USING THE TAX SYSTEM TO ADDRESS COMPETITION ISSUES WITH A CARBON TAX

Gilbert E. Metcalf

This paper considers how tax reductions financed by a carbon tax could be designed to mitigate the need for specific relief for firms in select energy-intensive, trade-exposed (EITE) sectors at the six-digit North American Industry Classification System level. Providing an output-based tax credit to EITE sectors or a broad based reduction in corporate income tax rates disproportionately benefits EITE sectors thereby potentially reducing pressure for other transitional relief. Payroll tax reductions, on the other hand, do not disproportionately benefit EITE sectors given their higher than average capital intensity.

Keywords: climate change, carbon tax, green tax reforms, trade competitiveness

JEL Codes: F64, H25, Q54
I. INTRODUCTION

Carbon pricing, whether in the form of a carbon tax or a cap-and-trade system, will have differential impacts among households and industries. Politicians have been especially concerned with the impact of a carbon price on energy-intensive, trade-exposed (EITE) manufacturing sectors. The Waxman–Markey Bill (H.R. 2454) carved out allowances for EITE sectors, and a U.S. government interagency report assessed those sectors most likely to be vulnerable to trade and leakage issues (see U.S. Environmental Protection Agency (2009)).\(^1\) Considerable research has been undertaken to assess what sorts of transitional relief schemes might be used to address industry losses from carbon pricing. Most of these analyses have focused on free allowance allocation in a cap-and-trade system.

This paper considers what role tax-related mechanisms might play to address competition and leakage concerns for EITE sectors arising from a carbon tax. If a carbon tax were incorporated as an element of an overarching tax reform initiative, it is reasonable to consider how other elements of the reform could be designed to address industry concerns over the trade and competition impacts of a carbon tax.

The tax code is a logical mechanism through which to address competition concerns for several reasons. First, it allows policymakers to integrate competition considerations into a broader tax reform in which a carbon tax could be used for revenue to avoid other tax increases, resulting in a revenue-neutral tax reform.\(^2\) Second, much of the sector-specific impact of carbon pricing arises from investments in long-lived capital. The tax code has a long history of

\(^1\) Leakage refers to the shifting of carbon intensive production from jurisdictions that levy a carbon price to those that don’t. An example would be if a firm moved its energy intensive manufacturing out of a country with a carbon tax or cap-and-trade system to a country with no carbon price. Not only would this adversely affect jobs and economic activity in the country with the carbon price, global emissions are not reduced (or not reduced as much as in the absence of leakage).

\(^2\) A large literature, going back to Bovenberg and de Mooij (1994) and Parry (1995), has emphasized the efficiency benefits of using environmental tax revenue to lower other distortionary taxes. A few specific tax swaps include those described by Metcalf (2007b), Rausch and Reilly (2012), and Carbone, Morgenstern and Williams (2012).
provisions designed to encourage capital investment and alter relative rates of return across
different forms of capital. It is natural to consider using the tax code in this context. Third,
transitional relief through the tax code contributes to political coherence by involving tax-writing
committees in the design of both a carbon tax and any transitional relief mechanisms needed to
address concerns of EITE sectors.

The findings of this paper with respect to the use of a carbon tax in broader tax reform
can be briefly summarized as follows: 1) A carbon tax reform can achieve desired efficiency and
distributional goals while addressing competitiveness concerns for EITE sectors in a variety of
ways; 2) Direct relief to EITE sectors can be justified based on distributional or political
considerations but may work at cross purposes with economic efficiency considerations; 3) Certain approaches to indirect relief provide above-average benefits to EITE sectors and thus can
be viewed as a form of transitional relief that mitigates the need for any direct compensation; 4) Direct relief through the corporate income tax in the form of a carbon tax credit is attractive on
political grounds. The carbon tax liability for EITE sectors, however, exceeds the corporate tax
liability, so tax appetite will be insufficient to fully offset the carbon tax liability through
reductions in the corporate income tax; 5) Direct relief can be designed to take into account
limitations on tax appetite while also addressing competitiveness concerns and providing
incentives to move toward best practices and technologies.

A tax credit modeled on the output-based allowance allocation approach for EITE firms
in H.R. 2454 is an attractive variant on a straight carbon tax credit. Setting a firm-level credit at
some benchmark for sector average emissions intensity (emissions per value of shipments) times
the firm-level value of shipments would maintain the incentive at the margin to reduce emissions

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3 Direct measures include some form of compensation that is linked to actual emissions and carbon tax payments. Indirect measures include tax reductions financed by the carbon tax that, while broad-based, benefit EITE sectors.
while also providing an indirect subsidy to output through the intensity mechanism. One attractive intensity benchmark would be a “best practices” benchmark, whereby a credit is provided for firm-level value of shipments times the sector-specific emissions intensity of the firms at the 90th percentile of emissions intensity efficiency. Firms are thus incentivized to make investments and improvements that move them toward the practices and investment levels of firms that are in the top 10 percent for low emissions per dollar of the value of shipments, a benchmark that is demonstrably achievable. I discuss this further below.

II. SUMMARY OF EXISTING LITERATURE

The literature on distributional impacts of carbon pricing has focused largely on impacts across income groups of households and, to a lesser extent, on regional impacts. The literature on impacts across industries is smaller. Bovenberg and Goulder (2001) tracked equity impacts of carbon policy on 12 industries using a computable general equilibrium (CGE) model of the U.S. economy. They simulate a number of policies to return revenue from a $25-per-ton carbon tax, including ways to achieve equity-value neutrality such as industry-specific reductions in the corporate income tax rate, lump-sum transfers, grandfathered emissions permits, and inframarginal tax exemptions. An important finding in their analysis is that full rebating of carbon pricing revenue to industry sectors in general will lead to overcompensation due to the ability of firms to pass a considerable amount of the tax (or value of allowances) forward to consumers in the form of higher product prices. Sijm, Neuhoff and Chen (2006) provide

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4 More efficient firms have lower emissions intensity. So firms at or above the 90th percentile of emissions intensity efficiency are in the lowest decile for emissions intensity. Put differently, firms at the 90th percentile of efficiency outperform 90 percent of all firms in their sector in the sense of having lower emissions intensity.

5 A highly selective list includes Bull, Hassett and Metcalf (1994); Metcalf (2007b); Hassett, Mathur and Metcalf (2009); Rausch, Metcalf, Reilly and Paltsev (2010); Burtraw, Walls and Blonz (2011); Rausch, Metcalf, Reilly and Paltsev (2011); Burtraw, Sweeney and Walls (2009); Dinan and Rogers (2002); and Parry (2004).

6 Papers that focus on regional impacts of carbon pricing include, among others, Bull, Hassett and Metcalf (1994), Hassett, Mathur and Metcalf (2009), Rausch, Metcalf, Reilly and Paltsev (2011), and Burtraw, Walls and Blonz (2011).
evidence for overcompensation to the electric power sector in Germany and the Netherlands in the E.U. Emissions Trading System (E.U.-ETS).

Ho, Morgenstern and Shih (2008), who consider manufacturing at the two- and three-digit Standard Industrial Classification level, find that the petroleum refining, chemicals and plastics, primary metals, and nonmetallic minerals industries suffer significant reductions in domestic output in response to U.S. carbon pricing. They find an aggregate leakage rate of 26 percent, with some sectors suffering leakage rates as high as 40 percent. Ho et al. do not consider compensation approaches to address leakage.7 Fischer and Fox (2009) analyze various approaches for addressing emissions leakage and competitiveness issues; they note the importance of focusing relief on those firms that are strong substitutes for carbon-intensive, unregulated goods and goods that are complements of employment. This suggests the importance of focusing relief on EITE sectors. They also find that optimal rebates may exceed a sector’s emissions tax payments by a factor of two or more for certain industries.8

In the U.S. context, U.S. Environmental Protection Agency (2009) led an interagency effort to study which industrial sectors would be most impacted by the enactment of the Waxman–Markey cap-and-trade legislation (H.R. 2454). The report identifies 44 manufacturing sectors and 2 additional mining sectors at the six-digit North American Industry Classification System (NAICS) level that would fall in the category of EITE sectors presumptively eligible for transitional relief under the proposed legislation. The study also highlights the highly skewed nature of emissions intensity for U.S. manufacturing firms. The report documents that the average energy intensity of manufacturing is 2 percent, with roughly 90 percent of

7 Adkins, Garbaccio, Ho, Moore and Morgenstern (2012) find that allowance allocations in H.R. 2454 significantly dampen the reductions in output for industries receiving subsidies.

8 Ederington, Levinson and Minier (2005) find that polluting industries tend to be relatively immobile, thereby mitigating the impact of regulatory stringency.
manufacturing produced by sectors with an energy intensity no greater than 10 percent. Presumptively eligible sectors are responsible for roughly half of manufacturing emissions and account for about 5 percent of manufacturing employment (0.5 percent of total nonfarm employment). A $20-per-ton carbon price would lead to a greenhouse gas (GHG) intensity measure (value of emissions per dollar of shipment) that is less than 5 percent for all but eight industry sectors. The impact is even lower if process emissions are excluded from the carbon tax.9

III. CONCEPTUAL ISSUES

A. Carbon Tax Design Issues in an International Setting

Tax economists are used to thinking about origin and destination taxes given the extensive literature on value added taxes (VAT's) and the relatively straightforward treatment of border tax adjustments in either case. In the case of a VAT, it is a well-known result that origin and destination based VAT's where the former taxes exports and zero rates imports while the latter taxes imports and credits exports are economically equivalent assuming exchange rates can adjust (and ignoring taxation of intermediate goods). This result does not carry over to the carbon tax world since a carbon tax taxes goods differentially on the basis of their carbon content and exchange rates cannot adjust to neutralize differences between origin and destination based taxation. Thus the decision to tax on an origin or destination basis will have real economic consequences.

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9 Process emissions are non-energy combustion-related emissions arising from production. The production of clinker, an essential component of cement, involves heating limestone and other ingredients; this leads to the direct release of carbon dioxide (CO₂) separate from the emissions associated with energy use in production. The United Nations Environment Program (2010) reports that process emissions account for half of total emissions from the production of clinker.
Origin based carbon taxes focus on the locus of emissions while destination based carbon taxes focus on where consumption of goods that result in carbon emissions occurs. While it might appear that imposing a carbon tax based on the combustion of fossil fuels indicates an origin based tax, it is the treatment of imports and exports of fossil fuels as well as the carbon embodied in traded goods that determines whether the tax is origin or destination based.

While generally not framed in the context of origin versus destination based carbon taxation, carbon pricing proposals typically include special provisions to address trade competitiveness concerns that tilt these proposals towards destination treatment of carbon emissions. The obvious approach in the tax context would be to include a border tax adjustment taxing some (or all) of the carbon content of imports while rebating the tax on exports. Such a border adjustment, while relatively straightforward for a VAT, is very difficult for a carbon tax. Metcalf and Weisbach (2009) consider the issue and suggest border adjustments on a select set of manufacturing industries based on the carbon content of like domestic industries. Even if only a few sectors are targeted for border adjustments the number of traded commodities on which border taxes would need to be calculated and set could be quite large. Border taxes also raise trade concerns with the GATT, an issue of great legal complexity that I do not address in this paper (see Hillman, 2013, however, for an optimistic analysis of the legal issues). I discuss border adjustments more when I outline the policy approaches analyzed in this paper.

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10 This definition is the one used by Caron, Metcalf and Reilly (2014) who contrast origin taxation with destination taxation in the context of state-level carbon taxation in the United States. This definition is not entirely obvious. One might, for example, define origin taxation in terms of where the fossil fuels are extracted rather than burned.

11 The approach in the Waxman-Markey cap-and-trade bill that passed the U.S. House of Representatives in 2009 included an output based allowance allocation to certain trade sensitive sectors. This is akin to a carbon rebate on exports – consistent with destination treatment of carbon. But it was not a truly destination based border adjustment since allowances were not required for the carbon embodied in imports (though the bill included a provision for the future imposition of allowance requirements for imports of goods in the same trade sensitive sectors in the event a binding international agreement on all major emitting countries to reduce emissions was not achieved). How the allowance requirement would be determined for specific imports was left to be worked out later.
B. Is Transitional Relief Desirable?

Before discussing specific transitional relief measures through the tax code, we need to consider three questions: (1) Is there sector-specific damage? (2) Do the benefits of relief outweigh the costs? (3) Which groups specifically, within a sector, are harmed by carbon pricing? With respect to the first question, it may well be that manufacturing industries are not particularly affected given their ability to pass costs on to consumers in the form of higher energy prices. The Bovenberg and Goulder (2001) analysis of energy-producing sectors supports this argument in general. However, one might argue that the ability of trade-exposed sectors to raise prices is limited by competition with foreign competitors that are not subject to carbon pricing. In that case, targeting assistance to a small set of sectors based on EITE status might be supportable. Even so, one might still argue that carbon pricing expectations may already be factored into asset prices, in which case relief may not go to capital owners who suffered losses (e.g., Aaron (1989)). In the presence of asset pricing effects, transitional relief designed to offset windfall losses may be poorly targeted, compensating the wrong group of capital owners. This assumes that capital owners bear the burden of carbon pricing. I return to this point in a moment.

Even in the presence of sector-specific damage, do the benefits of transitional relief outweigh the costs? While compensation may appear to be simply a lump-sum transfer giving rise to no efficiency losses, that view is incorrect for at least three reasons. First, compensation may undercut the carbon price signal for carbon-intensive industries and so raise the cost of achieving a given emissions reduction target. With careful design, this problem can be avoided. Second, compensation reduces revenue that could be used for efficiency-enhancing tax reductions. This is the message of the “double dividend literature,” that has extensively documented the efficiency costs of using environmental revenues to make lump-sum transfers
rather than reducing existing distortionary taxes.\textsuperscript{12} Third, Kaplow (1992) raises a dynamic moral hazard consideration. He argues that compensation for government policy changes can lead to social inefficiencies in investment decisions as firms do not take into account possible government actions, such as action to address climate change. Moreover, a fairness issue is apparent here. Gains and losses arising from changes in government policy are similar to gains and losses arising from technological innovation and other such phenomena that merit no special consideration. Why should climate policy be any different?

Finally, if transitional relief for a select group of sectors is deemed socially desirable, it is important to understand which groups (e.g. labor, capital owners, consumers) are bearing losses from carbon taxes so that relief is directed appropriately. This is an especially important question as we consider specific tax reforms below. In other words, who bears the burden within EITE sectors of carbon pricing? By the very nature of the competition concerns giving rise to our focus on EITE sectors, I assume that customers of these sectors do not bear the burden of the EITE component of the carbon tax. The elasticity of demand for products from EITE sectors presumably is quite high given the existence of competition from producers not subject to the carbon price. If consumers do not bear the burden, then it must fall on one or more of the factors of production, with capital, labor, and energy suppliers being the most relevant factors to consider.

Fossil fuel producer prices will presumably fall in response to a carbon tax. Whether they fall significantly relative to the carbon content of fuels is another question. One would expect oil and natural gas prices to decline by a small share of the carbon tax per unit of oil or gas given the worldwide trade in oil and the increasing trade in natural gas. The likeliest candidate for a

\textsuperscript{12} This is an example of the so-called “weak double dividend.” See Goulder (1995) and Bovenberg (1999) for surveys of this literature.
significant reduction in price is coal. But even here, it is unlikely that mine-mouth coal prices will decline much. A U.S. Energy Information Administration (2009) analysis of the economic impacts of H.R. 2454 projected that, while coal costs to electricity producers in 2020 would rise by $2.88 per million British thermal units, costs of coal itself (exclusive of carbon pricing) would fall by only $0.13. That is not surprising given the low degree of Hotelling rents in coal. So, while energy costs (exclusive of the tax) may fall a bit for firms, energy resource owners are unlikely to bear a significant portion of the tax. This leaves capital and labor to bear the burden.

In the long run, capital is unlikely to bear the burden of the tax given the ability of capital to flow from high to low taxed sectors in search of high rates of return. Any burden on capital is likely to be a burden on owners of old, as distinct from new, capital.\footnote{Old capital is capital in place at the time of a reform. New capital is capital put in place after the reform. A putty-clay investment model gives rise to new versus old capital distinctions. In such a model, energy intensity is fixed in existing capital but is responsive in new investments to energy price expectations. See Atkeson and Kehoe (1999) for a discussion of putty-clay and putty-putty models in the context of energy.} That implies two things. First, any relief should be limited in duration since old capital eventually is replaced by new capital. Second, impacts on old capital are pure windfall losses; any relief provided, therefore, will not undo or offset any efficiency losses from the carbon tax.

The burden of the tax could fall on labor employed in these sectors in the form of lower wages and/or job losses. This is more likely to the extent that workers in EITE sectors have sector-specific skills and/or have low geographic mobility. In the medium and long run, labor is likely to bear significantly more of the burden of the tax than capital will, given the high supply elasticity for new capital.

C. Tax-Based Relief

The use of the tax code to compensate EITE industries leads to a new set of design considerations. Compensation approaches differ across a number of dimensions. One dimension
is the degree of linkage to emissions. Reductions in other taxes can be directly linked to emissions or to other tax-related characteristics of firms. If the latter, an important consideration will be the degree to which reductions in taxes are correlated with carbon tax liabilities of EITE sectors. Tax reductions that achieve some desirable policy goal while also reducing taxes of EITE sectors may reduce the overall revenue diversion from a carbon tax required for enactment. A second consideration is the tax relief channel. Compensation can be used to reduce carbon tax liability directly or to reduce income tax liability. Applying the credit against the corporate income tax creates “psychic” distance between the carbon tax and the credit. To the extent that different divisions within a firm take responsibility for monitoring carbon emissions and for computing income tax liability, managers focused on the carbon emissions may act more aggressively to reduce emissions. It also highlights the use of carbon taxes to lower corporate income taxes.

A third consideration is whether relief is permanent or phased out over time. An important role for compensation is to address locked-in investment and business decisions made before a policy change. This suggests that phasing out the compensation over time is appropriate as it allows sectors to adjust to a price on emissions.

Compensation linked to carbon emissions can affect marginal or inframarginal emissions. Compensation that affects inframarginal emissions is preferable on efficiency grounds as it avoids undermining efforts to reduce emissions by diluting the price signal. A fifth consideration is whether taxes are reduced by reducing tax rates or by adjusting the tax base. Economic efficiency would argue, *ceteris paribus*, for lower tax rates on a broad tax base. Finally, compensation can be applied to specific EITE industries or more broadly. Economic efficiency is enhanced by applying the corporate income tax in a uniform fashion to all corporate
entities. Political and fiscal considerations might argue for narrowly based tax reductions aimed at specific EITE sectors.

I consider these aspects of tax reform in the context of specific proposals to address competition issues. In particular, I focus on four approaches to providing compensation: corporate tax rate reduction, payroll tax reduction, capital investment incentives, and a carbon tax credit. While some economists argue for the use of border tax adjustments as an efficient mechanism to reduce leakage (e.g., Borhinger, Carbone and Rutherford (2012)), border tax adjustments raise the level of legal and political complexity, creating barriers to this approach.14 On the other hand, political optics may call for policies that apply to domestic and foreign producers equally. Border adjustments attempt to apply the carbon price to all goods consumed in the United States, regardless of their source of production. This satisfies a political imperative to apply the carbon price fairly across producers. Using tax reductions to address competitiveness ignores foreign production and focuses on addressing competitiveness concerns for especially trade-sensitive sectors. Each approach has trade-offs.

The options below range from targeted tax compensation for EITE sectors to broad-based tax reductions. If not specifically targeted to EITE sectors, the options provide relief to the extent that firms in these sectors disproportionately benefit from the broad-based tax reductions.

**IV. IDENTIFYING ENERGY-INTENSIVE, TRADE-EXPOSED SECTORS**

Before turning to an analysis of various tax swap options, I identify EITE sectors for which the tax swap is designed to provide compensation. I consider a carbon tax, set at a rate of $20 per ton, on energy-related carbon dioxide (CO₂) emissions.

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14 Cosbey, Droge, Fischer, Reinaud, Stephenson, Weischer and Wooders (2012) consider in detail the political complexity of border tax adjustments for a carbon tax. Metcalf and Weisbach (2009) make the case for border adjustments on a limited number of items based on the carbon content of equivalent domestic products. Even if one limits border adjustments to a small set of commodities, this approach still is likely to be administratively challenging to implement in practice.
Carbone, Morgenstern and Williams (2012) estimate that a $20-per-ton carbon tax would raise a little over $100 billion annually. This is consistent with other estimates in the literature. The Congressional Budget Office (CBO 2011) estimates that a $20-per-ton carbon price would raise $88 billion annually (over the 2011 CBO current baseline). Both these estimates are consistent with a simple calculation based on the EPA GHG inventory (EPA 2013): average emissions over 2009–2011 for energy-related CO₂ equals 5,302 gigatons. A $20 carbon price would raise $106 billion based on these emissions and no behavioral change. Assuming short-run reductions on the order of 5 percent yields revenue of $100 billion.15 This is gross revenue from which reductions in tax revenue arising from the imposition of the carbon tax would need to be subtracted since the carbon tax would be a cost of business to firms and would, therefore, affect taxable income. This carbon tax offset reduces the revenue that can be used for other purposes, including tax reduction. The simplest way to think about the offset is to imagine perfectly inelastic supply so that firms are unable to pass the tax along to consumers in the form of higher prices. In that case, corporate revenues are unchanged by the tax, and taxable income falls by the full amount of the carbon tax, thereby lowering the corporate income tax by 35 percent of the carbon tax revenue.16 I incorporate an offset in each of the scenarios analyzed below.

As a first step in the analysis, I revisit the selection of presumptively eligible sectors at the six-digit NAICS level using the criteria set forth in H.R. 2454 (see Schneck, Murray, Mazurek

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15 Reductions would grow over time. Rausch and Reilly (2012) estimate that a $20-per-ton carbon tax implemented in 2013 with a rate growing at 4 percent per year would lead to a 14 percent reduction in emissions relative to 2006 by 2020. Given the 6 percent reduction in emissions between 2006 and 2010, the reduction would be more on the order of 8 percent relative to 2010. Note, though, that the tax could be applied to more than energy-related CO₂ emissions, thereby raising more revenue.

16 As explained by the Congressional Budget Office (2009), the situation is slightly more complicated as the analysis needs to account for the possibility that the carbon tax may be passed forward to consumers in the form of higher prices or back to workers in the form of lower wages. But following the CBO approach, consumer purchasing power falls by the amount of tax they pay, thereby lowering business tax revenues by the full amount of the carbon tax (accounting for tax paid by firms and by consumers). For purposes of scoring, CBO relies on offset estimates made by the Joint Committee on Taxation. See Joint Committee on Taxation (2014) for its most recent offset estimate of roughly 25 percent.
Sectors are presumptively eligible if they satisfy one of the following four criteria:

- energy intensity is 5 percent or greater, and trade intensity is 15 percent or greater
- greenhouse gas (GHG) intensity is 5 percent or greater, and trade intensity is 15 percent or greater
- energy intensity is 20 percent or greater
- GHG intensity is 20 percent or greater

Energy intensity is defined as the ratio of expenditures on purchased fuels and electricity to the value of shipments; trade intensity is defined as the ratio of the sum of imports and exports to the sum of the value of shipments and imports; and GHG intensity is defined as the ratio of the emissions from direct fuel consumption and electricity use, times $20, to the value of shipments. My measures correspond to those used in the EPA competitiveness report (EPA 2009), except that I exclude process emissions under the assumption that a carbon tax would be applied only to energy-related CO2 emissions. All values are computed using average 2009–2011 data. Sector-specific emissions are not available for these years, so I estimate them based on the aggregate growth in emissions between 2007 and 2009–2011 and the change in the value of shipments for sectors.18

Using average data for 2009 through 2011, I find that the number of manufacturing sectors that would be presumptively eligible under the criteria above falls from the 44 sectors cited in EPA (2009) to 34 (see Table 1); 1 sector becomes presumptively eligible, and 11 sectors are no longer presumptively eligible. Ethyl alcohol manufacturing (sector 325193) becomes eligible because of an increase in its trade intensity from 10 to 15 percent. A decline in energy intensity 

17 Below I refer to sectors that are (presumptively) eligible for compensation as EITE sectors. H.R. 2454 also provided a process for sectors to petition for presumptive eligibility.
18 See the appendix in Metcalf (2013) for details on the computations.
intensity explains the loss of eligibility for the 11 sectors. Energy prices for industry did not appreciably change between 2007 and 2009–2011 (an index of industrial energy prices fell by 3.2 percent between 2007 and 2009–2010; see U.S. Energy Information Administration (2012), Table 3.4). So, presumably, the fall in energy intensity among formerly presumptively eligible sectors follows from an improvement in energy efficiency in these sectors.

These results suggest some sensitivity of eligibility to the cut-off for energy intensity. The previously eligible sectors that now fall below the 5 percent energy intensity threshold account for 4 percent of the total value of manufacturing shipments and 8 percent of industrial GHG emissions. Although some changes occur in the set of presumptively eligible sectors, the failure to include process emissions in the calculation of GHG intensity does not affect the results. Only one sector (lime manufacturing) has a GHG intensity in excess of 20 percent due to process emissions. This sector continues to be presumptively eligible since its energy intensity exceeds 20 percent.

Figure 1 shows the distribution of energy intensity of the U.S. manufacturing sector graphed against the value of manufacturing shipments. The distribution of energy intensity across firms by value of shipments is very similar to the distribution using 2007 data, with over 90 percent of the value of manufacturing shipments coming from firms with an energy intensity below 5 percent. A similar result holds for the share of employment and tax payments in manufacturing.

19 If updating of EITE eligibility were to take place as envisioned in H.R. 2454, sectors run the risk of abrupt policy change if they switch in or out of EITE status.
Summing up, an analysis of the presumptive eligibility criteria in H.R. 2454 suggests some sensitivity around the 5 percent energy intensity threshold for sectors. Intensities of energy and GHG emissions continue to be highly skewed, with a very few sectors vulnerable on the grounds of high energy or emissions intensity. In the analysis below, I provide results for the sectors that are presumptively eligible based on the 2009–2011 data.

V. ASSESSMENT OF TAX REFORM OPTIONS

In the analysis below, I focus on corporate tax payments and deductions. Businesses can organize as corporations (either C or S corporations), partnerships, or sole proprietorships. As Table 2 shows, while corporations in 2008 were responsible for only 41 percent of manufacturing business tax returns filed in the United States, they were responsible for 88 percent of receipts and 91 percent of net income among manufacturing businesses.20, 21

TABLE 2 ABOUT HERE

Tax data on 65 manufacturing “minor industries” (sectors at the four- to six-digit NAICS level) are taken from IRS (2010). For those minor manufacturing industries for which 2010 tax data are provided only at a four- or five-digit NAICS level, I allocate tax data within the minor industry at the six-digit NAICS level based on the 2007 value of shipments for the sectors within that minor industry.22 Assuming that the pattern of deductions within a minor industry is similar

20 A cursory review of partnership returns data suggests that the corporate share of receipts and net income is even higher if one focuses attention on EITE sectors.
21 All but one of the analyzed uses of carbon taxes to compensate EITE sectors benefit C and S corporations equally. Reducing the corporate income tax rate benefits only C corporations (and S corporations with some C corporation income).
22 Data from the 2007 economic census are available on value of shipments for all manufacturing sectors at the six-digit North American Industry Classification System (NAICS) level. For 2010, the value of shipments is rolled up to a higher level for some sectors. I allocate the value of shipments based on the distribution of the 2007 value of shipments. The correlation between value of shipments between 2007 and 2010 as reported in the Annual Survey of Manufacturers (ASM; including the rolled up sectors) is over 0.99. Hence, using the 2007 value of shipments to allocate tax data should not be problematic. Other aggregated data in the ASM are disaggregated on the basis of their distribution within lower-level sectors in 2007. Data were downloaded from http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml in June 2013.
(and proportional to the value of shipments), this should not introduce too much error into the calculations. More importantly, it should not introduce any systematic bias into the analysis.

A. Crediting Mechanism for Carbon Tax

EITE sector firms could be provided a credit for carbon taxes paid on a pro rata basis, with the credit rate declining over time. The credit could be taken against the carbon tax itself or against each firm’s income tax. The pro rata rate might start at 100 percent, for example, and decline annually at some given rate until it is fully phased out.

The benefit of this approach is that it is simple and transparent. Its disadvantage, however, is that it weakens (if not eliminates) the price signal of the carbon tax. In effect, full crediting is equivalent to exempting EITE sectors from the carbon tax. An improvement on a straight credit for the carbon tax would be to put a ceiling on the credit that falls toward zero over time as compensation is phased out. This approach, which is economically equivalent to a free distribution of a share of allowances to a firm, provides a lump-sum transfer while preserving the marginal price on emissions.

The credit could take the form of a credit for carbon taxes paid or could be structured as an output-based tax credit to mimic the allowance allocation for EITE sector firms in H.R. 2454. In this latter form, EITE firms would receive a tax credit based on a measure of historic output at the firm level times sector-specific average emissions per unit of output. The output-based credit approach simply substitutes a distribution of allowances to firms with a tax credit. In both cases, the benefit could be phased out by lowering the credit (or cap) over a specified time period.23

In effect, tying credits to historic average output provides a subsidy to production that serves to offset the increased cost of the carbon tax and thus addresses competitiveness concerns.

23 H.R. 2454 provides a schedule of output-based allowances between 2012 and 2025. Beyond 2025, rebated allowances to EITE firms would be based on presidential determination of the timing of the phase-out of rebates.
The drawback, of course, is that the price signal to domestic consumers that encourages them to shift away from carbon-intensive products is also dampened.

A variant of the output-based credit linked to sector average emissions is to provide a credit for emissions linked to sector-specific best practices. Here, EITE firms in a sector receive a credit equal to the emissions intensity level of the firm in the 90th percentile (for example) of efficiency in emissions intensity times the firm’s output. To illustrate, if the average emissions intensity in a sector is 0.015, while the 90th percentile of emissions intensity is 0.011, then each firm would receive a credit equal to the carbon tax rate times 0.011 times the firm’s output. As with the credit tied to average sector emissions intensity, firms receive a larger tax credit as output rises, thereby helping to address competitiveness concerns. Setting the credit on the basis of sector-specific best practices reduces the revenue loss and can be motivated by the reasonable desire to incentivize firms within a sector to adopt best practices and technologies that reduce emissions intensity toward a target that is demonstrably attainable.

An important question is what share of carbon tax would be credited. The treatment of EITE sectors in H.R. 2454 is instructive here. The House bill set aside 15 percent of allowances for EITE sectors. According to the EPA interagency competitiveness report (EPA 2009), this amounts to somewhere between 700 and 900 million allowances annually from 2014 through 2025 (EPA 2009, Figure 13). Emissions from EITE sectors in 2006 equaled 730 million metric tons (Table 1), which in turn equaled roughly 13 percent of emissions that would be covered under H.R. 2454 if it applied to emissions in 2006. Projecting future emissions is difficult, but the 2009 interagency report notes that improvements in emissions intensity in EITE sectors would lead to a 20 percent reduction in emissions between 2006 and 2020 for the six key EITE sectors under business-as-usual modeling. Stronger than expected output growth—along with
additional EITE sector eligibility based on individual showings—would offset this emissions intensity improvement. It seems fair to say that the intent of the allowance allocation amount in H.R. 2454 was to initially offset all covered emissions of EITE sectors.

If a carbon tax credit is implemented, firms would be allowed to take a tax credit for carbon taxes paid by the firm on the corporate income tax in lieu of a deduction. Based on average emissions for 2009 through 2011, carbon tax revenue from EITE sectors in 2010 would be $8.5 billion.\(^24\) Note that firms in EITE sectors have insufficient tax appetite to fully use an unrestricted credit. The average ratio of income tax after credits to carbon tax for the EITE sectors is 0.23 (weighted by carbon tax liability), with an interquartile range (across sectors) of 0.16 to 0.24. General tax practice is to allow firms to carry forward excess credits.\(^25\)

As noted above, simply crediting carbon taxes on the corporate income tax does not address the competitiveness issue in the sense of lowering the marginal cost of production. By tying the allowance allocation to output, H.R. 2454 would effectively lower the cost of production and so allow firms to offset some of the upward price pressure created by the carbon pricing.\(^26\) In addition, firms that could reduce their emissions per unit of output below the sector average would not be penalized by receiving reduced tax credits despite their reduced emissions.

Providing tax credits analogous to the output-based allowance allocation for firms in EITE sectors is an appealing way of addressing trade competitiveness issues. It avoids many of the problems that border tax adjustments would have to confront, including possible noncompliance with the World Trade Organization. With appropriate design, it could serve as an

\(^{24}\) Note that the share of carbon revenue required to compensate EITE sectors is considerably below that projected in H.R. 2454 (~15 percent). This reflects the decrease in emissions arising from both lower economic output and reductions in emissions intensity.

\(^{25}\) Tax credits included in the general business credit may be carried back 1 year and forward for up to 20 years.

\(^{26}\) Providing what is, in effect, an output subsidy to energy-intensive firms seems perverse given the desire to reduce emissions. But in the second-best policy world, where global carbon pricing is not possible, this approach could be viewed as a reasonable compromise position. For a clear analysis of the political and economic trade-offs, see Stavins (2009).
output subsidy that would allow (before-tax) prices to rise, thereby avoiding some of the burden on capital and labor while still maintaining firm-level incentives to reduce emissions. The lack of sufficient tax liability among EITE sectors can be addressed by the use of the best practices crediting mechanism. As discussed above, a firm could be provided a tax credit for carbon tax payments equal to its output times the emissions intensity of firms that have an emissions intensity at a designated high level of efficiency (e.g., the 90th percentile).27

B. Payroll Tax Reduction

A second option for returning carbon tax revenue is through a general reduction in the payroll tax rate. Using carbon tax revenues to reduce payroll taxes contributes to mitigating the regressivity of carbon taxes (see Metcalf (2007b)) while benefiting EITE firms that are relatively labor intensive. Metcalf (2007b) considers an environmental earned income tax credit equal to the employer and employee payroll taxes on earnings subject to a cap.

This approach is attractive because it links the carbon tax to employment-creating opportunities. Whether general payroll tax reduction is effective at providing support to EITE sectors depends on the labor intensity of EITE sectors relative to that of manufacturing as a whole. Alternatively, payroll tax reduction could be targeted to EITE sectors only. This would reduce the overall cost while clearly targeting compensation to EITE sectors; however, it raises administrative and fairness issues if it results in a sharp delineation between sectors that receive compensation and those that don’t based on very small differences in, say, energy intensity. I consider a general payroll tax reduction.

27 Firm-level emissions and value of shipment data would be required to estimate the cost of this approach for different cut-off percentiles.
As a rough guide to how much the payroll tax rate could be reduced, revenue neutrality in the tax swap requires that changes in corporate income tax and payroll tax revenue be offset by carbon tax revenue:

\[
\begin{align*}
(1) \quad & t_c \left( R_c - (1 + t_p^0)w_c^0 \right) + 2t_p^0(w_c^0 + w_{nc}^0) = \\
& = t_c \left( R_c - (1 + t_p^1)w_c^1 - CT \right) + 2t_p^1(w_c^1 + w_{nc}^1) + CT
\end{align*}
\]

where \( t_c \) is the corporate tax rate, \( t_p \) is the employer payroll tax rate, \( R_c \) is net corporate taxable income (excluding tax-inclusive payroll and the carbon tax), \( w_c \) is corporate wages, \( w_{nc} \) is other wages in the payroll tax base, and \( CT \) is the carbon tax. Payroll tax revenue is doubled to reflect the employee portion of the payroll tax, which equals the employer portion.28 A superscript 0 indicates values prior to imposition of the carbon tax, and 1 indicates values after imposition. Taxes on labor income are generally viewed as borne entirely by labor (consistent with a labor supply elasticity of zero). Under this assumption, any reduction in payroll tax rates is offset by increases in wages so that workers fully benefit from the reduction in the payroll tax. Firms meanwhile see their tax-inclusive payroll unaffected by the tax change. This assumption implies that \( d((1+t)w)/dt = 0 \), or

\[
\begin{align*}
(2) \quad & \frac{dw}{dt} = \frac{-w}{1+t},
\end{align*}
\]

and the change in employer payroll tax revenue is

\[
\begin{align*}
(3) \quad & \frac{d(tw)}{dt} = t \frac{dw}{dt} + w = w \left(1 - \frac{t}{1+t} \right) = \frac{w}{1+t}.
\end{align*}
\]

Simplifying (1) above and accounting for the fact that the tax-inclusive wage is unchanged, I get

\[
\begin{align*}
(4) \quad & (1 - t_c)CT = 2(t^0_p w_c^0 - t^1_p w_c^1) + 2(t^0_p w_{nc}^0 - t^1_p w_{nc}^1) \\ & \approx \frac{2(t^0_p - t^1_p)(w_c + w_{nc})}{1 + t^0_p} \\
& \quad \text{or}
\end{align*}
\]

28 I ignore payroll tax contributions by the self-employed in this calculation.
With a corporate tax rate of 35 percent and a payroll tax base in 2010 of $4,860 billion, this suggests that the employer and employee payroll tax rates can each be reduced by 0.72 percentage points. The percentage increase in tax-exclusive wages paid by firms follows from (2) and equals \( \Delta t/(1+t) \), or 0.67 percentage points.

Table 3 provides some statistics for manufacturing sectors as a whole and for the EITE sectors. The change in wages is slightly lower for EITE sectors than for manufacturing as a group (whether in dollar terms or as a share of the value of shipments). But the significantly higher carbon tax for EITE sectors, on average, means that the benefit to workers in higher wages is more than offset by the carbon tax. For every incremental dollar of carbon tax, wages go up by 28¢ for manufacturing overall but by only 5¢ for EITE sectors.

TABLE 3 ABOUT HERE

These rough calculations suggest that using carbon tax revenue to lower payroll taxes will not provide disproportionate benefits for EITE sectors. The benefits of payroll tax reductions are spread over all workers, not just workers in EITE sectors. Workers in other sectors, where the carbon tax can be passed forward in the form of higher prices, would actually benefit. Thus, we cannot expect such a tax swap to blunt demands for compensation to EITE sectors to address competitiveness issues. One may find other good reasons to support such a tax swap; addressing competitiveness is simply not one of those reasons.

---

29 The payroll tax base is computed as employer and employee Old-Age, Survivors, and Disability Insurance (OASDI) tax revenue in 2010 divided by the employer and employee OASDI tax rate of 0.124. This accounts for the fact that only wages up to $106,800 are subject to the tax in 2010.

30 This is focusing on the “sources of income” burden of the tax. All workers are also consumers and would face higher consumer prices. But a payroll tax reduction would bring about a transfer from workers in sectors with high carbon intensity to workers in sectors with low carbon intensity.
C. Capital Investment Incentives

Rather than lowering payroll taxes, carbon tax revenue could be used to lower taxes on capital income (or otherwise reduce the effective tax rate on capital). In addition to (or in place of) lowering the corporate tax rate (discussed below), carbon tax revenue could be used to fund an investment tax credit (ITC) for new capital investment or provide accelerated depreciation (including the possibility of expensing) for new capital investment. As with a payroll tax reduction, special incentives for capital investment could be provided to all firms or only to firms in EITE sectors.

Unlike the other scenarios, this option would not use all of the revenue from the carbon tax. I include it to illustrate a reform that could be part of a package of tax changes or deficit reduction. Capital expenditures on machinery and equipment (new and used) totaled $108.5 billion in the manufacturing sector in 2010. For illustrative purposes, I consider a 10 percent ITC applicable to new machinery and equipment.

Annual capital spending on machinery and equipment across the 472 manufacturing sectors between 2009 and 2011 was $238.8 million, on average (Table 4). In contrast, EITE sectors spent, on average, $419.8 million, roughly 75 percent more than manufacturing sectors on average. Even after controlling for size of the sectors (value of shipments), EITE sectors spend over 50 percent more on new capital (other than buildings) than the manufacturing average. Any investment incentive would disproportionately benefit EITE sectors and provide some offset to the carbon tax. It would also contribute to a speeding up of investment in new, more energy-efficient capital and would, thereby, contribute to a reduction in the energy and carbon intensity of EITE sectors.

TABLE 4 ABOUT HERE
While beneficial, tax incentives for investment would be unlikely to fully compensate EITE sectors for their disproportionate carbon tax burden. Based on average expenditures in 2009–2011, a 10 percent ITC would equal 44 percent of the carbon tax liability for manufacturing sectors on average and 16.7 percent for EITE sectors. While a number of manufacturing sectors would receive an ITC in excess of their carbon tax liability, no EITE sector would.

Another issue is that ITCs serve as a subsidy to new capital and a tax on old capital (see, for example, Kotlikoff (1983)). Above, I argue that any burden of a carbon tax on the sources of the income side in EITE sectors is likely to fall on old capital and labor. To the extent that the tax falls on old capital, investment incentives are poorly targeted and would lead to complicated redistributions across sectors based on the carbon intensity of sectors and the importance of old capital in their capital stock.

D. Corporate Income Tax Rate Reduction

The final approach that I consider uses carbon tax revenue to lower the corporate tax rate. Compensation to EITE firms then hinges on the degree to which tax reductions benefit EITE firms. As with other options, corporate rate reduction could be provided to all firms or only to firms in EITE industries. The latter, while sharper in its targeting of benefits, creates some administrative and compliance complexity by creating opportunities for arbitrage between high- and low-rate corporate entities. I focus here on using a carbon tax to finance broad-based corporate tax reduction. I assume that all of the tax (net of tax offsets) is used to finance a

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31 The ASM data do not distinguish between capital expenditures on new and used capital. Limits would need to be set on the use of an investment tax credit (ITC) for used capital to ensure that multiple credits are not taken on the same capital. Note also that the tax code prior to 1986 adjusted the tax basis of an asset for which an ITC was taken. For capital on which a 10 percent ITC was taken, depreciation was allowed on 95 percent of the capital cost.

32 An alternative approach not analyzed in this paper would be to use carbon tax revenue to finance integration of the corporate and personal income tax, as analyzed, for example, by Metcalf (2007a).
corporate tax rate cut. How much can the top corporate income tax rate be reduced with $100 billion? Carbone, Morgenstern and Williams (2012) estimate that a $20-per-ton carbon tax can finance a 4.4 percentage point reduction in the “tax on capital.” Based on 2010 IRS data, a back-of-the-envelope calculation suggests that one could lower the corporate income tax rate by between 7 and 8 percentage points. If $Y_0$ is corporate taxable income prior to implementation of the carbon tax, and $\tau_0$ is the corporate tax rate, then the corporate tax rate can be lowered to the rate $\tau_1$ given by the relationship

$$\tau_1(Y_0 - CT) + CT = \tau_0 Y_0,$$

where $CT$ is the carbon tax revenue. Manipulating this equation gives the reduction in corporate tax rate possible if all carbon tax revenue is used to lower corporate income tax rate:

$$\tau_0 - \tau_1 = \frac{(1-\tau_0)CT}{Y_0-CT}$$

Corporate income subject to tax in 2010 was $1,022 billion. A $100 billion carbon tax would thus allow a reduction in the corporate income tax rate of 7.0 percentage points.

This calculation assumes that taxable income is unaffected by the carbon tax. Recent research suggests that corporate taxable income may respond to changes in the tax rate. Using U.S. corporate data, Gruber and Rauh (2007) estimate the elasticity of corporate income with respect to 1 minus the tax rate $\left(\varepsilon_{TL,1-\tau}\right)$ to be 0.20.

Allowing corporate taxable income to adjust to changes in the tax rate means that the corporate tax rate can change to rate $\tau_1$ such that

$$\tau_1(Y_1 - CT) + CT = \tau_0 Y_0.$$
Applying Gruber and Rauh’s elasticity of corporate income, I calculate that a 7.9 percentage point reduction is feasible if carbon tax revenue is used to lower the corporate income tax. Corporate taxable income increases by 3 percent in response to the lower corporate tax rate.

While these are back-of-the-envelope calculations, it is useful to compare them to the modeling results of Carbone, Morgenstern and Williams (2012). These authors model the use of carbon tax revenues to reduce taxes on all capital income, not just corporate capital income. Net income for all nonfarm businesses in 2008 (the latest year for which data are available) equaled $1,784 billion, of which net income subject to the corporate income tax accounted for 42 percent. The rest is income earned by S corporations, partnerships, and nonfarm sole proprietorships. Thus, a tax rate reduction of 7.9 percentage points on corporate income would correspond to a 3.3 percentage point drop in the taxation of all capital (7.9*0.42).34, 35

Assuming a 3 percent change in corporate taxable income in response to the tax cut, I use (8) to construct a back-of-the-envelope calculation of the change in tax liability for each manufacturing sector following a tax reform in which the corporate income tax cut is financed by the carbon tax.36 Table 5 reports results for manufacturing and EITE sectors.

TABLE 5 ABOUT HERE

On average, each manufacturing sector pays $78 million less in corporate income tax following the reform. EITE sectors see their corporate taxes fall by about $70 million per sector.

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34 Newer modeling by Burtraw, Carbone, Morgenstern, and Williams reported at an RFF event on June 25, 2013, suggests that the carbon tax could fund a 3.5 percentage point drop in capital income taxation.
35 My back-of-the-envelope calculation is consistent with the CBO modeling results discussed by Marron and Toder (2013) suggesting that a $1.2 trillion carbon tax over 10 years could pay for reducing the corporate tax rate by 10 percentage points.
36 The change in tax is computed as the new tax rate applied to income subject to tax times 1.03 less the carbon tax minus 0.35 times income subject to tax. The latter is very close to reported total tax before credits. The carbon tax cannot drive taxable income below zero. This calculation ignores changes in tax credits or the ability to use tax credits in the current year.
on average. As a share of income subject to tax, EITE sectors gain significantly more with a reduction, on average, of 22 percent compared to 8 percent for manufacturing overall.

Manufacturing as a whole pays $11.2 billion less in taxes as a result of a carbon tax reform that is used to finance a reduction in the corporate income tax. This represents 17.3 percent of total corporate tax after credits for manufacturing in 2010. Finally, to the extent that the carbon tax burden on EITE sectors falls on capital and labor in these sectors, the corporate tax rate reduction aligns the benefits of reform to the burdened EITE factors of production.\textsuperscript{37}

As with initiatives to stimulate capital investment, linking the carbon tax to corporate tax reduction could have bipartisan appeal. It is also efficiency enhancing. The swap, however, may be too diffuse a policy initiative to provide sufficient compensation to EITE sectors. It would also be a regressive reform.

VI. CONCLUSION

Incorporating a carbon tax as an element of a broad-based tax reform initiative is highly attractive. It provides revenue to overcome obstacles to a negotiated outcome in Congress, and including it as part of a larger tax reform effort shifts the equity question away from the distributional consequences of the carbon tax in isolation toward the desired distributional impacts of the overall tax system. Including a carbon tax in overall tax reform means that the carbon tax could substitute for increases in existing distortionary taxes and contribute to the overall efficiency of the tax system.

This paper has focused on whether reforms in the tax system could mitigate the need for specific relief for firms in select EITE sectors. To address that question, I have applied the criteria for presumptive eligibility for relief afforded to EITE sectors, as specified in the

\textsuperscript{37} The U.S. Department of the Treasury tax model assumes that 82 percent of the corporate income tax burden is borne by capital and the remainder by labor. See Cronin, Lin, Power and Cooper (2013).
Waxman–Markey cap-and-trade bill using more recent energy and trade flow data. My first finding is that determination of eligibility for relief analogous to the free allowance allocation in H.R. 2454 is sensitive to energy intensity at the six-digit NAICS level. A number of sectors are very close to the 5 percent threshold, and periodic review (four years in H.R. 2454) could lead to sectors shifting in and out of eligibility for compensation.

I then considered carbon tax liabilities for sectors based on average 2009–2011 energy-related CO₂ emissions relative to corporate tax liabilities under several reform possibilities. I find that providing compensation to EITE sectors—analogous to the output-based allowance allocation in Waxman–Markey through the corporate income tax—is feasible, but tax appetite within the EITE sectors is insufficient to fully use any credits meant to offset more than about one-quarter of the carbon tax liability of firms in EITE sectors. More generally, none of the tax reforms I consider provide anywhere near full compensation to EITE sectors in the sense of providing tax relief equal to their carbon tax liability.

The credit approach could be crafted to benefit EITE sectors in a very targeted way without reducing the price incentive to firms to reduce emissions. One way to maintain the carbon price signal while also addressing competitiveness concerns is through a “best practices” credit approach, in which firms are provided a credit equal to the 90th percentile of emissions intensity efficiency in the sector times the firm’s output. Such a credit reduces the revenue loss, thereby freeing up revenue for other tax reductions, and incentivizes practices and investments to achieve lower emissions intensity in ways that are demonstrably achievable given that the best 10 percent of firms in the sector are operating at or below that intensity level.

A third finding of this paper is that certain reforms do better than others at providing disproportionate relief indirectly to EITE sectors. Using carbon tax revenue to lower the top
corporate income tax rate disproportionately benefits EITE sectors in the sense of lowering EITE sector firms’ corporate tax liability as a percentage of income subject to tax over twice as much as it does for manufacturing sectors, on average. And within those sectors, it benefits capital owners and labor, the factors bearing the carbon tax burden within EITE sectors. Using carbon taxes to reduce corporate tax rates would allow for a significant reduction in the tax rate on corporate income. Finally, using some carbon tax revenue to finance investment incentives, such as an ITC, is attractive in the sense that it could encourage a more rapid transition to newer, more energy-efficient capital in manufacturing sectors in general. It also provides disproportionate benefits to EITE sectors. It does not provide targeted compensation to labor or to owners of old capital, however, which might limit its ability to blunt calls for EITE sector–specific compensation.

Economic theory predicts a substantial cost to diverting carbon tax revenue toward compensation of specific sectors. Theory also suggests that one should treat policy risk no differently from other risks firms face as they do business. But politics may dictate otherwise. And, if so, the analysis here suggests that certain approaches may work better than others to ensure that relief is appropriately targeted at minimal cost.

ACKNOWLEDGMENTS

Grateful acknowledgement is made to Resources for the Future, which provided financial support for this project; to Ray Kopp and Carolyn Fischer for helpful comments on early drafts of this paper; and to Megan Miller, who provided first-rate research assistance on the project.

REFERENCES


### Table 1
Changes in Presumptive Eligibility for Manufacturing Sectors

<table>
<thead>
<tr>
<th>NAICS Code</th>
<th>Sector</th>
<th>Energy Intensity (%)</th>
<th>Trade Intensity (%)</th>
<th>Greenhouse Gas Intensity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>325193</td>
<td>Ethyl alcohol manufacturing</td>
<td>7</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>314992</td>
<td>Tire cord and tire fabric mills</td>
<td>4</td>
<td>47</td>
<td>1</td>
</tr>
<tr>
<td>325110</td>
<td>Petrochemical manufacturing</td>
<td>3</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>325182</td>
<td>Carbon black manufacturing</td>
<td>3</td>
<td>26</td>
<td>1</td>
</tr>
<tr>
<td>325192</td>
<td>Cyclic crude and intermediate manufacturing</td>
<td>4</td>
<td>98</td>
<td>1</td>
</tr>
<tr>
<td>325211</td>
<td>Plastics material and resin manufacturing</td>
<td>4</td>
<td>44</td>
<td>1</td>
</tr>
<tr>
<td>325212</td>
<td>Synthetic rubber manufacturing</td>
<td>3</td>
<td>61</td>
<td>1</td>
</tr>
<tr>
<td>327111</td>
<td>Earthenware bathroom accessories manufacturing</td>
<td>2</td>
<td>72</td>
<td>2</td>
</tr>
<tr>
<td>327112</td>
<td>Product manufacturing</td>
<td>3</td>
<td>95</td>
<td>1</td>
</tr>
<tr>
<td>327125</td>
<td>Nonclay refractory manufacturing</td>
<td>4</td>
<td>54</td>
<td>2</td>
</tr>
<tr>
<td>331210</td>
<td>Purchased steel</td>
<td>2</td>
<td>41</td>
<td>0</td>
</tr>
<tr>
<td>331411</td>
<td>Primary smelting and refining of copper</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Notes:
Bold-faced entries denote the intensity measure whose change led to the change in presumptive eligibility based on the criteria of H.R. 2454. U.S. Environmental Protection Agency (2010) notes that sector 322130 (paperboard mills) has a trade intensity of 0.8 percent before adjusting the measure for a BEA classification change to the trade data to go into effect in 2009, and a trade intensity of 25 percent after the change. Using more recent data, the trade intensity is 1 percent. I assume this sector continues to be presumptively eligible in the later data, even though the trade intensity measure is below the threshold.

**Source:** Author’s calculations as described in text.
Table 2

<table>
<thead>
<tr>
<th>Business Form</th>
<th>Share of Returns</th>
<th>Share of Receipts</th>
<th>Share of Net Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporations</td>
<td>41%</td>
<td>88%</td>
<td>91%</td>
</tr>
<tr>
<td>C Corporations</td>
<td>17%</td>
<td>79%</td>
<td>81%</td>
</tr>
<tr>
<td>Partnerships</td>
<td>7%</td>
<td>12%</td>
<td>8%</td>
</tr>
<tr>
<td>Nonfarm Sole</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proprietorships</td>
<td>52%</td>
<td>0%</td>
<td>1%</td>
</tr>
</tbody>
</table>

Note: Net income deducts deficits.
<table>
<thead>
<tr>
<th></th>
<th>All Manufacturing Sectors</th>
<th>EITE Sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in wages paid by firms ($ millions)</td>
<td>$7.6</td>
<td>$6.6</td>
</tr>
<tr>
<td></td>
<td>(11.4)</td>
<td>(9.9)</td>
</tr>
<tr>
<td>IQR: $1.6 to $8.2</td>
<td></td>
<td>IQR: $2.1 to $5.3</td>
</tr>
<tr>
<td>Change in wages as a share of the value of shipments</td>
<td>0.07%</td>
<td>0.05%</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>IQR: 0.03% to 0.11%</td>
<td></td>
<td>IQR: 0.04% to 0.06%</td>
</tr>
<tr>
<td>Change in wages less carbon tax ($ millions)</td>
<td>–$46.6</td>
<td>–$252.3</td>
</tr>
<tr>
<td></td>
<td>(257.6)</td>
<td>(410.4)</td>
</tr>
<tr>
<td>IQR: –27.2 to –1.1</td>
<td></td>
<td>IQR: –233.9 to –55.2</td>
</tr>
<tr>
<td>Change in wages per dollar of carbon tax</td>
<td>0.14</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>(0.25)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>IQR: 0.01 to 0.15</td>
<td></td>
<td>IQR: 0.02 to 0.04</td>
</tr>
<tr>
<td>Number of sectors that gain/lose</td>
<td>84/387</td>
<td>0/34</td>
</tr>
</tbody>
</table>

Notes: Table reports sector averages for 471 manufacturing sectors and 34 EITE manufacturing sectors. All ratio statistics are weighted by the variable in the denominator; therefore, the mean represents the mean for the sectors in aggregate. Standard deviations are reported in parentheses. IQR = interquartile range.
Table 4
Carbon Tax and Investment Incentives

<table>
<thead>
<tr>
<th></th>
<th>All Sectors</th>
<th>EITE Sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital spending on machinery and equipment ($ millions)</td>
<td>$238.8</td>
<td>$419.8</td>
</tr>
<tr>
<td></td>
<td>(658.3)</td>
<td>(609.1)</td>
</tr>
<tr>
<td>IQR:</td>
<td>$30.0 to $224.3</td>
<td>IQR: $66.6 to $448.7</td>
</tr>
<tr>
<td>Capital spending on machinery and equipment per $1,000 of shipment value</td>
<td>$22.79</td>
<td>$35.79</td>
</tr>
<tr>
<td></td>
<td>(13.27)</td>
<td>(16.25)</td>
</tr>
<tr>
<td>IQR:</td>
<td>$15.43 to $27.84</td>
<td>IQR: $27.84 to $41.40</td>
</tr>
<tr>
<td>ITC per dollar of carbon tax</td>
<td>0.440</td>
<td>0.166</td>
</tr>
<tr>
<td></td>
<td>(0.594)</td>
<td>(0.100)</td>
</tr>
<tr>
<td>IQR:</td>
<td>0.166 to 0.510</td>
<td>IQR: 0.113 to 0.221</td>
</tr>
<tr>
<td>Sectors with ITC in excess of carbon tax</td>
<td>166</td>
<td>0</td>
</tr>
</tbody>
</table>

Notes: Table reports sector averages for 471 manufacturing sectors and 34 EITE manufacturing sectors. All ratio statistics are weighted by the variable in the denominator; therefore, the mean represents the mean for the sectors in aggregate. Standard deviations are reported in parentheses. IQR = interquartile range.
Table 5  
Carbon Tax and Corporate Tax Reduction

<table>
<thead>
<tr>
<th></th>
<th>All Sectors</th>
<th>EITE Sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in corporate tax before credits ($ millions)</td>
<td>–$77.8</td>
<td>–$70.2</td>
</tr>
<tr>
<td></td>
<td>(517.0)</td>
<td>(120.6)</td>
</tr>
<tr>
<td>IQR: –$45.1 to –$5.6</td>
<td></td>
<td>IQR: –$74.6 to –$7.9</td>
</tr>
<tr>
<td>Change in corporate tax before credits as a percentage of income subject to tax</td>
<td>–8.5%</td>
<td>–21.5%</td>
</tr>
<tr>
<td></td>
<td>(3.3)</td>
<td>(9.5)</td>
</tr>
<tr>
<td>IQR: –8.1 to –7.3</td>
<td></td>
<td>IQR: –34.9 to –13.4</td>
</tr>
<tr>
<td>Net tax change ($ millions)</td>
<td>–$23.8</td>
<td>$186.9</td>
</tr>
<tr>
<td></td>
<td>(327.1)</td>
<td>(321.2)</td>
</tr>
<tr>
<td>IQR: –13.7 to 9.1</td>
<td></td>
<td>IQR: 38.3 to 232.1</td>
</tr>
<tr>
<td>Net tax change as a percentage of income subject to tax</td>
<td>–2.6%</td>
<td>56.2%</td>
</tr>
<tr>
<td></td>
<td>(23.2)</td>
<td>(127.6)</td>
</tr>
<tr>
<td>IQR: –6.6% to –4.4%</td>
<td></td>
<td>IQR: 10.0% to 71.7%</td>
</tr>
<tr>
<td>Change in CIT per dollar of carbon tax</td>
<td>–1.44</td>
<td>–0.28</td>
</tr>
<tr>
<td></td>
<td>(4.51)</td>
<td>(0.16)</td>
</tr>
<tr>
<td>IQR: –2.22 to –0.35</td>
<td></td>
<td>IQR: –0.37 to –0.22</td>
</tr>
<tr>
<td>Number of sectors that gain/lose</td>
<td>240/232</td>
<td>0/34</td>
</tr>
</tbody>
</table>

Notes: Table reports sector averages for 472 manufacturing sectors and 34 EITE manufacturing sectors. The net change is the sum of the change in corporate income tax plus the carbon tax. All ratio statistics are weighted by the variable in the denominator; therefore, the mean represents the mean for sectors in aggregate. Standard deviations are reported in parentheses. IQR = interquartile range.
Figure 1
Energy Intensity and Value of Shipments