ultimate emissions. Even if they do result in lower emissions, the risk remains that the cost is high relative to the benefits. Prior experience with both firm-level information disclosure and product labeling provides us with some confidence that it is possible to design carbon information disclosure programs in a manner that is socially desirable. Yet, the lessons learned from these earlier programs suggest that climate information policies could benefit from further research.

The research gaps that need to be addressed are considerable. Even if we accept the scientific consensus regarding the human contribution to climate change, the ultimate

effects of any carbon emissions are highly uncertain, in part because the science is imprecise and actions throughout the world and over a long time frame will determine the effects. As indicated earlier, providing information and context in addition to the labels themselves has shown to be important in many cases — something that is likely to be true in the case of carbon labels. How then should we communicate the carbon footprint associated with different activities?

There is the additional uncertainty in ascertaining the carbon footprint of products, especially given the limited information about the carbon generation associated with all components of a product, which often are from multiple countries that cannot be readily identified.[11] The full life-cycle of the carbon emissions should serve as the reference point in assessing the carbon content, but assessing this value poses severe challenges. The practical task is to devise an information system that can communicate the carbon content in a credible manner in the presence of these uncertainties. Doing so can utilize insights from other informational efforts, but the strong externality component and the temporal remoteness of climate impacts makes it imperative that specific guidelines be developed for communicating carbon content. This suggests that competing carbon labels will only confuse and diminish the value of any labeling program.[12] Experimental studies and empirical analysis of actual carbon information programs are needed to refine the guidance and to ascertain which policy approaches will be most effective.

The types of concerns raised with respect to carbon labeling policies pertain to all forms of information provision regarding the effect of firms' activities and products on climate change. At the firm level, most government policies to date have simply disclosed raw data (often at the facility level) with little context relying on third parties to translate this into a comprehensible format for consumers or the public. That is the approach currently being planned by EPA with the Greenhouse Gas Reporting Program. Whether or not it is the right approach is not something we know from past research.

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[11]Vandenbergh and Cohen (2010) discussed this issue at length.

[12]Theoretical analysis by Fischer and Lyon (2008) showed how competing environmental labels may under certain circumstances provide a better environmental outcome. However, their model relied upon two labels with "threshold" effects as opposed to our recommendation that labels allow for many gradations or a continuous carbon measure.

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