Is a Carbon-Dividend an Efficient Transfer?
The Labor Supply Effects of a Cap-and-Dividend

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A Policy Memo

I. Introduction

Any policy able to significantly curb carbon dioxide (CO_2) emissions – the most impacting anthropogenic greenhouse gas – must reduce CO_2 consumption. This may be achieved through limiting the supply of CO_2 or by taxing CO_2. Either mechanism will raise the cost of goods and services associated with carbon emissions – a ubiquitous array of products from steel to everyday groceries. Since low-income earners dedicate a higher share of their income towards consumption, raising the cost of carbon may be regressive. The most popular policy proposals aimed at lowering CO_2 emissions (i.e. cap-and-trade and a revenue-neutral carbon tax) accept these regressive outcomes. However, a cap-and-dividend system offers a way of internalizing the cost of CO_2 and lowering emissions, while preventing regressive outcomes.[1]

Under a cap-and-dividend, the primary entry points of carbon into the economy (e.g. oil extractors and factories) would be required to purchase carbon permits. Revenue from the sale of carbon permits would be recycled back to consumers as a direct cash transfer. Boyce and Riddle (2007) estimate that a cap-and-dividend proposal limiting US emissions to 7% below 2007 levels would effectively impose a tax of $225 on each metric ton of carbon, generating $223 billion in revenue in the program's first year and a $763 dividend for each US resident.[2] Absent dynamic effects, Boyce and Riddle estimate the lowest six expenditure deciles would see a net benefit, while those at the top of the distribution would see a net loss (see Table 2).

Beyond offering a way to ameliorate the regressive impacts of capping carbon, a carbon-dividend holds promise as an efficient income transfer program – a facet of this program that has often been overlooked. With few exceptions, American transfer programs impose implicit taxes

[1] A tax-and-dividend program would be able to achieve comparable, if not identical results. For reason of brevity, I solely focus on a cap-and-dividend system.
[2] All dollar figures are in 2007 USD.

on recipients' earnings, disincentivizing labor supply. The higher the marginal tax on transfer recipients' earnings, the greater the incentive to substitute leisure for work (i.e. substitution effect). In contrast, a carbon-dividend would be void of implicit marginal taxes on earnings. A cap-and-dividend program would only change labor supply through income effects (e.g. a drop in income will push folks to work more, while a hike in income will incentivize less work), which are standardly estimated to have a smaller magnitude than substitution effects (see McClelland and Mok, 2012)

To illuminate the efficacy of a cap-and-dividend as a transfer program, I simulate the labor supply effects of the program proposed by Boyce and Riddle. I triangulate data on non-retired/non-disabled working-age US residents from the 2008 CPS March Supplement and Boyce and Riddle's estimates on the distributional impacts of a cap-and-dividend program with a labor supply model I adapt from Immervoll, Kleven, Kreiner, and Saez (2007).

II. Methodology

Firstly, I estimate the effect of a change in income on working hours for those employed with the following equation for each individual, i,

$$1)\quad \partial l_i = \frac{\partial Y_i}{Y_i} \times \rho_i \times l_i$$

where change in total income, $\partial Y_i,$ is derived from Boyce and Riddle's estimates; reported net of tax total income, Y_i, and annual hours worked, l_i, are based on the 2008 CPS; and the elasticities of labor supply with respect to total income, ρ_i, are based on elasticities the Congressional Budget Office commonly uses (see Table 2). By multiplying each individual's change in hours worked by that individual's wage-rate, I find one's change in earnings (see Table 3).

To simulate employment effects, I assign each observation to a group based on characteristics relevant to employment (e.g. education, family size, etc.), and then estimate the following equation for each group, j,

$$2)\quad \eta \times \frac{Emply_j}{C_j - C_o} = \frac{\partial Emply_j}{\partial (C_j - C_o)}$$

where η is the assumed elasticity of employment (see Table 2); $Emply_j$ is the predicted probability that an individual in each group is employed; $C_j - C_o$ is the net benefit from employment (i.e. net income when employed minus the net income that individual would receive if not employed); and $\frac{\partial Emply_j}{\partial (C_j - C_o)}$ tells us the percentage point change in employment for group *j*.

Since some members of each group may not be employed, to find $C_j - C_o$ I find the average earnings of those employed in each group to impute what the non-employed would earn if they were employed. To find one's expected earnings, C_j, I run a model restricted to those employed of the following form,

$$3)\quad C_j = \beta_K X_{ki} + u_i$$

where β_K is the vector of variables related to employment used to construct each group, j. I treat the fitted values of this regression as the group members' net income if they were employed.

Similarly, I estimate the average transfer income of those not employed if they were employed by running an analogous model to equation 3, except the dependent variable is net transfer income when not employed, C_o, and the observations are restricted to those not employed. Lastly, I run a linear probability model of the same form as equation 3 to estimate the employment rate of each group, $Emply_j$.

With this information I solve for $\frac{\partial Emply_j}{\partial(C_j - C_o)}$ from equation 2. I then multiply this term by the predicted change in earned income for each group, $\Delta(C_j - C_o)$, to find the percentage point change in employment for each group.

III. Conclusion

This microsimulation model estimates that the carbon-dividend proposed by Boyce and Riddle would transfer $96.9 billion to the 127 million Americans employed in 2007 – nearly $30 billion greater than the $67.5 billion in combined cash and food stamp payments the employed received in 2007. Under the income and employment elasticities I assume, which are at the high end of any reasonable range of elasticities (see Table 2), this program would at most imply a decrease in average annual hours worked for those employed by 1.2 hours annually (see Table 3) and a decline in fulltime equivalent employment of 28,769 working years (see Table 4). This reduction in hours worked and employment translates into $75.8 million (see Table 3) and $244 million (see Table 4), respectively, in lost national output – 0.4% of the total cost of the dividend and .0023% of 2007 US GDP. These findings clearly suggest that a carbon-dividend can serve as an efficient transfer.

References Cited

Boyce, James K., and Matthew Riddle, "Cap and dividend: how to curb global warming while protecting the incomes of American families" (working paper 150, Political Economy Research Institute, 2007).

Immervoll, Herwig, Henrik Jacobsen Kleven, Claus Thustrup Kreiner, and Emmanuel Saez, "Welfare reform in European countries: a microsimulation analysis," *The Economic Journal* 117.516 (2007): 1-44.

McClelland, Robert, and Shannon Mok. "A review of recent research on labor supply elasticities" (working paper 2012-12, Congressional Budget Office, 2012).

Table 1: Distributional Impact of Cap-and-Dividend, Absent Labor Supply Effects

Expenditure Deciles	Per Capita Incidence			As Percentage of Expenditures		
	Added Cost	Dividend	Net Benefit	Added Cost	Dividend	Net Benefit
1	242	763	521	11.2	35.2	24
2	381	763	384	9.6	19.3	9.7
3	477	763	286	9.0	14.3	5.4
4	579	763	185	8.6	11.3	2.7
5	649	763	115	7.8	9.2	1.4
6	731	763	34	7.3	7.7	0.3
7	824	763	-60	6.8	6.3	-0.5
8	942	763	-178	6.3	5.1	-1.2
9	1153	763	-390	6.0	3.9	-2.0
10	1661	763	-897	4.9	2.3	-2.7

Source: Adapted from Table 7 in Boyce and Riddle (2007)
Notes: Based on a $225 tax on each ton of carbon and 100 recycling of revenue.

Table 2: Assumed Income and Employment Elasticities by Earned Income Quintiles

		Quintiles				
		Lowest fifth	Second fifth	Middle fifth	Fourth fifth	Highest fifth
Income Elasticity	Men & Single Women	-0.10	-0.10	-0.05	-0.01	-0.01
	Married Women	-0.10	-0.10	-0.05	-0.01	-0.01
Employment Elasticity	Men & Single Women	0.10	0.10	0.05	0.01	0.01
	Married Women	0.30	0.30	0.25	0.20	0.20

Sources: Mok and McClelland (2012).

Table 3: Estimated Changes in Annual Hours and Associated Change in Income for Those Employed

Deciles	Mean Earnings	Mean Change in Earnings	Total Change in Earnings	Net Change in Total Income	Pre-Policy Mean Annual Hours Worked	Post-Policy Mean Annual Hours Worked
1	$2,728	-$50	-$1,190,199	$471	976	0
2	$3,468	-$36	-$341,000,000	$348	684	674
3	$9,266	-$25	-$274,000,000	$261	1323	1320
4	$15,782	-$17	-$262,000,000	$168	1736	1734
5	$22,125	-$5	-$74,300,000	$110	1920	1920
6	$28,714	-$2	-$24,700,000	$32	2021	2021
7	$36,752	$1	$8,969,548	-$59	2112	2112
8	$46,799	$2	$26,000,000	-$176	2167	2167
9	$62,252	$4	$56,900,000	-$386	2235	2236
10	$125,899	$8	$127,000,000	-$889	2375	2376
Total	$35,378	-$12	-$75,832,065	-$12	1914	1912.8

Source: Author's Analysis of the 2008 CPS March Supplement

Table 4: Change in Full-Time Equivalent Employment & Earnings

	Employment		Earnings	
Deciles	Percentage Point Change	Total Change	Mean Change	Total Change
1	-0.00051	-9,067	$0.00	-$7,504
2	-0.00041	-6,904	-$1.46	-$24,800,000
3	-0.00031	-5,377	-$2.41	-$41,200,000
4	-0.00022	-4,203	-$4.25	-$79,800,000
5	-0.00009	-1,394	-$2.04	-$31,500,000
6	-0.00008	-1,347	-$2.46	-$41,500,000
7	-0.00001	-223	-$0.48	-$8,217,694
8	0.00002	302	$0.97	$16,100,000
9	-0.00001	-149	-$0.50	-$8,301,941
10	-0.00002	-409	-$1.47	-$24,500,000
Total	-0.00017	-28,769	-$1.43	-$244,000,000

Source: Author's Analysis of the 2008 CPS March Supplement