2012

Does the Indexing of Government Transfers Make Carbon Pricing Progressive?

Don Fullerton, *University of Illinois at Urbana-Champaign*
Garth Heutel, *University of North Carolina at Greensboro*
Gilbert E. Metcalf, *Tufts University*

Climate Change Policy Design
(Wallace Tyner, Purdue University, Organizer)

Does the Indexing of Government Transfers Make Carbon Pricing Progressive?

Don Fullerton, Garth Heutel, and Gilbert E. Metcalf

Whether in the form of a carbon tax or cap-and-trade permit system, climate policy is likely to raise the price of all energy-intensive goods such as electricity, heating fuel, and gasoline. The fraction of income used on these goods falls with income, measured either by annual income or by total annual expenditure (as a proxy for permanent income). Thus, climate policy is found to be regressive on the "uses side" (e.g. Burtraw, Sweeney, and Walls 2009, and Hasset et al. 2009). For these reasons, the economics literature and actual legislation have focused on whether permit revenue can be used to offset regressive burdens.

In contrast, Rausch et al. (2010) use a computable general equilibrium model of the U.S. to find that carbon pricing is modestly progressive, even ignoring the use of the proceeds from a carbon tax or auctioned permits. One factor driving this surprising result is the progressivity of impacts on the "sources side". Carbon pricing drives down returns to capital and to resource owners (both relative to the wage). Those returns are a large share of income sources for high income households. A second factor is their treatment of transfers. Rausch et al. (2010) hold real transfer payments constant as an element of their decision to hold government spending constant (and thereby isolate the effects of carbon pricing itself). Because transfer payments disproportionately accrue to low income households, the impact is progressive. This approach is justified in part based on the logic put forward by Browning and Johnson (1979) that government transfer policy is implicitly if not explicitly indexed. Some U.S. transfer programs such as Social Security are explicitly indexed to inflation, which means that higher energy prices would automatically lead to cost-of-living adjustments for recipients.

This paper explores that assumption and the actual extent of indexing. We analyze both the uses side and the sources side incidence of domestic climate policy using an analytical general equilibrium model, taking into account the degree of government program indexing. In particular we consider three scenarios: no indexing, 100 percent indexing, and partial indexing based on our analysis of actual transfer programs.

Using the model of Fullerton and Heutel (2010), we quantify the burdens of carbon pricing. The model is calibrated to the U.S. economy using expenditure and income data from the 2008 Consumer Expenditure Survey (CEX) and capital income data from the 2007 Survey of Consumer Finances (SCF). We then analyze the distributional effects of carbon policy in two ways. First, we categorize households by annual income. This procedure aggregates some with temporarily low income together with others who are perennially poor. Second, to employ a proxy for permanent or lifetime income, we categorize households by annual

---

Don Fullerton (dfullert@illinois.edu) is Gutgsell Professor in the Finance Department and Institute of Government and Public Affairs at the University of Illinois at Urbana-Champaign and a Research Associate at NBER, Garth Heutel (gaheutel@uncg.edu) is Assistant Professor in the Economics Department at the University of North Carolina at Greensboro, Gilbert E. Metcalf (gmetcalf@tufts.edu) is Professor in the Economics Department at Tufts University and a Research Associate at NBER. We thank David Hennessy, Dan Karney, and Wallace Tyner. Any views expressed are those of the authors and not those of the National Bureau of Economic Research.

This article was presented in an invited paper session at the 2011 ASSA annual meeting in Denver, CO. The articles in these sessions are not subjected to the journal's standard refereeing process.

Amer. J. Agr. Econ. 94(2): 347–353; doi: 10.1093/ajae/aar096
Published on October 21, 2011

expenditures. See Fullerton and Metcalf (2002) for a survey of literature on tax incidence.

When families are categorized by annual income, we find that the uses-side incidence of a carbon tax is regressive. The burden on the sources side is U-shaped, with the largest burdens on the lowest and highest income groups. In addition, either partial or full indexing of transfers is progressive. Thus, an analysis that ignores current indexing rules will overestimate the regressivity of carbon pricing.

Indexing has a more striking impact when households are ranked by annual expenditures. Regressivity on the uses side is offset by progressivity in transfer program indexing; the overall burden is progressive over the bottom half of the distribution and regressive across the top half. The choice of income measurement (annual v. lifetime) has a major impact on the measured progressivity or regressivity of carbon pricing.

Analytic General Equilibrium Model

We use the model of Fullerton and Heutel (2010), a two-sector closed economy analytical general equilibrium model in the tradition of Harberger (1962). Two fixed factors are mobile between sectors and fully employed, with full information, certainty, perfect competition, and constant returns to scale. A "clean" sector, X, uses only capital K_X and labor L_X, while a dirty sector, Y, uses both capital and labor (K_Y and L_Y) and a third input, pollution (Z). The model is then linearized by differentiating production and utility functions, budget constraints, zero profit conditions, and resource constraints. For a small change in the pollution tax, the N linear equations can then be solved for the N unknown changes in each quantity and price. Fullerton and Heutel (2010) discuss the analytical results, and then calibrate the model to the U.S. economy, where the dirty sector includes electricity generation, transportation, and petroleum refining. Like Harberger (1962), we ensure that tax revenue reallocation has no impact on relative prices by assuming that pollution tax revenue is spent on the two goods in the same proportions as in consumer spending. We refer the interested reader to that previous paper for model, data, and sensitivity analysis. Using their primary set of parameters, for an increase in the tax on carbon dioxide from \$15/ton to \$30/ton, the price of the dirty good rises 7%, the wage rises 0.07%, and the return to capital falls by 0.12%.[1] In order to translate those price changes into effects on real people, they look at thousands of households' expenditure and income data from the 2008 Consumer Expenditure Survey (CEX) and 2007 Survey of Consumer Finances (SCF). Their results for the effects of a carbon tax on output prices and factor prices appear in our tables below. The purpose of the current paper is to add consideration of indexed transfers.

Table 1 summarizes the breakdown of income and expenditures by annual income decile. Columns 2 through 4 show the percent of each group's income from wages, capital, and transfer income such as public assistance and social security. We omit the category "other income," which accounts for less than 1% of total income. Although fractions vary by income group, about 69% of overall consumer income is from wages, 25% from capital, and 6% from transfers. Notice that the fraction of income from transfers falls as income rises (except that the lowest income decile has a slightly lower fraction than the next decile). The fraction of income from capital rises with income (but for the same exception). Then column 5 shows the percent of transfers that are indexed, as explained in the next section. On average, over 90 percent of transfer income is indexed in the U.S. The share of transfers that are indexed is lowest for the lowest income decile and highest for the highest income decile.

In the last two columns, we show each group's expenditures on the clean and dirty outputs.[2] Each entry shows the ratio of expenditure over annual income, not over total expenditures, so these two values in each row do not add to 100%. The poorest households

[1] The return to capital falls because the dirty sector is capital-intensive, not because capital and pollution are complementary inputs. In our parameters, capital is a better substitute for pollution than is labor. In sensitivity cases, the return falls by more if labor is a better substitute for pollution, and it rises if capital is a better substitute for pollution. Burdens on the sources side are always smaller and more sensitive to parameter values than those on the uses side.

[2] In the CEX, the overall ratio of expenditure to annual income is 78.7%, but our addition of imputed capital income from the SCF then reduces it to 65.3% (shown in the top row of table 1). This figure is lower than the 85% figure in table 2.1 (http://www.bea.gov/national/nipaweb/SelectTable.asp?Selected=Y) of the National Income and Product Accounts (NIPA). We could scale all household expenditures upward so that their sum is 85% of income as in the NIPA accounts, but we want to avoid unnecessary manipulation of the data. In any case, a proportional scaling would not change our relative burden results.

Table 1. Sources and Uses of Income for each Annual Income Group

(1) Annual Income Decile	(2) % of Income from Wages	(3) % of Income from Capital	(4) % of Income from Transfers	(5) % of Transfer Income Indexed	(6) Dirty Good Expenditure as % of Income	(7) Clean Good Expenditure as % of Income
All	69.1	24.6	6.3	94.7	6.6	58.7
1	35.8	5.7	58.5	87.2	47.4	361.0
2	33.9	4.1	62.1	95.2	20.3	141.9
3	55.1	6.5	38.4	96.1	16.7	116.5
4	68.1	7.4	24.5	95.9	13.5	97.3
5	79.9	7.8	12.2	95.2	11.1	84.0
6	83.4	8.8	7.8	94.5	9.6	74.8
7	86.6	9.1	4.3	93.6	8.3	68.0
8	86.8	10.6	2.6	91.6	7.2	62.9
9	84.9	13.2	1.9	94.8	5.9	58.1
10	53.5	45.6	0.9	96.9	2.5	32.6

spend more than their income, while the richest spend less than their income.

To map output price changes into consumer price changes, we label consumer goods as clean or dirty. Four types of expenditures out of 74 are categorized as dirty because they directly involve the combustion of fossil fuels: electricity, natural gas, fuel oil and other fuels, and gasoline. This choice is consistent with a more complete analysis of the pass-through of the costs of intermediate goods: for a CO_2 tax of $15 per metric ton, Hassett, Mathur, and Metcalf (2009) find that the prices of these four goods increase by 8-13%, while the prices of all other categories of goods rise less than 1%.[3]

Overall, in table 1, we see that 6.6% of income is spent on these dirty goods, and about nine times as much is spent on clean goods. The expenditures pattern for these annual income groups is smoother than their pattern for income sources. Lower income households spend a higher fraction of their total income on dirty goods than do higher income households.

Table 2 presents the same information, but where households are classified by annual expenditure as a proxy for lifetime income. Income from wages now constitutes over 100 percent of expenditures, reflecting the fact that the households in our dataset save roughly one-third of income. The share of income from capital rises monotonically across expenditure groups, while the transfer share falls monotonically. This pattern will be relevant below, when we consider the progressivity of carbon pricing.

The Treatment of Indexing in our Model

In this paper, we provide results for three different treatments of government transfers' indexing to the price level. First, we show distributional effects of carbon pricing that ignore indexing entirely. These results c an be compared to previous papers in this literature that also ignore the indexing of transfers. Second, we show results for 100% indexing of all transfers, as in Rausch et al. (2010).[4] Third, we show results based on a calculation of the actual indexing of U.S. government cash transfers.

Table 3 shows the six categories for cash transfers in the CEX data, along with the mean amount for each category (the average annual receipts per household in the survey). The first category is unemployment compensation (UC). Because UC benefits do not extend more than a year, they are not indexed to inflation. Thus, we assume that an increase in energy prices would not raise the amount of these transfers.

The second category includes a broad set of public assistance and welfare programs, best exemplified by Temporary Assistance for Needy Families (TANF). In the U.S., each state administers its own welfare programs, so

[3] Air transportation prices increases by 1.86%, but rather than list spending on that item separately, the CEX lumps air transport with public transportation.

[4] This treatment might also be preferred for reasons discussed in Browning (1985). He argues that the theory of tax incidence is based on the presumption that only relative prices matter, not the overall price level, and that any treatment of transfers other than 100% indexing would violate that principle.

Table 2. Sources and Uses of Income for each Annual Expenditure Group

(1) Annual Expenditure Decile	(2) Wage Income as % of Expenditure	(3) Capital Income as % of Expenditure	(4) Transfer Income as % of Expenditure	(5) % of Transfer Income Indexed	(6) % of Expenditures on Dirty Good	(7) % of Expenditures on Clean Good
All	105.8	37.6	9.7	94.7	10.1	89.9
1	42.8	13.5	63.5	93.6	14.5	85.5
2	74.5	13.8	36.6	95.2	15.2	84.8
3	86.3	16.2	26.8	94.5	14.6	85.4
4	103.5	18.0	17.7	94.6	13.9	86.1
5	108.8	20.4	13.8	94.9	13.2	86.8
6	114.4	29.4	10.0	94.1	12.3	87.7
7	118.8	31.2	7.3	94.5	11.5	88.5
8	120.0	38.4	5.7	94.6	10.8	89.2
9	124.6	45.1	3.9	95.3	9.3	90.7
10	93.4	54.7	2.4	96.9	5.9	94.1

Table 3. Six Categories of Cash Transfers, and their Treatment in our Model

	Category	Symbol	Mean[a]	Treatment in the model
1	unemployment compensation	UC	114.5	Not indexed
2	income from public assistance or welfare, including money received from job training grants such as Job Corps	TANF[b]	30.1	Not indexed
3	value of all food stamps and electronic benefits received	SNAP[c]	100.6	Not indexed
4	amount of Social Security and Railroad Retirement income, prior to deductions for medical insurance and Medicare	SSA	4047.3	100% indexed
5	Supplementary Security Income	SSI	230.7	100% indexed
6	income from workers' compensation or veterans' benefits, including education benefits, excluding military retirement	WC&VB	100.4	100% indexed

[a] "Mean" is the annual dollar transfer, averaged over all households in the sample.
[b] TANF stands for Temporary Assistance for Needy Families, the major welfare program.
[c] SNAP stands for Supplemental Nutrition Assistance Program (food stamps).

indexing is decided by each state. For the states we have studied, welfare benefits are intended to be temporary and therefore not officially indexed to inflation. Of course, a state might periodically decide to raise the benefit level, and may do so because inflation has reduced the real value of those benefits, but these programs typically are not explicitly indexed.

The third category is "food stamps," officially known as the Supplemental Nutrition Assistance Program (SNAP). The U.S. Department of Agriculture (USDA) maintains the real purchasing power of the program by calculating the cost of a "thrifty food plan" to set benefits each year. SNAP is essentially indexed to a food price index. In our model, however, food is a component of the "clean good" (because the food industry's use of energy is small and indirect). No change in the price of food means no increase in food stamp benefits. Thus, SNAP is not indexed to energy prices.

The fourth category of transfers is by far the largest, including all payouts from the Social Security Administration (SSA) and Railroad Retirement programs. The fifth category is Supplemental Security Income (SSI), and the sixth category of transfers includes both workers' compensation (WC) and veterans benefits (VB). The statutes treat all of these programs similarly in terms of indexing. SSA and SSI payments are adjusted each year by the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W). This index uses the CEX weights for different goods purchased by urban workers, representing 32% of the U.S. population. It is thus a broad based index, best approximated in our model by an index of all consumption of all households.

Numerical Results

We consider the effects of doubling the CO_2 tax from \$15 to \$30 per ton. The incidence results for our annual income classification of households are presented in table 4. As in Fullerton and Heutel (2010), we normalize the calculated uses side burden for each group by subtracting from it a uses side calculation for the entire sample (because the choice of numeraire is arbitrary). A positive value means that group's ratio of expenditures to income increases more than average, while a negative value means it increases less than average. The calculation is analogous for factor price changes and transfers. This procedure ensures that our results are not affected by the choice of numeraire. We change the sign on the sources side, however, so that groups with income falling more than average have a positive "burden", while groups with income falling less than average have a negative burden. Finally, to calculate each group's normalized overall burden, we sum effects of output prices, factor prices, and transfers.

In the first column, the pattern of uses-side burdens clearly shows that the highest income groups (deciles 9 and 10) suffer a smaller than average relative burden. The cost of goods decreases for them relative to the average, because they spend less than average on the dirty good. Since the clean good is our numeraire, the average increase in overall price is about 0.48% (a 7.2% jump in the price of a good that constitutes 6.6% of annual income). Thus, table 4 says that the highest income group's price increase under this normalization is only about 0.18%, whereas the lowest income group faces an overall price increase of about 3.4%. Our results here are consistent with Hassett, Mathur, and Metcalf (2009), who study the uses-side incidence of a CO_2 tax and find that the burden falls across income deciles monotonically. For a cap-and-trade policy, Burtraw, Sweeney, and Walls (2009) find the same kind of regressivity on the uses side.

In the second column of table 4, the sources-side burden is most on the highest and lowest income deciles. The positive burdens for the lowest deciles indicate that their incomes fall proportionally more than average. Columns (4) through (7) show how these basic uses and sources side impacts are affected by indexing. Columns (4) and (6) indicate that indexing of transfers adds progressivity to carbon pricing. The difference in the two columns is small, because explicit indexing applies to a large share of U.S. transfers. Analyses that ignore transfer program indexing will overestimate the regressivity of carbon pricing. Using annual income, however, we do not find that the effect of indexing is sufficient to overcome the regressive effects on the uses side. It remains to be determined why these results differ from those of Rausch et al. (2010).

Table 4. Incidence for Annual Income Deciles (%)

			Partial Indexing		Full Indexing	
(1) Annual Income Decile	(2) Relative Burden from Output Prices	(3) Relative Burden from Factor Prices	(4) Relative Burden from Transfers	(5) Relative Overall Burden	(6) Relative Burden from Transfers	(7) Relative Overall Burden
1	2.936	0.001	−0.214	2.723	−0.249	2.689
2	0.986	0.001	−0.253	0.733	−0.266	0.720
3	0.724	−0.012	−0.148	0.565	−0.153	0.560
4	0.496	−0.020	−0.083	0.393	−0.086	0.389
5	0.323	−0.028	−0.027	0.268	−0.028	0.267
6	0.216	−0.029	−0.006	0.180	−0.007	0.180
7	0.123	−0.031	0.009	0.101	0.010	0.101
8	0.045	−0.029	0.017	0.032	0.018	0.033
9	−0.051	−0.025	0.020	−0.056	0.021	−0.054
10	−0.297	0.036	0.024	−0.236	0.026	−0.235

Table 5. Incidence for Annual Expenditure Deciles (%)

			Partial Indexing		Full Indexing	
(1) Annual Expenditure Decile	(2) Relative Burden from Output Prices	(3) Relative Burden from Factor Prices	(4) Relative Burden from Transfers	(5) Relative Overall Burden	(6) Relative Burden from Transfers	(7) Relative Overall Burden
1	0.316	0.016	−0.367	−0.034	−0.393	−0.060
2	0.366	−0.006	−0.187	0.173	−0.196	0.164
3	0.319	−0.012	−0.118	0.189	−0.125	0.182
4	0.273	−0.022	−0.055	0.196	−0.058	0.193
5	0.218	−0.023	−0.029	0.166	−0.030	0.165
6	0.157	−0.016	−0.002	0.139	−0.003	0.139
7	0.099	−0.017	0.017	0.098	0.018	0.099
8	0.046	−0.009	0.028	0.064	0.029	0.065
9	−0.063	−0.005	0.040	−0.028	0.042	−0.025
10	−0.303	0.029	0.050	−0.223	0.053	−0.220

Table 5 presents results for the analysis where we classify households by annual expenditures as a proxy for lifetime income. The uses side burden is significantly less regressive than in table 4. The sources side burden from factor price changes is initially regressive but then progressive over the top 60 percent of the distribution. The effect of indexed transfers continues to be sharply progressive under either partial or full indexing. Now, however, the overall burden from carbon pricing is mixed, with progressivity over the bottom half of the distribution combined with regressivity over the top half.

In other words, we find that the automatic indexing of government transfers in existing statutes converts the net loss from carbon pricing into a net gain for the poorest group (categorized by total expenditure, as a proxy for permanent income). A major caveat, however, is that a third of these households receive no transfer income and thus clearly lose from climate policy. For either type of indexing, about 40% of this poorest group have an overall relative burden that is almost 0.8% of income (higher than the economy-wide average), while the rest have a relative gain that is 0.7% of income (less burden than the economy-wide average). Thus, automatic indexing of transfers does not protect all of the poorest families in our sample.

Conclusion

In this paper, we use a general equilibrium model of tax incidence to examine the burden of carbon pricing. We find generally that changes on the uses-side are relatively more burdensome for low income households who spend more than average on dirty goods such as electricity, natural gas, gasoline, and heating oil. Because carbon-intensive industries tend to be relatively capital-intensive, we find that the sources-side is relatively more burdensome for those who have a more than average share of income from capital. Thus, the burden is U-shaped when households are categorized by annual income, given the capital/labor income ratios in our data from the CEX and SCF. Transfer policy adds progressivity, but not enough to overcome the regressive uses-side effects.

Categorizing households by annual expenditures tells a different story. Now the uses side impacts are less dominant, so the overall burden of carbon pricing is progressive across the bottom half of the distribution and regressive across the top half. Impacts from factor price changes are hump-shaped, with the greatest relative losses at the top and bottom of the distribution. The indexing of transfers confers significant progressivity to the system. The choice of income measurement (annual v. lifetime) has a major impact on the measured progressivity or regressivity of carbon pricing. Hassett, Mathur, and Metcalf (2009) provide a discussion of this point.

The model could be improved by a number of extensions, such as adding more sectors, more final goods, intermediate goods, or market power and regulation. Electric utilities are large emitters of CO_2 and are often highly regulated, so the effect of market power or industry regulation may be of particular relevance to a carbon tax.

References

Browning, E. 1985. "Tax Incidence, Indirect Taxes, and Transfers." *National Tax Journal* 38(4): 525–533.

Browning, E., and W. Johnson. 1979. *The Distribution of the Tax Burden*. Washington, DC: American Enterprise Institute.

Burtraw, D., R. Sweeney, and M. Walls. 2009. "The Incidence of U.S. Climate Policy: Alternative Uses of Revenues from a Cap-and-Trade Auction." *National Tax Journal* 62(3): 497–518.

Fullerton, D., and G. Heutel. 2010. "Analytical General Equilibrium Effects of Energy Policy on Output and Factor Prices." *The B.E. Journal of Economic Analysis & Policy* 10(2), Symposium.

Fullerton, D., and G. Metcalf. 2002. "Tax Incidence." In A. Auerbach and M. Feldstein, eds., *Handbook of Public Economics, Volume 4*, Amsterdam: Elsevier.

Harberger, A. 1962. "The Incidence of the Corporation Income Tax." *Journal of Political Economy* 70(3): 215–240.

Hassett, K., A. Mathur, and G. Metcalf. 2009. "The Incidence of a U.S. Carbon Tax: A Lifetime and Regional Analysis." *Energy Journal* 30(2): 155–177.

Rausch, S., G. Metcalf, J. Reilly, and S. Paltsev. 2010. "Distributional Implications of Alternative U.S. Greenhouse Gas Control Measures." *The B.E. Journal of Economic Analysis & Policy* 10(2), Symposium.