PAYING FOR GREENHOUSE GAS REDUCTIONS: WHAT ROLE FOR FAIRNESS?

by
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Several authors have made different claims regarding the property rights associated with the atmosphere. This discussion is essentially one of fairness and asset ownership. Indirectly, it gets at the question of who should bear the burden of policies to reduce greenhouse gas emissions. While reviewing various ownership claims, this Essay argues that economics cannot adjudicate among competing claims to the atmosphere. What economics can do is improve our understanding of the economic burdens arising from climate change legislation. In particular, this Essay considers the distributional impacts of carbon pricing as a means to reduce greenhouse gas emissions.

This Essay makes several points. First, the ultimate burden depends on the combination of impacts from carbon pricing along with the impacts of the distribution of revenues (from a carbon tax or auctioned permits) and any freely allocated permits. Any regressivity from carbon pricing itself can be undone through judicious allocation of permits or revenue. Second, measuring the burden of carbon pricing requires knowing how consumers spend their income on carbon intensive products that become more expensive (uses side impacts), and on how their income is earned when factor prices may adjust in response to carbon pricing (sources side impacts). While uses side impacts appear regressive, sources side impacts appear proportional to progressive. This leads to the third point. Concerns that carbon pricing disproportionately burdens low income households may be overblown. Sources side impacts blunt the regressivity, and allocation of revenues or permits from carbon pricing can undo any remaining regressivity.

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I. INTRODUCTION

A market-based approach focusing on a cap-and-trade system with auctioned permits would raise substantial sums of money in the early years of the program. The Congressional Budget Office estimates the ten year revenue impact of the Clean Energy Jobs and American Power Act (S. 1733) at $854 billion for an emissions system that begins with an initial price of $17 per ton of carbon dioxide and rises to $30 per ton by 2019.[1] To whom does that money belong?

The debate over climate policy in Washington, D.C. has as much to do with the answer to this question as it does with the question of the appropriate level of controls on greenhouse gas emissions or safe levels of cumulative emissions over this century. This question transcends U.S. policymaking as it is at the core of the debate over responsibility for emission reductions in the global discussion over international greenhouse gas policy.

Given the vast sums involved, climate policy has often been couched in terms of rights to the atmosphere. I argue in this Essay that economists can offer little of value in the debate over who owns the atmosphere. What we can provide is some insight into the distributional impact of any allocation of ownership rights. It turns out that understanding who benefits from any given allocation of rights is not immediately obvious as price shifts and changes in behavior can obscure the burden of any given policy.

Rather than answer the question: "To whom does the money belong?" I answer a preliminary question: "Who is adversely (or positively) impacted by climate policy?" The first question is normative and one which reasonable people may answer differently. The second question is a positive question and subject to economic analysis. Moreover, it is an important input into any substantive discussion of the first question.

In the next Part of the Essay, I briefly review the evolution of environmental policy in the United States with a particular focus on the use of market-based instruments and climate change. I also provide a non-exhaustive list of arguments for different property rights over the atmosphere. In Part III, I discuss the concept of incidence with a particular emphasis on issues that relate to climate change policy. In Part IV, I review some of the recent empirical literature on the impacts of climate change policy.[2] I conclude in Part V.

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[1] *See* CONG. BUDGET OFFICE, S. 1733 CLEAN ENERGY JOBS AND AMERICAN POWER ACT COST ESTIMATE 9 tbl.2, 11 tbl.3 (2009).

[2] The reader will quickly note that nowhere do I attempt to measure the household impacts of climate change mitigation arising from climate policy. Our understanding of the damages from climate change is sufficiently poor at the micro level that little of substance has yet been written. Thus the entire discussion below focuses on the distributional impacts of mitigation policies. Ignoring damages for a

II. BACKGROUND

A. *Policy Choices*

Environmental policy has evolved dramatically over the past 40 or so years since the establishment of the United States Environmental Protection Agency in 1970. Initial controls focused on command-and-control regulatory approaches. Common approaches embedded in the Clean Air Act Amendments of 1977 included the definition of "best available control technology," among other things.[3] While economists had long promoted the idea of using taxes on environmental externalities as a means of controlling pollution[4], in practice, they have not been much relied upon.[5] A key breakthrough in the use of market-based instruments was the development of the idea of tradable emission rights.[6] The first major application of tradable emission rights was in the Clean Air Act Amendments of 1990 which established a trading program in the electric utility industry for sulfur dioxide emissions.[7]

Tradable emission programs establish a right to emit. The right is backed up by an emissions permit that is created by the government and distributed in some fashion to members of society. Emission permits may be bought and sold (and in some instances banked and potentially lent) and the market clearing price determines the opportunity cost of releasing covered emissions. In the context of the sulfur dioxide trading program, the decision to release a ton of sulfur dioxide (SO_2) by a covered utility means the utility incurs a cost of surrendering an SO_2 permit to the federal government which in turn retires it. This is a cost since the utility must either purchase a permit if it does not have one or it

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domestic assessment of domestic policy is unlikely to introduce much bias as the variation in domestic damages from climate change are likely dwarfed by variation in policy impacts. If there is a bias, it is likely to be that we underestimate the progressivity of policy. Low income households are less able to adapt to natural disasters in general. For evidence on this point, see Matthew E. Kahn, *The Death Toll From Natural Disasters: The Role of Income, Geography, and Institutions*, 87 REV. ECON. & STAT. 271, 277 (2005).

[3] Clean Air Act Amendments of 1977, Pub. L. No. 95-95, § 127(a), 91 Stat. 685, 741 (1977).

[4] The concept of taxing environmental externalities is generally credited to Pigou. *See* A. C. PIGOU, THE ECONOMICS OF WELFARE 183–87 (4th ed. 1962).

[5] *See generally* Don Fullerton, *Why Have Separate Environmental Taxes?*, 10 TAX POL'Y & ECON. 33 (1996).

[6] Clean Air Act Amendments of 1990, Pub. L. No. 101-549, § 401, 104 Stat. 2399, 2589–92 (1990). The idea of tradable emission rights is often attributed to J.H. Dales. *See, e.g.*, J.H. DALES, POLLUTION, PROPERTY, AND PRICES 93–97 (1968).

[7] The use of market-based instruments in environmental policy is documented in Robert N. Stavins, *Experience with Market-Based Environmental Policy Instruments*, *in* 1 HANDBOOK OF ENVIRONMENTAL ECONOMICS: ENVIRONMENTAL DEGRADATION AND INSTITUTIONAL RESPONSES 355 (Karl-Göran Mäler & Jeffrey R. Vincent eds., 2003). The sulfur dioxide trading program has been carefully studied by A. DENNY ELLERMAN ET AL., MARKETS FOR CLEAN AIR: THE U.S. ACID RAIN PROGRAM (2000).

must forego the opportunity to sell a permit on the market and realize the revenue by releasing the SO_2 emissions. Tradable emission programs—like environmental taxes—internalize the social cost of emissions by forcing the firm to realize a cost of pollution that they previously did not have to face.[8]

Cap-and-trade has proven to be politically attractive. The SO_2 trading program has been estimated to cut the costs of reducing emissions in the electric utility industry by roughly one-half.[9] And the European Union Emissions Trading Scheme, a cap-and-trade system for greenhouse gas emissions, has been functioning smoothly in its first full phase of operation to help the EU achieve its Kyoto targets.[10] Key to the success of a cap-and-trade program is the establishment of property rights in the atmosphere. Who owns those rights is a critical question to which I turn next.

B. *Establishing Property Rights*

One can enumerate any number of theories over who owns the rights to the atmosphere. One view is that the atmosphere belongs to the public. This motivates the proposal by Peter Barnes and others for the establishment of a Sky Trust. Rights to emit greenhouse gases into the atmosphere would be sold by the government on behalf of U.S. citizens and the proceeds would be distributed to citizens on an equal per capita basis.[11] Such an approach underlies the Carbon Limits and Energy for America's Renewal (CLEAR) Act (S. 2877), introduced by Senators Cantwell and Collins in late 2009. Three-quarters of the proceeds from auctioning emission permits would be allocated to legally residing residents in the United States on a monthly basis.[12]

A second view is that the rights are owned by the corporations that currently emit greenhouse gases into the atmosphere. This view would be manifested by a free allocation of emission permits to firms on the basis of historic emissions. Such an approach underlies the distribution of permits under the SO_2 trading program for electric utilities and the first two phases of the EU Emission Trading System.[13] The argument for free

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[8] This assumes that the emissions price (tax or permit price) is set equal to the social marginal damages of pollution.

[9] ELLERMAN ET AL., *supra* note 7, at 280–82.

[10] A. Denny Ellerman & Barbara K. Buchner, *The European Union Emissions Trading Scheme: Origins, Allocation, and Early Results*, 1 REV. ENVTL. ECON. & POL'Y 66, 82–83 (2007).

[11] PETER BARNES, WHO OWNS THE SKY? OUR COMMON ASSETS AND THE FUTURE OF CAPITALISM 53–59 (2001).

[12] Carbon Limits and Energy for America's Renewal (CLEAR) Act, S. 2877, 111th Cong. §§ 4(f)(2), 5(a) (2009).

[13] For a discussion of allocation issues in the EU ETS, see generally ALLOCATION IN THE EUROPEAN EMISSIONS TRADING SCHEME (A. Denny Ellerman, Barbara K. Buchner & Carlo Carraro eds., 2007).

allocation of permits to firms on the basis of historic emissions (grandfathering) is generally couched not so much in the argument that they "own" these rights but rather that the allocation can reduce political opposition to carbon pricing while in no way affecting the efficient outcome arising from carbon pricing.[14]

One might make an argument for grandfathering on the grounds that firms have been given rights by the state to operate on the basis that they provide socially beneficial goods and services to society. The extension of legal rights such as limited liability are an acknowledgement that firms are socially productive and worthy of societal support. Since the emission of greenhouse gases is essential to the firms' ability to engage in production, so the argument might go, firms should be allowed free rein to emit these gases.

At first blush this appears to conflict with the economic prescription for efficiency that firms recognize the full costs of using resources in production. Those full costs include the climate change damages arising from greenhouse gas emissions.[15] There is, in fact, no conflict at all. Tradable emission schemes have two key design elements. The first is the carbon price which is set by the intersection of demand for permits and the supply. The second is the means of allocating those permits. The carbon price ensures that firms internalize the external costs of climate change. As noted above, how the permits are allocated is entirely separate and can be determined through political negotiation or the reliance on some principal of property rights.

A third view of property rights is based on the concept of distributional neutrality. This view is grounded in the principle of horizontal equity—the principle that policy changes should treat "like" people in a similar fashion.[16] Distributional neutrality takes the perspective that revenues raised from auctioning permits in a cap-and-

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[14] *See, e.g.*, Robert N. Stavins, *Addressing Climate Change with a Comprehensive US Cap-and-Trade System*, 24 OXFORD REV. ECON. POL'Y 298, 305–07 (2008). The argument has its intellectual roots in R.H. Coase, *The Problem of Social Cost*, 3 J. L. & ECON. 1 (1960).

[15] The Obama Administration recently released an analysis which established a schedule of marginal damages for greenhouse gas emissions for regulatory purposes. *See* U.S. DEP'T OF ENERGY, FINAL RULE TECHNICAL SUPPORT DOCUMENT (TSD): ENERGY EFFICIENCY PROGRAM FOR COMMERCIAL AND INDUSTRIAL EQUIPMENT: SMALL ELECTRONIC MOTORS app. 15A, at 2 tbl.15A.1.1 (2010). Assuming a 3% discount rate, the social cost of carbon emissions is $21.40 per ton of CO_2 in 2010 according to this report.

[16] Horizontal equity has a long tradition in economics going back at least as far as RICHARD A. MUSGRAVE, THE THEORY OF PUBLIC FINANCE (1959); *see also* Martin Feldstein, *On the Theory of Tax Reform*, 6 J. PUB. ECON. 77, 82–83 (1976) (discussing the concept in the context of tax reform and arguing for transitions as a mode of reducing horizontal inequity). Kaplow provides a critique of the concept by arguing that it conflicts with standard welfare theory. Moreover, horizontal equity may place undue weight on the status quo. *See* Louis Kaplow, *An Economic Analysis of Legal Transitions*, 99 HARV. L. REV. 509, 580–81 (1986); Louis Kaplow, *Horizontal Equity: Measures in Search of a Principle*, 42 NAT'L TAX J. 139, 146–47 (1989).

trade system (or equivalently from a carbon tax) should be used to lower other taxes in a fashion such that the distribution of income is unchanged. Here the property rights are not clearly enunciated. But the allocation of the rights to the federal government is not inconsistent with this view. In this case, the federal government is appropriating the revenue and using it to reduce other taxes in this distributionally neutral manner.[17] This approach has been advocated by Metcalf, among others.[18] Metcalf argues for distributional neutrality so as to avoid confounding climate policy with the question of the appropriate size of the federal government.[19]

The notion that carbon pricing policy should be constructed on a distributionally neutral basis could be argued on the grounds that the federal government owns the property rights to the atmosphere (presumably on behalf of the public).[20] The large literature on the double dividend is posited on the idea that environmental revenues—here the revenue from auctioning permits—should be used to lower highly distortionary taxes to improve the overall efficiency of the fiscal system.[21] An alternative use of the funds might be to pay down the federal deficit as part of an effort to redress the intergenerational transfers from future generations to the current generation. One proposal suggests providing temporary support to groups adversely affected by carbon pricing with a gradual transition to the full use of carbon revenues to reduce the federal debt.[22]

These are important normative questions over which members of society can reasonably disagree. Notions of justice can help inform this discussion.[23] A legal conference may be an appropriate setting to debate the merits of the various property rights described above. The tools of economics, however, are not sufficient to answer this normative question. What economics can do is describe the implications of any distributional

[17] It may also be possible to use the revenue to improve the efficiency of the tax system. Such a goal underlies a large literature on the double dividend. *See generally* Don Fullerton & Gilbert E. Metcalf, *Environmental Taxes and the Double-Dividend Hypothesis: Did You Really Expect Something For Nothing?*, 73 CHI.-KENT L. REV. 221 (1998).

[18] *See* Gilbert E. Metcalf, *A Proposal for a U.S. Carbon Tax Swap: An Equitable Tax Reform to Address Global Climate Change* (Hamilton Project Discussion Paper No. 2007-12, 2007), http://www.brookings.edu/papers/2007/10carbontax_metcalf.aspx.

[19] *Id.* at 34.

[20] Note that this is a view explicitly rejected by Barnes in his formulation of the Sky Trust. *See* BARNES, *supra* note 11, at 49–50.

[21] *See*, *e.g.*, Fullerton & Metcalf, *supra* note 17.

[22] Gilbert E. Metcalf, *Submission on the Use of Carbon Fees To Achieve Fiscal Sustainability in the Federal Budget* (July, 2010), http://works.bepress.com/cgi/viewcontent.cgi?article=1085&context=gilbert_metcalf.

[23] Given the large uncertainties associated with the potential damages from climate change, one might, for example, invoke John Rawls and argue for a distribution that favors the most disadvantaged members of society. *See* JOHN RAWLS, A THEORY OF JUSTICE 27 (rev. ed. 1999).

approach taken. Understanding how policy impacts different households may provide guidance and insight into the discussion of the first question. To that modest question I turn next.

III. DEFINING AND MEASURING FAIRNESS

Fairness may be in the eyes of the beholder, but impacts arising from the application of environmental policy can readily be measured. Those impacts can be negative (a household has lower disposable income as a result of higher taxes to fund environmental remediation) or positive (the property value for a home near a newly reclaimed brownfield site goes up). I begin with a discussion of the economic principle of incidence.

Economists distinguish between *statutory incidence* and *economic incidence*. Statutory incidence refers to the legal obligation to incur some cost as the result of government policy while economic incidence refers to the ultimate bearer of the burden in terms of lower factor payments or higher consumer costs.[24] A simple example illustrates the concept. Consider a government regulation that a coal-fired power plant must install a scrubber to remove sulfur dioxide from its exhaust. The scrubber is costly and the statutory burden falls on the power plant that must install the required capital equipment. The owner of the power plant, however, may respond by raising the price it charges for its electricity or lowering wages of workers in order to respond to this costly environmental mandate. In the former case, we would say that the economic burden of the regulation falls on customers of the plant whereas in the latter case, it falls on workers in this industry.

As the term suggests, the statutory burden of a regulation or tax is determined through a legislative or administrative process. The economic burden, in contrast, is determined by the economic laws of supply and demand. As a rough guide, the economic burden of a regulation or tax falls more heavily on the side of the market that is relatively less elastic.

For the purposes of this discussion, the distinction between statutory and economic incidence is important because it means that you cannot legislate a fairness outcome in environmental policy. All you can do is measure the outcome with the use of economic models. Also the differences between statutory and economic incidence can be large. Changes in prices arising from behavioral responses to the policy under examination drive this difference.

With a measure of the economic incidence (or burden) of an environmental policy, we can state whether the policy is progressive or regressive. A policy is said to be progressive if the ratio of the economic

[24] For a thorough discussion of incidence in the context of taxation, see generally Don Fullerton & Gilbert E. Metcalf, *Tax Incidence*, *in* 4 HANDBOOK OF PUBLIC ECONOMICS 1787 (Alan J. Auerbach & Martin Feldstein eds., 2002).

impact (measured in dollars) to some measure of household well-being rises with that measure of well-being. Conversely, if the ratio falls as the measure of well-being rises, the policy is said to be regressive. A policy could be monotonically progressive (or regressive) or it could be progressive over some range and regressive over another range. If the ratio is constant across income groups, the policy is proportional.

Typically, income is used as the measure of well-being, but one might want to use some sort of wealth measure or an expanded income concept. In the latter case, we might wish to include the value of leisure or non-market income (the value of housing services for owner-occupied housing, for example). I will use income as the measure of well-being from this point forward but leave ambiguous what precisely is included in that measure.

A complicating factor is the timeframe over which income is measured. Ranking households on the basis of their current annual income can be misleading for certain household groups, in particular retired households with large amounts of accumulated savings that they are drawing down, or young people just starting out in life whose consumption may be more driven by their anticipated rather than actual income.[25] The distinction between annual and lifetime income is important for the analysis of consumption-based taxes (such as energy taxes). Analyses based on annual income tend to find that consumption-based taxes are more regressive than analyses based on lifetime income.[26]

[25] The idea that households make consumption decisions on the basis of lifetime rather than annual income was first conjectured and studied by Friedman. *See* MILTON FRIEDMAN, A THEORY OF THE CONSUMPTION FUNCTION 20–21 (1957). A full discussion of the biases arising from using annual income to rank households is contained in DON FULLERTON & DIANE LIM ROGERS, WHO BEARS THE LIFETIME TAX BURDEN? 17–20 (1993).

[26] *See, e.g.*, Erik Caspersen & Gilbert Metcalf, *Is a Value Added Tax Regressive? Annual Versus Lifetime Incidence Measures*, 47 NAT'L TAX J. 731, 731 (1994); James Davies, France St-Hilaire & John Whalley, *Some Calculations of Lifetime Tax Incidence*, 74 AM. ECON. REV. 633, 636 (1984); Kevin A. Hassett, Aparna Mathur & Gilbert E. Metcalf, *The Incidence of a U.S. Carbon Tax: A Lifetime and Regional Analysis*, 30 ENERGY J. 155, 162–65 (2009); James M. Poterba, *Lifetime Incidence and the Distributional Burden of Excise Taxes*, 79 AM. ECON. REV. 325, 325–29 (1989).

The economic burden of a tax is in large measure determined by various price elasticities of supply and demand. This has given rise to a useful but potentially misleading characterization of incidence that will be relevant for evaluating much of the literature on the burden of greenhouse gas policy. Often, it is said that a tax is passed forward to consumers of a taxed product or back to suppliers. Figure 1 illustrates the concept with a supply and demand diagram in a partial equilibrium model. In the absence of a tax on this commodity (*Q*), the market is in equilibrium with Q_0 amount of the commodity supplied at price P_0. A tax is levied on this commodity to be paid by the supplier. The demand curve (from the point of view of the supplier) shifts down to D^1. For an excise tax, a per-unit tax on the commodity, the demand curve shifts down by the amount of the tax. At Q_1, the consumer pays P_1^C to the supplier who in turn receives P_1^S after paying the tax to the government. The relation between the price paid by the consumer and the price received by the supplier is $P_1^C = P_1^S + t$, where *t* is the unit tax on the commodity.

FIGURE 1a. Tax Shifting

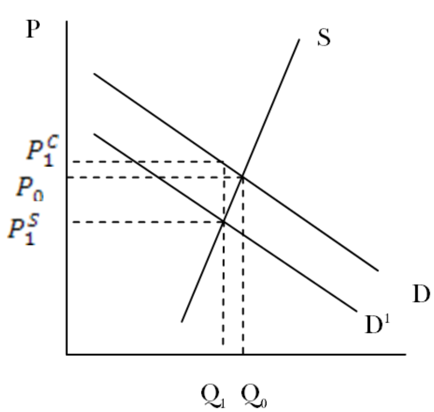
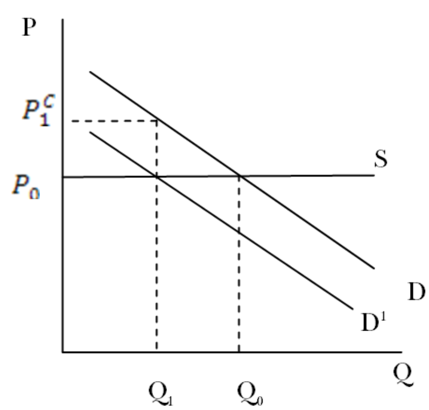


FIGURE 1b. Forward Shifting



As drawn, supply is highly inelastic and the share of the tax paid by the consumer ($P_1^C - P_0$) is quite small relative to the share of the tax paid by the supplier ($P_0 - P_1^S$). In this partial equilibrium framework, the tax has been predominantly *passed back* to the supplier.[27] If supply had been drawn as highly elastic, then we would obtain the opposite result with the tax predominantly *passed forward* to consumers.

It has long been argued that supply for competitively supplied commodities is perfectly elastic, in which case commodity based taxes are passed forward to consumers in the form of higher prices.[28] Figure 1b illustrates this. With a completely elastic supply, the firm's price does not change and the consumer's price rises by the full amount of the tax.

[27] More precisely, it is passed back to the factors of production. We cannot say without further analysis whether the tax is borne by workers or owners (or some other factor of production).

[28] *See* JOSEPH A. PECHMAN, WHO PAID THE TAXES, 1966–85?, at 28–29 (1985).

While a useful pedagogic approach for understanding how price changes can lead to the economic incidence of a tax differing from the statutory incidence, the notion that taxes pass forward and backward is without economic content. The difficulty is that in general equilibrium we can only talk in terms of relative prices (relative to some numeraire good). We could, for example, choose labor as the numeraire good. Further assume that this commodity is produced with a linear technology in which one unit of labor is required to produce one unit of *Q*. If the commodity is produced in a perfectly competitive market, its price will equal its marginal cost of production, which in this case equals 1. The effect of the tax is to raise the consumer price from 1 to $1+t$.

But we could as easily have chosen the consumer price of this commodity as the numeraire good. Now the imposition of the tax leads to a fall in the supplier price from 1 to $1-t$. Assuming our linear production technology, the wage rate must also fall from 1 to $1-\tau$ where $\tau = t/(1+t)$.[29] Now we have an anomalous result. Depending on our choice of numeraire, the tax is either fully passed forward to consumers or fully passed back to workers (in the form of lower wages). Since the choice of numeraire is entirely arbitrary, the entire notion of forward and backward shifting cannot be meaningful.

What is meaningful is the differential impact of price changes on heterogeneous economic agents. As prices change, individuals are impacted in one of two ways. Real factor prices (relative to the numeraire good) change, and those households who disproportionately earn income from those factors whose prices fall the most following a policy change are disproportionately impacted by the policy. At the same time, real consumer prices change and those households who spend a disproportionate share of their income on those goods whose prices rise the most following the policy change are disproportionately impacted by the policy. In the former case, the burden of the policy is driven by *sources of income* impacts while in the latter case the burden is driven by *uses of income* impacts. These impacts are unaffected by the choice of numeraire.[30] This point will be particularly important for interpreting results from the literature below on the purported regressivity of climate policy.

[29] The required reduction in the wage rate (τ) is determined by the following formula: $1-\tau=1/(1+t)$. Other prices must also adjust in the general equilibrium. The essential point here is that the ratio of prices between any two commodities or factors of production is unaffected by our choice of numeraire. Only relative prices matter.

[30] In addition to sources and uses side effects, Don Fullerton identifies four other distributional impacts of environmental policy: (1) scarcity rents from quotas; (2) benefits and costs by household characteristics other than income (e.g. race, ethnicity, etc.); (3) capitalization impacts for asset owners; and (4) transitional burden impacts on workers in adversely impacted industries. *See* Don Fullerton, *Distributional Effects of Environmental and Energy Policy: An Introduction*, at xi–xii (Nat'l Bureau of Econ. Res., Working Paper No. 14241, 2008).

Two additional aspects of measuring the progressivity of environmental policy merit closer attention. First, if we are considering the use of environmental taxes or other revenue-raising proposals (e.g. cap-and-trade programs with auctioned permits), we should distinguish between an environmental tax (to focus on the tax example) and an environmental tax reform. The distinction has to do with the use of the revenue from the environmental reform. An environmental tax might be distinctly regressive. However, the revenue raised from that tax could be used to lower other taxes in a progressive fashion so that the net change in taxes could exhibit any degree of progressivity desired.

Second, we need to be clear about what is fixed in the analysis. To isolate the impact of a particular policy, we want to hold all other policies constant. Significant carbon pricing over a 40-plus-year period will have large general equilibrium impacts on various parts of the economy. Modelers need to decide how they will treat government spending. Is it held constant in absolute terms? In real or nominal dollars? As a share of GDP? There is no single correct way to treat the government in the analysis. As discussed below, the government's treatment of the economy in large computer models can have important influences on the final results. With this as background, I next turn to a survey of results on burden impacts from climate policy.

IV. APPLICATION TO CLIMATE CHANGE

Carbon pricing through a cap-and-trade system has very similar impacts to broad-based energy taxes—not surprising since over 80% of greenhouse gas emissions are associated with the combustion of fossil fuels.[31] The literature on distributional implications across income groups of energy taxes is a long and extensive one and some general conclusions have been reached that help inform the distributional analysis of carbon pricing. First, analyses that rank households by their annual income find that excise taxes in general tend to be regressive.[32]

As noted above, the difficulty with this ranking procedure is that many households in the lowest income groups are not poor in any traditional sense that should raise welfare concerns. This group includes households that are facing transitory negative income shocks or who are making human capital investments that will lead to higher incomes later in life (e.g., graduate students). It also includes many retired households which may have little current income but are able to draw on extensive savings.

That current income may not be a good measure of household well-being has long been known and has led to a number of efforts to

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[31] *See* U.S. ENVTL. PROT. AGENCY, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990–2007, at tbl.ES-2 (2009).

[32] *See*, *e.g*, PECHMAN, *supra* note 28, at 56 tbl.4.9 (analyzing excise taxes in general).

measure lifetime income. This leads to the second major finding in the literature. Consumption taxes—including taxes on energy—look considerably less regressive when lifetime income measures are used than when annual income measures are used.[33] The following table illustrates this finding.[34]

TABLE 1. Absolute Incidence of a Carbon Tax									
	Annual Income			Current Consumption			Lifetime Consumption		
	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
Bottom	2.12	1.60	3.74	0.98	0.50	1.49	0.67	0.50	1.16
Second	1.74	1.31	3.06	0.92	0.49	1.41	0.66	0.51	1.16
Third	1.36	0.99	2.36	0.84	0.50	1.34	0.76	0.51	1.24
Fourth	1.19	0.88	2.06	0.79	0.50	1.29	0.72	0.51	1.23
Fifth	0.97	0.78	1.76	0.73	0.51	1.24	0.81	0.50	1.30
Sixth	0.85	0.68	1.53	0.65	0.52	1.16	0.71	0.50	1.22
Seventh	0.69	0.61	1.30	0.65	0.51	1.17	0.66	0.51	1.18
Eighth	0.61	0.63	1.23	0.54	0.53	1.07	0.56	0.51	1.08
Ninth	0.53	0.49	1.01	0.48	0.52	1.00	0.49	0.53	1.02
Top	0.36	0.45	0.81	0.37	0.52	0.89	0.41	0.52	0.93
Incidence of a \$15 per ton CO_2 carbon tax on fossil fuels only. "Direct" refers to the consumer burden of gasoline, home heating fuels, and electricity. "Indirect" refers to all other commodities. Calculation using 2003 data.									

Table 1 provides estimates of the incidence of a \$15 per ton CO_2 carbon tax on fossil fuels based on data for 2003. The first three columns provide a measure of the incidence using an annual income approach. Under the assumption that the tax is fully passed forward into higher consumer prices, Table 1 demonstrates that the burden, measured as the additional expenditures required to buy the same basket of commodities in 2003 relative to household income, is quite regressive. The lowest income decile pays a tax of nearly 4% of their annual income while the top decile pays a tax of less than 1%. Table 1 decomposes the burden into direct and indirect components. Direct refers to the additional cost of buying gasoline, home heating fuel (natural gas or heating oil), and electricity while indirect refers to all other commodities. The distinction between direct and indirect is useful for two reasons. First, while the price increases for goods included in the indirect category are an order of magnitude lower than those for goods included in the direct

[33] *See supra* note 26. Most of these studies look at a snapshot of taxes in one year relative to some proxy for lifetime income—often current consumption based on the permanent income hypothesis. An exception is FULLERTON & ROGERS, *supra* note 25 (modeling the lifetime pattern of tax payments as well as income).

[34] Hassett, Mathur & Metcalf, *supra* note 26, at 162–64 tbls.1–3.

category,[35] spending on indirect goods makes up a large share of household budgets so that the burden from indirect spending is of a similar magnitude as that from direct fuel-related spending. Second, annual income studies that attempt to extrapolate the regressivity of carbon pricing from studies of gasoline (or more generally fuel) taxes will underestimate the annual income-based regressivity of a carbon tax.

The columns for annual and lifetime consumption are efforts to construct proxies for lifetime income. Here the idea is that households (1) wish to smooth consumption over their lifetimes; and (2) make consumption decisions on the basis of lifetime income.[36] If households are not subject to borrowing constraints and are fully forward-looking, current consumption serves as a proxy for lifetime income. A comparison of the annual income and current consumption total burden measures in Table 1 illustrates how moving to a lifetime analysis reduces the regressivity of the carbon tax.

Hassett, Mathur, and Metcalf note that consumption patterns are not fully smoothed in the consumer expenditure data they use for their analysis.[37] Thus they make a further adjustment to their consumption proxy for lifetime income to remove temporary fluctuations in consumption. This lifetime consumption proxy for lifetime income reduces the regressivity of the carbon tax even further.

The lifetime income approach is an important caveat to distributional findings from annual incidence analyses, but it relies on strong assumptions about household consumption decisions. In particular it assumes that households base current consumption decisions knowing their full stream of earnings over their lifetime. While it is reasonable to assume that households have some sense of future income, it may be implausible to assume they have complete knowledge or that they necessarily base spending decisions on income that may be received far in the future. It may be that the truth lies somewhere between annual and lifetime income analyses. Moreover, if one were to use a lifetime income approach, one would like to track consumption over the lifecycle to capture any lifecycle changes in the consumption of carbon-intensive products and compare lifetime carbon pricing burdens rather than a single-year snapshot. Further, as noted above, analyses based on the idea that taxes are passed forward miss any burden impact arising from differential impacts on the sources of income side. I will return to this below.

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[35] *See id.* at 162 tbl.1.

[36] The idea that consumers base annual consumption decisions on the basis of some long-run measure of income is attributed to Milton Friedman. *See* FRIEDMAN, *supra* note 25. Consumption smoothing follows from the lifecycle consumption theory of Franco Modigliani & Richard Brumberg, *Utility Analysis and the Consumption Function: An Interpretation of Cross-Section Data*, *in* POST KEYNESIAN ECONOMICS 388, 391–92 (Kenneth K. Kurihara ed., 1954).

[37] *See* Hassett, Mathur & Metcalf, *supra* note 26, at 163–65.

Turning to climate policy in particular, a number of papers have attempted to measure the distributional impacts of carbon pricing across household income groups. Dinan and Rogers build on research by Metcalf to consider how the distribution of allowances from a cap-and-trade program affects the distributional outcome.[38] Both papers emphasize that focusing on the distributional burden of carbon pricing (either a tax or auctioned permits) without regard to the use of the revenue raised (or potentially raised) from carbon pricing provides an incomplete distributional analysis. How the proceeds from carbon pricing are distributed have important impacts on the ultimate distributional outcome.

Table 2 shows an illustrative green tax reform that replaces 10% of federal tax revenues with various environmental tax reforms.[39]

TABLE 2. A Green Tax Reform	
Tax Increase	
Carbon Tax	$ 56.0
Gasoline Tax	$ 19.8
Air Pollution Taxes	$ 40.5
Virgin Materials Tax	$ 9.3
Total	$ 125.6
Tax Decrease	
Payroll Tax Reduction	$ 71.2
$150 Refundable Tax Credit	$ 34.9
4% Personal Income Tax Reduction	$ 19.3
Total	$ 125.4
Amounts in billions of dollars.	

The reform replaces $125 billion of personal income tax collections with taxes on gasoline, carbon emissions, virgin materials (to encourage the use of recycled materials) and air pollution. The distributional impact is shown in Table 3.[40] Households are sorted according to their annual income from the poorest 10% of households (decile 1) to the richest (decile 10). To reduce the influence of households whose annual income may not reflect lifetime resources, I focus only on households that have married heads of household in the age range of 40 to 50.

[38] Terry Dinan & Diane Lim Rogers, *Distributional Effects of Carbon Allowance Trading: How Government Decisions Determine Winners and Losers*, 55 NAT'L TAX J. 199, 200 (2002); Gilbert E. Metcalf, *A Distributional Analysis of Green Tax Reforms*, 52 NAT'L TAX J. 655 (1999).

[39] *See* Metcalf, *supra* note 38, at 659–68 (describing this reform).

[40] *Id.*

TABLE 3. Green Tax Reform Burden Impacts

Decile	Increase	Decrease	Net
1	1,248	1,214	34
2	1,406	1,580	-174
3	1,382	1,681	-299
4	1,513	1,761	-248
5	1,861	1,903	-42
6	1,706	2,097	-391
7	1,761	2,163	-402
8	1,972	2,133	-161
9	1,998	2,107	-110
10	2,830	2,954	-124
Δ Suits	-0.224	0.234	0.010

Table shows tax change for households with married head of households age 40 to 50.

The column labeled "Increase" shows the impact of the new environmental taxes under the assumption that factor prices do not change and that the full impact of the taxes shows up in higher product prices. The largest dollar increases occur for the highest income households. But the burden relative to income is highest for lower income households. This can be seen by the decline in the Suits Index following the imposition of the green taxes. The Suits Index is a summary measure of tax progressivity that ranges from –1 to +1.[41] A negative value of the Suits Index indicates a regressive tax while a positive value indicates a progressive tax. The Suits Index for the tax system falls by 0.224 with the imposition of the green taxes, indicating a regressive impact of these reforms.

The next column shows the distributional impact of the reduction in taxes funded by the environmental tax levies. While the dollar value of the decrease in taxes is higher for the highest income groups than for the lowest income groups, the tax decrease has a positive impact on progressivity (as evidenced by the increase in the Suits Index). This follows because the tax cuts as a share of income are greater for low income groups than for high income groups. The green tax reform impacts are shown in the last column which shows the average change in disposable income for each income group taking into account the overall change in tax liabilities. The Suits Index for the tax system is essentially unchanged as a result of this reform.[42]

[41] Daniel B. Suits, *Measurement of Tax Progressivity*, 67 AM. ECON. REV. 747, 747 (1977).

[42] Average tax burdens fall for all but the lowest income group. Despite this, the reform is revenue neutral. The discrepancy is explained by the fact that Table 2 only

The point that the use of carbon revenues matters for distribution is the basis for the distributional and revenue neutral carbon tax swap proposal explained in *A Proposal for a U.S. Carbon Tax Swap: An Equitable Tax Reform to Address Global Climate Change*, as well as the focus of analysis in *The Incidence of U.S. Climate Policy: Alternative Uses of Revenue from a Cap and Trade Auction*.[43] This latter paper considers five different uses of revenue from a cap and trade auction, focusing on income distribution as well as regional distribution.[44] Burtraw, Walls, and Blonz consider the distributional impacts in an expenditure side analysis where they focus on the allocation of permits to local distribution companies (LDCs).[45] Finally, Rausch, Metcalf, Reilly and Paltsev also investigate the welfare costs of allocations to LDCs and find that allocations that lead to real or perceived reductions in electricity prices by consumers have large efficiency costs.[46]

With the exception of the last paper, all of the papers above assume that the burden of carbon pricing is shifted forward to consumers in the form of higher energy prices and higher prices of energy consumption intensive goods and services. That carbon pricing is passed forward to consumers follows from the analysis of a number of computable general equilibrium models. Bovenberg and Goulder, for example, find that coal prices rise by over 90% of a $25 per ton carbon tax in the short and long run.[47] This incidence result underlies their finding that only a small percentage of permits need be freely allocated to energy intensive

focuses on certain households. These results are robust to the inclusion of all households. *See* Metcalf, *supra* note 38, at 665.

[43] Metcalf, *supra* note 18; Dallas Burtraw, Richard Sweeney & Margaret Walls, *The Incidence of U.S. Climate Policy: Alternative Uses of Revenue from a Cap-and-Trade Auction*, RESOURCES FOR THE FUTURE (2009), http://www.rff.org/RFF/Documents/RFF-DP-09-17-REV.pdf.

[44] *See* Burtraw, Sweeney & Walls, *supra* note 43. *See also* Hassett, Mathur & Metcalf, *supra* note 26 (also doing a regional analysis); Corbett A. Grainger & Charles D. Kolstad, *Who Pays a Price on Carbon?* 2–3 (Nat'l Bureau of Econ. Res., Working Paper No. 15239, 2009) (doing a similar analysis as that of Hassett, Mathur & Metcalf above, and noting that the use of household equivalence scales can exacerbate the regressivity of carbon pricing).

[45] Dallas Burtraw, Margaret Walls & Joshua Blonz, *Distributional Impacts of Carbon Pricing Policies in the Electricity Sector*, RESOURCES FOR THE FUTURE (2009), http://www.rff.org/rff/documents/rff-dp-09-43.pdf.

[46] Sebastian Rausch et al., *Distributional Impacts of a U.S. Greenhouse Gas Policy: A General Equilibrium Analysis of Carbon Pricing*, *in* U.S. ENERGY TAX POLICY (Gilbert E. Metcalf ed.) (forthcoming Mar. 2011).

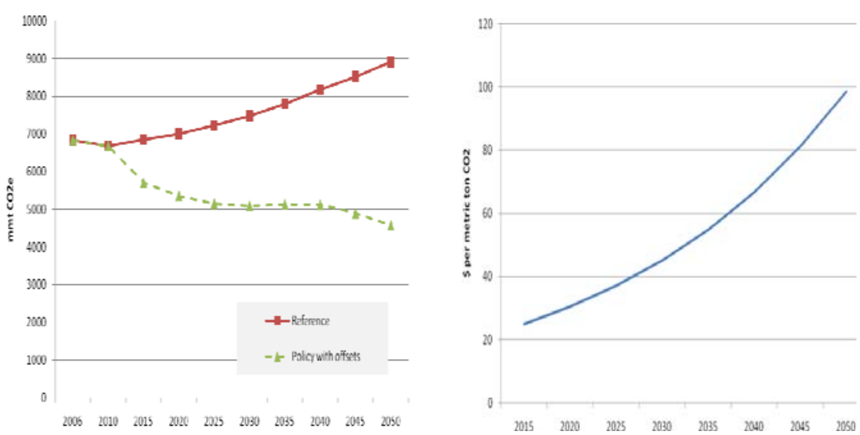
[47] They assume world pricing for oil and natural gas so that the gross of tax prices for these two fossil fuels rise by the full amount of the tax. *See* A. Lans Bovenberg & Lawrence H. Goulder, *Neutralizing the Adverse Industry Impacts of CO2 Abatement Policies: What Does It Cost?*, *in* BEHAVIORAL AND DISTRIBUTIONAL EFFECTS OF ENVIRONMENTAL POLICY 45, 72 tbl.2.4 (Carlo Carraro & Gilbert E. Metcalf eds., 2001). *See also* A. Lans Bovenberg, Lawrence H. Goulder & Derek J. Gurney, *Efficiency Costs of Meeting Industry-Distributional Constraints Under Environmental Permits and Taxes*, 36 RAND J. ECON. 951 (2005).

industries to compensate shareholders for any windfall losses from a cap and trade program.

Fullerton and Heutel construct an analytic general equilibrium model to identify the various key parameters and relationships that determine the ultimate burden of a tax on a pollutant.[48] While the model is not sufficiently detailed to provide a realistic assessment of climate change impacts on the U.S. economy it illustrates critical parameters and relationships that drive burden results.

The general equilibrium models discussed above all assume a representative agent in the United States, thereby limiting their usefulness to considering distributional questions. Rausch et al. extend the MIT Emissions Prediction and Policy Analysis (EPPA) model to allow for heterogeneous households focusing on variation over income and location.[49] The United States Regional Energy Policy (USREP) model also allows us to study the biases that arise from analyses of carbon pricing that assume that carbon prices are fully passed forward into higher consumer prices. Figure 2 below provides information about one of the scenarios analyzed in that paper.[50]

FIGURE 2. U.S. Greenhouse Gas Emissions and Carbon Price (TAAS)



(a) GHG Emissions (b) CO_2 Price

Figure 2(a) shows emissions under a reference scenario in which no greenhouse gas control policy is implemented in the United States and for the policy scenario analyzed in the paper. In the absence of policy,

[48] The paper also provides a thorough summary of the literature on the incidence impacts of environmental taxes. *See* Don Fullerton & Garth Heutel, *The General Equilibrium Incidence of Environmental Taxes*, 91 J. PUB. ECON. 571 (2007).

[49] Sebastian Rausch et al., *Distributional Implications of Alternative U.S. Greenhouse Gas Control Measures*, 10 B.E. J. ECON. ANALYSIS & POL'Y Iss. 2, Art. 1 (2010).

[50] This is the Targeted Allowance Allocation Scenario (TAAS). *Id.* at 12–19.

cumulative emissions between 2015 and 2050 would be roughly 300 billion metric tons (bmt) of carbon dioxide equivalent (CO_2e). With the policy in place, cumulative emissions are just over 200 bmt.[51]

The major focus of that analysis is the burden impact of climate policy taking into account the allocation of allowances from a scenario loosely modeled on the American Clean Energy and Security Act (H.R. 2454) passed by the House of Representatives on June 26, 2009.[52] Using a computable general equilibrium model with multiple households in different income groups and across different regions of the country, Rausch et al. measure the burden of the carbon pricing policy cum allowance allocation using a money-metric measure of the change in welfare divided by full income.[53]

Figure 3 below shows the welfare impact across different income groups for three different years over the control period. In each of the three years, the carbon pricing policy is distinctly progressive. In fact, the welfare change for lower income households is positive indicating that these income groups on average are receiving compensation in excess of the damages they suffer from carbon pricing.[54]

The progressive nature of reform illustrated in Figure 3 stands in striking contrast to earlier results in the literature that carbon pricing is regressive. Two factors help explain the difference in results. First, analyses such as those done by Hassett, Mathur, and Metcalf do not account for how the value of allowance auctions is allocated in the economy. In the jargon of tax incidence, they are doing absolute incidence analyses while Rausch et al. are doing a balanced budget analysis. Second, the early analyses discussed above focused on the uses of income effects of carbon pricing while Rausch et al. also allow for sources of income side impacts.[55]

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[51] Greenhouse gases are a stock pollutant. What matters for climate change is the cumulated emissions over long periods of time. For this analysis, we focus on the cumulative emissions over the control period.

[52] American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong. (2009). The TAAS scenario analyzed by Rausch et al. only focuses on the cap-and-trade program contained in the bill and none of the other policy initiatives. Thus any distributional results from that paper should not be viewed as distributional results from the legislation itself.

[53] The authors use an Equivalent Variation measure divided by full income, defined as money income plus the value of leisure and residential capital. *See* Rausch et al., *supra* note 49, at 20–22.

[54] The income groups are households with income less than $10,000 (hh1), income between $10,000 and $15,000 (hh10), income between $15,000 and $25,000 (hh15), income between $25,000 and $30,000 (hh25), income between $30,000 and $50,000 (hh30), income between $50,000 and $75,000 (hh50), income between $75,000 and $100,000 (hh75), income between $100,000 and $150,000 (hh100), and income of $150,000 or more (hh150). *Id.* at 6 tbl.2.

[55] *See* Hassett, Mathur & Metcalf, *supra* note 26; Rausch et al., *supra* note 49, at 2.

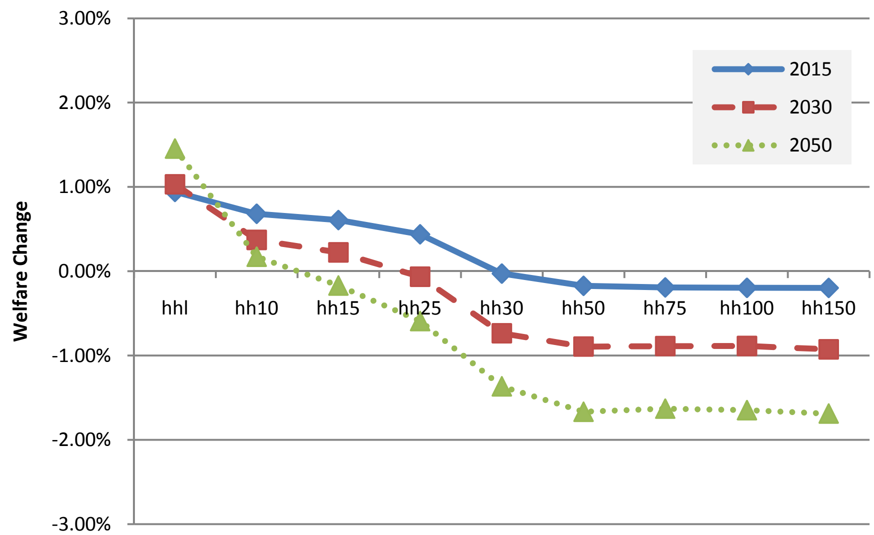

FIGURE 3. Welfare Change by Income Group, U.S. Average (TAAS)

To see how these differences play out, Rausch et al. undertake a counterfactual analysis in which they assume the government does not allocate the value of allowances to households but spends it in ways that do not enter consumer utility functions.[56] Moreover, they provide welfare impacts across income groups for three scenarios designed to disentangle the contribution of sources and uses side effects on welfare *across* the income distribution.[57] The logic of their counterfactual analysis is as follows:

> If households in different income groups are characterized by identical income shares i.e., have equal ratios of capital, labor, and transfer income, then a change in relative factor prices affects all households equally. Th[e] counterfactual analysis isolates the distributional impacts of the uses of income effects of a policy. If households are assumed to have identical expenditure shares for all goods and services, a change in relative product prices produces an equal impact on consumers in different income classes. In that case, . . . the distributional impacts [of the] sources of income [effects] of a policy [are isolated]. Any differential burden impacts of a policy across households from the counterfactual case that eliminates differences among households in how they spend their income are then determined by sources of income effects. Results that eliminate differences in income sources, allows a focus on how uses side factors shape the relative burden of carbon pricing.

[56] *See* Rausch et al., *supra* note 49, at 35.
[57] *Id.*

> The two counterfactual cases do not eliminate these drivers of incidence but by eliminating household heterogeneity they suppress *differential* impacts across the income distribution.[58]

Note that as Rausch et al. measure the *real* burden, i.e., the change in equivalent variation, their incidence calculation is independent from the choice of numeraire.

Figure 4 shows results for 2050. The line labeled "carbon pricing burden" shows the welfare effect that combines income and expenditure heterogeneity. This is the welfare effect, without any recycling, given observed income sources and expenditures shares as they vary among households. The line labeled "identical income shares" eliminates heterogeneity of income sources to isolate the uses side effect of the policy. The line labeled "identical expenditure shares" eliminates expenditure heterogeneity to isolate the sources side effect. A downward slope indicates a progressive result and an upward slope a regressive result. We also show the observed burden policy impacts labeled as "carbon pricing burden." This shows the differential burden impacts resulting from heterogeneity in both the sources and uses of income.

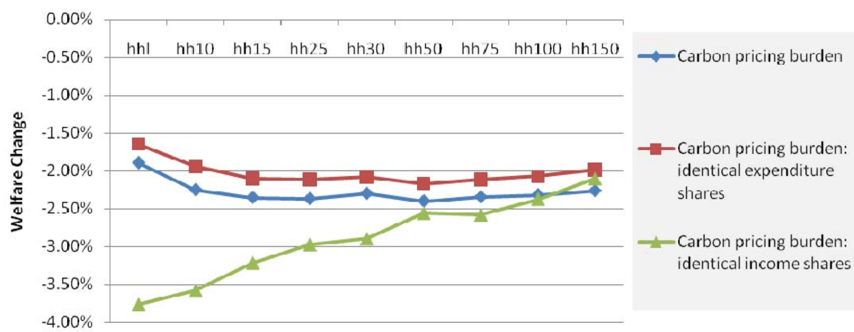

FIGURE 4. Relative Sources and Uses Side Impacts in 2050

Because this scenario does not return revenue to households (or spend it in some fashion that enters household utility functions), the costs of the policy are higher (the curves are shifted down). Despite that, we still see the striking result: Carbon pricing is modestly progressive over the lower half of the income distribution and essentially neutral in the upper half.

The uses side impacts are sharply regressive in all years in accord with previous analyses that focus on expenditure side burdens only. Sources side impacts, on the other hand, are modestly progressive in 2015 and essentially proportional in the other years. In all years, combined effects in the line "carbon pricing burden" track closely the line "identical expenditure shares." This suggests that relative welfare

[58] *Id.* Harberger uses a similar analysis to identify the incidence of a corporate income tax. *See* Arnold C. Harberger, *The Incidence of the Corporation Income Tax*, 70 J. POL. ECON. 215 (1962).

impacts across the income distribution are largely driven by sources side effects.

Here we need to be a bit careful in how we define sources side effects. One of the reasons Rausch et al. find that the sources side effects are progressive is their treatment of government transfer programs. This returns us to the issue of what is *ceteris paribus* in the policy analysis. Rausch et al. fixed government spending and, more importantly, government transfers.[59] Low income households derive a large fraction of income from transfers relative to high income households.[60] As a result transfer income thus insulates households from changes in capital and labor income. Table 4 shows the sources of income for households in the USREP model.[61] This effect is strongest for the two lowest income households where transfers account for about 80% and 60% of income as shown in Table 4.[62]

TABLE 4. Sources of Income

	Fraction of Income from Labor	Fraction of Income from Capital	Fraction of Income from Transfers
hhl	12.8%	6.5%	80.8%
hh10	28.6%	9.8%	61.6%
hh15	43.0%	18.2%	38.8%
hh25	48.3%	22.3%	29.5%
hh30	55.3%	24.7%	20.0%
hh50	60.4%	35.4%	4.2%
hh75	62.0%	37.5%	0.5%
hh100	59.4%	42.3%	-1.7%
hh150	57.6%	45.7%	-3.3%

Figure 4 also suggests that especially in a dynamic setting, the sources side effect is more important in determining the welfare impact than is the uses side effect for a *given* income class. The intuition for this result seems fairly obvious—over time the impacts of an ongoing mitigation policy cumulate through effects on overall economic growth and are reflected in general wage rates and capital returns. The annual abatement costs become an ever smaller share of the economic burden

[59] Rausch et al., *supra* note 49, at 19 n.20, 37.
[60] *Id.* at 37.
[61] *Id.* at 38 tbl.5.
[62] The sensitivity of distributional impacts of policies to the treatment of government transfers has been found in other work. Browning and Johnson, for example, found that holding transfers fixed in real terms sharply increases the progressivity of the U.S. tax system. EDGAR K. BROWNING & WILLIAM R. JOHNSON, THE DISTRIBUTION OF THE TAX BURDEN 59 (1979).

of the policy, and so are less important in determining the overall impacts. Furthermore, because the fraction of income derived from transfers increases over time, Rausch et al. find that the progressivity of the sources side effect also slightly increases for the five lowest income groups.

Overall, this analysis demonstrates that it can be misleading to base the distributional analysis on uses side factors only. The virtue of a general equilibrium framework is the ability to capture both expenditure and income effects in a comprehensive manner.

Where does this leave us? The distributional impacts of climate policy depend both on variation in how households spend their income (uses side impacts) and variation in how households obtain their income (sources side impacts). Seemingly unrelated issues like the government transfer indexing policy turn out to play important roles in influencing the final distributional outcome. Other issues remain to be studied. One important area is capitalization effects. Asset pricing changes as policy (and climate change) unfolds and concentrates the impacts on the owners of assets at the time policy changes. This complicates the measurement of distributional effects.[63] Another is the role that adaptation plays. The ability to move provides households with a (relatively) low-cost means of avoiding particularly damaging climate impacts. It also may provide a means for footloose families to avoid the costs of sub-federal climate policies (and perhaps even national level policies).[64]

V. CONCLUSION

The research on the distributional impacts of climate policy has evolved and become more sophisticated over the past several decades. Early analyses used models focusing on heterogeneity in consumer expenditure patterns to argue that carbon pricing would be regressive. This distributional view of climate policy was nuanced to the extent that researchers used different measures of well-being and attempted to construct lifetime measures of income (and in certain cases to measure lifetime tax burdens as well). But an important advance was the shift in the debate from the distributional impacts of carbon pricing to the impacts of climate policy. The difference is in incorporating into the discussion the use of the proceeds from carbon pricing, whether a carbon tax or the proceeds from auctioning emission allowances.

[63] *See* Henry J. Aaron, *Politics and the Professors Revisited*, 79 AM. ECON. REV. 1, 4 (1989).

[64] For a thoughtful (if sometimes playful) analysis of the role that cities and migration may play in dealing with climate change, see MATTHEW E. KAHN, CLIMATOPOLIS: HOW OUR CITIES WILL THRIVE IN THE HOTTER FUTURE 2–3 (2010).

A more recent advance has been the recognition that sources side impacts can play an important role in affecting distributional impacts.[65] In addition, the interaction of climate policy with other government policies will necessarily affect the final distributional outcome.

Let me return to the question I began the Essay with. In one sense this Essay has engaged in a bait-and-switch strategy by setting out a highly charged question and then shifting to a question that can only delight economists (and dull the eyes of others). But any discussion of climate justice must involve a discussion of climate policy impacts. If I cannot contribute to the first discussion, I hope I have contributed to the second one.

[65] Another recent paper focusing on sources side impacts is Fullerton & Heutel, *supra* note 48.