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The Macroeconomic Effect of a Carbon Dividends Plan

Introduction

Rising global temperatures caused by increasing greenhouse gas pollution pose substantial risks to the global economy. Global temperatures have risen by just over 1 degree Celsius since the industrial revolution that began in the late 1800s, and the economic consequences are mounting. Increasingly, serious weather events such as hurricanes, droughts, floods, wildfires, and sea level rise that are tied to climate change are doing serious damage, creating new health risks, and weighing on worker productivity. The fast-changing global climate is also resulting in significant costs as the global economy is forced to adjust. The agriculture, tourism, energy and transportation industries are being disrupted, and populations are already moving from climate change-impacted areas.

Climate Bonus: Macroeconomics of a Carbon Dividends Plan

BY MARK ZANDI AND CHRIS LAFAKIS

Rising global temperatures caused by increasing greenhouse gas pollution pose substantial risks to the global economy. Global temperatures have risen by just over 1 degree Celsius since the industrial revolution that began in the late 1800s, and the economic consequences are mounting. Increasingly serious weather events from hurricanes, droughts, flooding, wildfires and sea level rise that are tied to climate change are doing serious damage, creating new health risks and weighing on worker productivity. The fast-changing global climate is also resulting in significant costs as the global economy is forced to adjust. The agriculture, tourism, energy and transportation industries are being disrupted, and populations are already moving from climate change impacted areas.

Carbon Dividends Plan

Global policymakers are under increasing political pressure to act to address temperature rise and its economic fallout. The most economically efficacious policy approach to address climate change is a carbon tax—a tax on carbon emissions. The economic logic of a carbon fee is straightforward, since it would require carbon emitters to bear more of the cost of their emissions. However, the political opposition to a carbon fee is fierce, in significant part because the fee would be regressive, hurting lower income populations significantly more than those with higher incomes.

To address this concern, the Climate Leadership Council has proposed a Carbon Dividends Plan. The plan assesses a carbon fee paid by businesses, with rebates for fossil fuel exporters and a border adjustment fee for fossil fuel importers. Government revenues generated by the carbon fee are used to finance a non-taxable per-household dividend payment. The payment would be the same for all households, so that lower income households would receive more as a percent of their total income than higher income households.

Methodology

The CLC commissioned Moody's Analytics to evaluate the macroeconomic impacts of its carbon fee dividend proposal. To this end, Moody's Analytics uses its large-scale structural econometric model of the U.S. and more than 100 other countries. Our global model has been enhanced to estimate the impact of climate change on country economies under different trajectories for greenhouse gas emissions. These enhancements include adding equations for U.S. carbon emissions for oil, natural gas, coal and nonfuel sources (see the Appendix for a complete description of these enhancements).

The CLC is focused on the near-term demand-side economic impacts of its plan, which the model is designed to capture. But, the model is also used to assess the longer-term supply-side impacts on the global economy. Results on the economic impact of the plan are available for the U.S. and more than 100 other countries over a 30-year horizon to 2050.

The global model captures the multiple channels through which CLC's carbon fee will impact the macroeconomy. Most directly, the analysis accounts for the impact of the carbon fee on carbon emissions by fuel type, government revenues, energy prices, corporate profits, and real personal incomes. This analysis depends on numerous factors, including most notably the price elasticity of energy demand and the pass-through of energy costs to profits and to producer and consumer prices. The global model also captures the simultaneous effects of the resulting changes to energy prices, corporate profits and real incomes on the rest of the economy.

Our analysis also captures the effects of the carbon dividend received by households, which will reduce the effective tax rate of U.S. households and boost consumer spending. The extent to which consumption of energy-intensive durable goods is pulled forward by the energy efficiency incentive created by the Carbon Dividend Plan is also considered. To do this we look toward recent incentive programs, such as the energy efficiency initiatives included in the 2009 American Recovery and Reinvestment Act and the 2009 cash for clunkers program. Certain regulations that would be eliminated

Table 1: Carbon Tax Dividends' Impact on CO2 Emissions

	2020	2021	2022	2023	2024	2025	2030	2049
Carbon tax ($ per ton of CO2)	0	43.62	46.82	50.25	53.95	57.88	82.53	312.43
Carbon tax revenue ($ bil)	0	159.07	216.48	223.93	232.63	242.33	315.66	999.81
Total emissions (mil metric tons)								
Baseline	5,254.2	5,231.0	5,223.4	5,209.2	5,207.4	5,201.8	5,186.6	5,367.9
Scenario	5,254.2	4,846.9	4,624.6	4,457.4	4,312.8	4,187.6	3,825.4	3,200.2
% difference	-0.0%	-7.3%	-11.5%	-14.4%	-17.2%	-19.5%	-26.2%	-40.4%
Coal emissions (mil metric tons)								
Baseline	1,129.1	1,091.8	1,072.7	1,065.8	1,077.5	1,071.8	1,068.9	986.6
Scenario	1,129.1	901.1	803.4	734.9	680.1	617.4	376.1	24.3
% difference	-0.0%	-17.5%	-25.1%	-31.0%	-36.9%	-42.4%	-64.8%	-97.5%
Oil emissions (mil metric tons)								
Baseline	2,318.2	2,320.2	2,313.2	2,297.2	2,280.0	2,262.3	2,206.4	2,271.4
Scenario	2,318.2	2,302.8	2,261.0	2,232.8	2,203.8	2,176.5	2,099.4	2,030.4
% difference	-0.0%	-0.8%	-2.3%	-2.8%	-3.3%	-3.8%	-4.8%	-10.6%
Natural gas emissions (mil metric tons)								
Baseline	1,654.2	1,665.2	1,681.3	1,688.7	1,690.5	1,706.6	1,740.5	1,902.8
Scenario	1,654.2	1,491.8	1,414.3	1,343.0	1,281.2	1,244.9	1,194.0	970.8
% difference	-0.0%	-10.4%	-15.9%	-20.5%	-24.2%	-27.1%	-31.4%	-49.0%
Nonfuel emissions (mil metric tons)								
Baseline	152.7	153.8	156.2	157.6	159.4	161.1	170.8	207.2
Scenario	152.7	151.2	146.0	146.7	147.6	148.8	155.8	174.7
% difference	-0.0%	-1.7%	-6.5%	-6.9%	-7.4%	-7.7%	-8.8%	-15.7%

Sources: EIA, EPA, Moody's Analytics

as part of the CLC's proposal do mitigate future risk but do not directly impact the modeling results.

Macroeconomic impact

The Carbon Dividends Plan is assumed to be implemented in the U.S. beginning in 2021. This involves a fee on carbon emissions of $40 per metric ton and quarterly dividend payments to households financed with the revenues from the fee. In 2021, total carbon emissions by fossil-fuel producers are reduced by more than 7% (see Table 1). The fee generates $160 billion in fee revenue, which are used to pay a $975 dividend to the typical American household, equal to almost 2% of their annual income. We withhold approximately 22% of the revenues collected to help the federal government finance new expenses and offset the hit to other federal revenue. This federal burden is on par with other literature. For households in the bottom quartile of the income distribution, the dividend amounts to approximately 5% of their income.

By 2025, the Carbon Dividends Plan reduces carbon emissions by almost 20%, and by well over 40% by 2050. Carbon emissions by oil and natural gas producers fall modestly over the next 30 years, which is significant given the much larger economy and increased energy needs, but emissions by coal producers effectively go to zero as the industry largely shuts down (see Chart 1). Coal becomes an uneconomic source of energy due to its high carbon content.

The Carbon Dividends Plan has a small negative near-term impact on the U.S. macroeconomy. Real GDP increases by 15 basis points in 2021, as the initial dividend payment precedes the imposition of the carbon fee, which takes some time to pass through to consumer and producer prices. But by 2022, the net impact of the plan is negative and remains so, although in the longer-term the plan has little impact on the economy (see Table 2). The economy ultimately adjusts to the higher cost of carbon with few ill-effects.

The plan impacts the economy through several countervailing channels captured in this analysis. The carbon fee negatively impacts the economy by raising consumer and producer prices as businesses paying the fee pass much of it on to their customers. All else being equal, this reduces the real incomes of households and thus their purchasing power. Any part of the carbon fee that businesses are unable to pass along to customers, given competitive pressures, reduces their after-fee profitability and thus investment and hiring. Government also pays more for energy, particularly for defense, and there are some modest administrative costs associated with implementing the plan.

Table 2: Economic Impact of Carbon Tax Dividends

	2020	2021	2022	2023	2024	2025	2030	2049
Real GDP (2012$ bil)								
Baseline	19,396.0	19,778.1	20,373.6	20,815.0	21,258.9	21,660.4	23,900.0	34,408.4
Scenario	19,396.0	19,808.4	20,272.8	20,730.4	21,144.2	21,566.2	23,847.2	34,326.5
% difference	-0.0%	0.2%	-0.5%	-0.4%	-0.5%	-0.4%	-0.2%	-0.2%
Employment (mil)								
Baseline	152.8	152.6	154.0	155.0	155.9	156.7	161.2	178.2
Scenario	152.8	152.8	153.5	154.6	155.2	156.1	160.8	177.4
% difference	-0.0%	0.2%	-0.3%	-0.3%	-0.4%	-0.4%	-0.2%	-0.4%
Unemployment rate (%)								
Baseline	3.6	4.3	4.4	4.5	4.5	4.5	4.2	4.6
Scenario	3.6	4.2	4.6	4.7	4.8	4.7	4.3	4.7
% difference	0.0%	-0.1%	0.2%	0.2%	0.3%	0.2%	0.1%	0.1%
Real disposable income (2012$)								
Baseline	15,252.9	15,468.1	15,884.5	16,238.6	16,546.5	16,882.0	18,859.0	27,299.0
Scenario	15,252.9	15,559.6	15,837.9	16,171.4	16,458.7	16,798.6	18,766.4	27,005.4
% difference	-0.0%	0.6%	-0.3%	-0.4%	-0.5%	-0.5%	-0.5%	-1.1%
Consumer price index								
Baseline	260.4	266.8	273.1	279.4	285.9	292.5	328.5	502.4
Scenario	260.4	269.3	276.5	283.3	290.1	296.8	334.5	519.8
% difference	0.0%	0.9%	1.3%	1.4%	1.4%	1.5%	1.8%	3.5%
Corporate profits ($ bil)								
Baseline	1,861.7	2,002.2	2,018.4	2,039.2	2,131.5	2,233.4	3,018.1	7,850.1
Scenario	1,861.7	1,862.6	1,803.3	1,798.0	1,877.4	1,973.7	2,722.5	6,985.3
% difference	0.0%	-7.0%	-10.7%	-11.8%	-11.9%	-11.6%	-9.8%	-11.0%
House prices (FHFA index)								
Baseline	459.7	472.9	485.1	499.3	518.4	541.7	667.7	1,118.6
Scenario	459.7	473.7	486.3	500.5	519.5	543.3	677.1	1,141.2
% difference	0.0%	0.2%	0.2%	0.2%	0.2%	0.3%	1.4%	2.0%
S&P 500 Index								
Baseline	2,799.2	2,917.8	3,106.7	3,262.8	3,443.8	3,619.1	4,531.5	10,171.8
Scenario	2,799.2	2,920.2	3,099.2	3,232.6	3,392.6	3,552.7	4,480.1	10,153.8
% difference	0.0%	0.1%	-0.2%	-0.9%	-1.5%	-1.8%	-1.1%	-0.2%
Federal funds rate (%)								
Baseline	1.5	1.6	2.4	2.9	3.0	3.0	2.9	3.2
Scenario	1.5	1.8	2.6	3.0	3.0	3.0	2.9	3.2
% difference	-0.0%	0.2%	0.2%	0.1%	-0.0%	-0.0%	0.0%	0.0%
10-yr Treasury yield (%)								
Baseline	2.4	3.1	3.9	4.0	4.1	4.2	4.4	4.2
Scenario	2.4	3.2	4.1	4.3	4.4	4.5	4.5	4.4
% difference	-0.0%	0.1%	0.2%	0.3%	0.3%	0.2%	0.1%	0.2%
Federal budget deficit ($ bil)								
Baseline	-1,014.4	-1,077.1	-1,117.9	-1,152.7	-1,191.8	-1,241.5	-1,382.3	-1,782.0
Scenario	-1,014.4	-1,111.7	-1,158.7	-1,202.0	-1,263.6	-1,315.9	-1,456.1	-2,098.0
Difference	0.0	-34.6	-40.8	-49.3	-71.7	-74.4	-73.8	-316.0
Federal government debt as a share of GDP (%)								
Baseline	81.2	84.0	85.6	87.9	89.9	91.3	97.9	97.3
Scenario	81.2	83.6	85.5	87.9	90.2	91.8	99.0	101.4
Difference	0.0	-0.3	0.0	0.0	0.3	0.5	1.1	4.1

Sources: BEA, BLS, Census Bureau, FHFA, S&P, Moody's Analytics

Working to offset these negative economic impacts is the dividend payment that households receive, financed by the revenues generated by the carbon fee. All households receive the same dividend amount. But, as a percent of income, the dividend is much larger for lower income households. Since these households are likely to spend more of the dividend than high income households, which have more financial resources, the boost provided by the dividend on consumer spending and the economy is magnified.

The near-term economic benefit of the plan is also increased as households pull forward spending on durable goods and they anticipate that prices will be higher in the future as the carbon fee takes full effect. Specifically, auto sales rise in the two months prior to the carbon dividend's implementation, then they revert to normal over the next year. The magnitude and timing of the projected increase in vehicle sales and the subsequent reduction in vehicle sales was based on the experience of the cash for clunkers program in the aftermath of the 2008 financial crisis. We calculated the net present value of the increase in vehicle operating costs as a result of the carbon tax and compared it to the rebate size provided during the cash for clunker program. But while cash for clunkers greatly enhanced auto sales over a two-month period, it merely pulled forward sales that would have otherwise taken place over the next 10 months. After a year, vehicle sales were what they would have been if the program had not taken place. We make the same assumption.

This analysis does not fully account for how the Carbon Dividends Plan could impact the macroeconomy, although the net impact of this would likely ultimately be a wash. The carbon fee will accelerate the shift away from fossil fuels to renewable energy sources. This will create transition costs that are not capture by the global model. However, the fee will also create greater economic incentives to invest in new technologies that may reduce emissions more quickly than anticipated in this analysis which is based on current technologies.

Regulation

The last component of the CLC's Carbon Dividends Plan is to eliminate federal stationary source carbon regulations that would no longer be needed. Such regulations include the Clean Power Plan, which was cancelled by the Trump administration and never took effect. These regulations are not currently in effect, have no effect on the economy and Moody's Analytics does not expect them to come into effect in its baseline forecast. Because they are not expected to come into effect in our baseline forecast, their elimination does not result in changes to our forecast in the Carbon Dividends Plan scenario. Their removal merely removes the downside risk for businesses that a future administration could use the powers of the federal government to regulate carbon emissions without congressional approval. The removal of federal stationary source carbon regulations is an important part of the CLC's Carbon Dividends Plan, providing businesses with added certainty, even though it does not affect our macroeconomic results.

Technical Appendix

To determine the macroeconomic impacts of the Carbon Dividends Plan, Moody's Analytics made a number of enhancements to its global macroeconomic model. We also made various calculations external to the model that were used to shock it. These enhancements and calculations are described in this technical appendix.

CO_2 Emissions

The most significant enhancement to the global model is the introduction of carbon dioxide emissions by fuel source, including for coal, natural gas and oil. Non-energy CO_2 emissions were also included, with the historical data derived using the Environmental Protection Agency's data on total CO_2 emissions and the Energy Information Administration's data on energy-related CO_2 emissions.

Moody's Analytics modeled emissions as a function of energy demand by source. Each fuel source has a different carbon dioxide emissions coefficient. As such, certain fuels such as coal will be more adversely affected by a carbon fee. Because these CO_2 coefficients are constant, CO_2 emissions by source will grow according to fluctuations in the demand for that source. It was necessary that the energy demand equations by source reflect the decline in demand in fossil fuels in response to the implementation of a carbon fee. The CLC proposal calls for a fee on production and a border adjustment, which ensure that the overall fee paid depends on the quantity of fossil fuels demanded.

Energy Demand

Energy demand by energy source is modeled using two-stage least squares estimation. This ensures that our regression results are not biased by the endogeneity between energy demand and energy price. Work by Stock, et al. indicates that traditional least squares estimates of the price elasticity of energy demand tend to be implausibly low. We used different instrumental variables to instrument for energy prices by energy source. For oil prices, we instrumented using federal and state gas taxes, consistent with Stock. For natural gas prices, we used the levelized cost of energy for new generation resources entering five years in advance. The EIA has reported this time series consistently since 2010. For coal prices, we used the coal levelized cost of energy in addition to the natural gas levelized cost of energy and coal electricity generating plant retirements. We constructed a time series of coal retirements using EIA data that was first introduced in 2002.

The variables used in these regressions differed by fuel source, but the equations had similar specifications. First, the equations account for differences in short-term and long-term price demand elasticities. The elasticities differ because it takes households and businesses time to respond to energy prices by changing their fuel consumption. For example, a spike in gasoline prices might not result in reduced gasoline demand today, but it could lead to the purchase of a more fuel-efficient vehicle in five years. Second, the equations all included utility industrial production. This variable reflects the increase in energy demand that results from rapid and extreme temperature fluctuations, be it increased demand for electricity, natural gas or heating oil. Third, macroeconomic factors such as the unemployment rate, industrial production, and per capita disposable income are used.

Lastly, fuel-specific variables are included in the equations. These include CAFE standards for petroleum demand and the ratio of coal to gas prices for coal demand. Coal demand was especially sensitive to the level of coal price in addition to fluctuations in the coal price. For petroleum product demand, we accounted for the presence of biofuels and biodiesel in motor gasoline and diesel fuel. We chose to forecast seasonally adjusted demand to be consistent with the rest of the macroeconomic model and prevent seasonality from obscuring our estimates of the price elasticities of energy demand. Non-energy CO2 emissions were modeled directly as a function of fossil fuel prices and economic variables.

The shock properties of the equations are important. The price elasticities of energy demand for these fuel sources is consistent with economic literature. The forecasts are also adjusted to be consistent with the EIA's baseline forecasts in its 2019 Annual Energy Outlook. This ensures that deviations from that EIA forecast are due solely to changes in energy prices caused by the carbon tax.

Carbon Fee

Moody's Analytics translated the carbon fee into inputs that could be used to shock the global model. To do this, we used the carbon dioxide emissions coefficients provided by the EIA. The CLC proposal stipulates a fee of $40 per ton of carbon dioxide emitted (in 2017 dollars) which increases annually by 5 percentage points more than inflation. By calculating the tax and applying it to the carbon dioxide content of each unit of fossil fuel, Moody's Analytics calculated the increase in prices by fuel source resulting from the carbon tax. These increases would be used to shock the model to create a scenario consistent with the carbon tax. We made no additional price adjustments for non-energy CO_2 emissions. Non-energy CO_2 emissions include those from petrochemicals, iron and steel production, ammonia production, and lubricant production among others. However, all of these processes consume fossil fuels, and as such their price effect on the broader economy would be captured by the model's dynamic properties and the shock to fossil fuel prices.

Implementation of the Carbon Dividends Plan

Moody's Analytics also made a number of changes to the federal fiscal and consumption equations in its global model to more fully account for the impact of the carbon tax dividend. The carbon tax revenue collected, which was calculated by multiplying emissions times the cost per ton emitted by source, was added to revenue collected by the federal government. The administrative cost of the program was calculated as 6% of the initial total revenue collected, rising at the rate of inflation thereafter. This is consistent with the Urban Institute-Brookings Tax Policy Center's findings.

Since under the Carbon Dividends Plan, the size of the dividend was equal to the carbon tax revenue collected less the administrative cost of the program, the plan does not directly add to the nation's deficits and debt. The carbon dividend was added to after-tax income, to reflect its non-taxable nature. The federal burden, which reflects the increase in the government's costs in response to the tax, were calculated by the model endogenously via its federal government spending deflators. We also added the carbon fee revenue to taxes paid by the corporate sector, since that is where the tax will be collected.

As stipulated in the CLC plan, the carbon fee goes into effect one quarter after the initial carbon dividend. Moreover, we adjust vehicle sales, since the tax will pull them forward, as did the Obama administration's 2009 cash for clunkers program. To do this, we calculated the net present value of the increase in fuel cost as perceived by consumers and compared it to the rebate households received in the cash for clunkers program. The increase in vehicle sales was spread out over two quarters, and after one year of the carbon tax being implemented, the net effect on vehicle demand was zero. This is consistent with the experience during cash for clunkers.

To implement the carbon fee, a carbon dummy variable equal to zero or one is used. In the carbon tax dividend scenario, the value of the dummy variable is set to 1, activating the carbon tax. The model results are a function of the carbon tax's effect on the household, corporate and government sectors of the economy. Between 80% and 90% of the carbon tax's cost is passed through to consumers via higher consumer prices.

About the Authors

Mark Zandi is chief economist of Moody's Analytics, where he directs economic research. Moody's Analytics, a subsidiary of Moody's Corp., is a leading provider of economic research, data and analytical tools. Dr. Zandi is a cofounder of Economy.com, which Moody's purchased in 2005.

Dr. Zandi's broad research interests encompass macroeconomics, financial markets and public policy. His recent research has focused on mortgage finance reform and the determinants of mortgage foreclosure and personal bankruptcy. He has analyzed the economic impact of various tax and government spending policies and assessed the appropriate monetary policy response to bubbles in asset markets.

A trusted adviser to policymakers and an influential source of economic analysis for businesses, journalists and the public, Dr. Zandi frequently testifies before Congress on topics including the economic outlook, the nation's daunting fiscal challenges, the merits of fiscal stimulus, financial regulatory reform, and foreclosure mitigation.

Dr. Zandi conducts regular briefings on the economy for corporate boards, trade associations and policymakers at all levels. He is on the board of directors of MGIC, the nation's largest private mortgage insurance company, and The Reinvestment Fund, a large CDFI that makes investments in disadvantaged neighborhoods. He is often quoted in national and global publications and interviewed by major news media outlets, and is a frequent guest on CNBC, NPR, Meet the Press, CNN, and various other national networks and news programs.

Dr. Zandi is the author of *Paying the Price: Ending the Great Recession and Beginning a New American Century*, which provides an assessment of the monetary and fiscal policy response to the Great Recession. His other book, *Financial Shock: A 360º Look at the Subprime Mortgage Implosion, and How to Avoid the Next Financial Crisis*, is described by the New York Times as the "clearest guide" to the financial crisis.

Dr. Zandi earned his BS from the Wharton School at the University of Pennsylvania and his PhD at the University of Pennsylvania. He lives with his wife and three children in the suburbs of Philadelphia.

Chris Lafakis is a director at Moody's Analytics. His expertise is in macroeconomics, energy economics, model development and model validation. Based in West Chester PA, he also covers the California economy and contributes to Economic View. Mr. Lafakis has been quoted by media outlets including The Wall Street Journal, CNBC, Bloomberg, and National Public Radio and often speaks at economic conferences and events.

Mr. Lafakis received his bachelor's degree in economics from the Georgia Institute of Technology and his master's degree in economics from the University of Alabama.

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