Macroeconomic impacts of carbon pricing relative to a higher corporate income tax rate

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Executive summary

Two policies that raise the same amount of revenue can have different economic impacts. Consumption taxes, which generally do not tax the economically important portion of an investment's return, are generally viewed as a relatively efficient form of taxation. Capital income taxes, in contrast, are generally viewed as relatively inefficient because they discourage investment, which reduces the capital stock, reduces the productive capacity of the economy, and, ultimately, dampens economic growth and living standards. Taxes levied on business income are often capital taxes. Examples include the corporate income tax, the global intangible low-taxed income (GILTI) tax, and pass-through income taxes.

Carbon pricing policies are, in effect, a type of consumption tax, albeit only on the consumption of carbon-intensive goods and services. Accordingly, they have some of the efficient revenue-raising attributes of consumption taxes generally. Moreover, to the extent carbon pricing policies also help reduce carbon emissions and address climate change, they may also have economic advantages that go beyond the advantages generally associated with consumption taxes.

This report compares the macroeconomic impacts of a carbon price (i.e., a consumption tax on carbon-intensive goods and services) to a revenue-equivalent increase in the corporate income tax rate (i.e., a business income tax). These two broad policy approaches have very different economic and distributional effects. To isolate these possible effects, the macroeconomic effects of three revenue-equivalent[i] policies are simulated using the EY Macroeconomic Model:

1. A 25% US corporate income tax rate
2. A $12 per ton carbon price
3. A $15 per ton carbon price with a cash grant or rebate to households in the bottom two quintiles that would exactly offset their carbon price liability

All three policies are designed to raise the same revenue over the 10-year budget window. The policy that includes the cash grant or rebate to lower-income households imposes the carbon price at a higher level – $15 per ton rather than $12 per ton – in order to generate sufficient additional revenue to hold households in the bottom two income quintiles harmless from the carbon price.

The carbon price policy options are estimated to have significantly less of an adverse effect on gross domestic product (GDP) than the increase in the corporate income tax rate. This analysis does not consider the potential benefits of the carbon pricing on climate change mitigation, which would be in addition to the results presented here.

Key findings

- **Carbon pricing is more efficient at raising revenue than a corporate income tax increase and results in less drag on GDP growth.** This result holds when designing a carbon price that addresses potential concerns about regressivity. Moreover, this result

[i] Revenue-equivalent refers to the revenue raised over the 10-year budget window by a conventional revenue estimate.

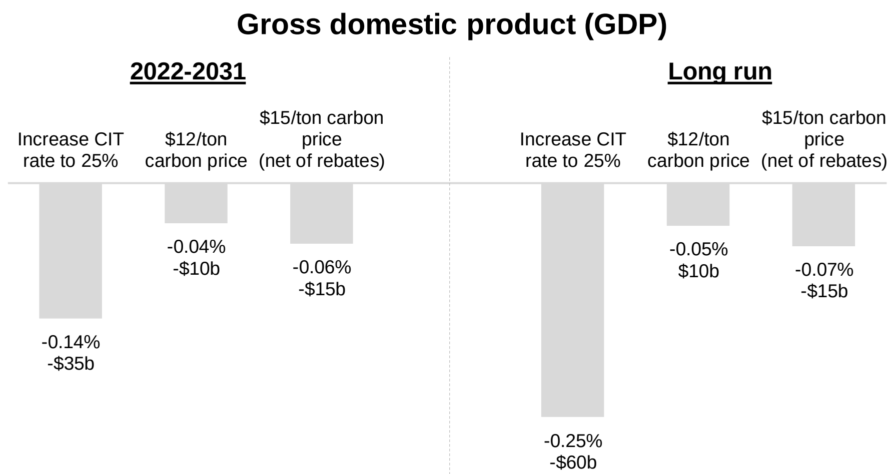
does not reflect the additional benefits that would result from climate change mitigation.

- **Increasing the corporate tax from 21% to 25% reduces GDP compared to the baseline projections. The revenue-equivalent $12 per ton carbon price decreases GDP by significantly less.** Taxing in a relatively efficient manner can significantly reduce the drag on GDP growth. Specifically, in the long run, the increase in the corporate income tax rate reduces GDP relative to the level in the baseline by 0.25% ($60 billion annually when scaled to the 2022 US economy), whereas the $12 per ton carbon price decreases GDP by only 0.05% ($10 billion annually when scaled to the 2022 US economy).

- **When setting a higher carbon price ($15 per ton in lieu of $12 per ton) so as to offset the impact on the bottom two quintiles of households but still raise the same amount of revenue as a 25% corporate income tax rate, the carbon price is still preferable to raising the corporate income tax rate in terms of the relative effect on GDP.** In the long run, the increase in the corporate income tax rate reduces GDP relative to the level in the baseline by 0.25% ($60 billion annually when scaled to the 2022 US economy), whereas the $15 per ton carbon price decreases GDP by only 0.07% ($15 billion annually when scaled to the 2022 US economy).

Figure ES-1. Economic impact of revenue-equivalent policies

Percent change in level relative to baseline | Annual impact relative to 2022 US economy



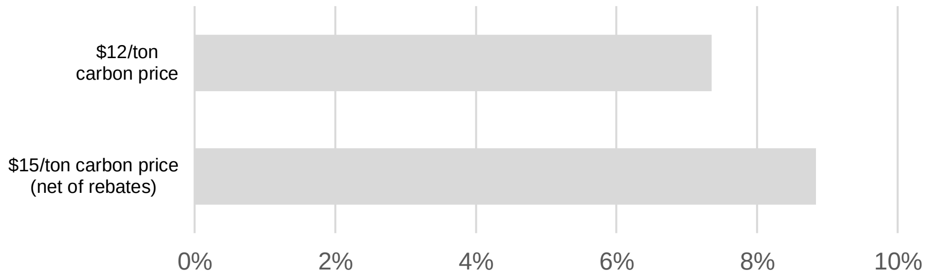
Note: Results assume the revenue raised is used to fund government transfer payments. While dedicating the revenue to a different use (e.g., reducing the deficit, spending on productivity-enhancing infrastructure, reducing other taxes) would have different macroeconomic impacts, the relative economic efficiency of the two broad policy options – carbon pricing versus higher corporate income taxes – would generally be unaffected. Figures are rounded.
Source: EY analysis.

Carbon emissions

Greenhouse gases (GHGs) trap heat in the atmosphere, leading to climate change. Although there are natural processes by which GHGs can be absorbed from the atmosphere, these processes are not able to neutralize the effect of the recent increase in carbon concentration levels in the atmosphere. Limiting human-induced CO_2 emissions down to at least net zero emissions, along with reductions in other GHG emissions, is necessary for limiting climate change and its associated physical risks. Although these results do not take into account the impact of the reduced physical risk of climate change, this report does estimate the change in carbon emissions relative to the level in the baseline. As seen in Figure ES-2, in the long run, the $12 per ton and $15 per ton carbon prices are estimated to reduce emissions by 7.4% and 8.8%, respectively, relative to baseline projections.

Figure ES-2. Impact of carbon pricing on carbon emissions

Percent decline in level relative to baseline



Source: EY analysis.

<u>Addressing regressivity</u>

Carbon pricing, and consumption taxes more broadly, are often regressive taxes. This is because low-income households, on average, spend a higher proportion of their income on consumption, while high-income households, on average, save a larger portion of their income. Most of the revenue raised from a carbon price comes from higher-income households.

This report considers the impact of cash grants or rebates to households in the bottom two income quintiles that would exactly offset their carbon price liability in one of the carbon pricing policy options (i.e., the $15 per ton carbon price). A rebate program to offset the effect of the carbon price on lower income quintiles is only one of many potential policy mechanisms that could address the regressivity of carbon pricing. The same amount of revenue could, instead, be used to support programs such as the Supplemental Nutrition Assistance Program (SNAP), Earned Income Tax Credit (EITC), the Low Income Housing Tax Credit (LIHTC), or Temporary Assistance to Needy Families (TANF).

<u>Use of revenues from the potential policy changes</u>

Different uses of the revenue generated by the tax policy options can have different economic impacts. For this analysis, the revenue is assumed to fund government transfer payments. Government transfer programs are assumed not to boost private sector productivity or private sector output but could achieve other policy objectives. While dedicating the revenue to a different use (e.g., reducing the deficit, spending on productivity-enhancing infrastructure, reducing other taxes) would have different macroeconomic impacts, the relative economic efficiency of the two broad policy options – carbon pricing versus higher corporate income taxes – would generally be unaffected.[ii]

[ii] Appendix B includes results assuming half of the revenue generated from the higher corporate income tax or carbon price is spent on public infrastructure investments and the remaining half on government transfer payments.

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Macroeconomic impacts of carbon pricing relative to a higher corporate income tax rate

I. Introduction

Two policies that raise the same amount of revenue can have different impacts on economic activity. Consumption taxes are generally considered to be a relatively efficient form of taxation. This is because they limit the disincentive to work and save. Taxing capital, in contrast, is generally considered to be a particularly distortionary form of taxation as it discourages productive investment, which dampens economic growth. Carbon pricing is a consumption tax on carbon-intensive goods and services. Capital taxes are often business taxes such as the corporate income tax. Other capital taxes include capital gains taxes and dividend taxes.

This report compares the macroeconomic impacts of a carbon price (i.e., a consumption tax) to an increase in the corporate income tax rate (i.e., a business tax and capital tax). Specifically, three revenue-equivalent policies are simulated using the EY Macroeconomic Model:[1]

1. Increase the corporate income tax rate to 25%
2. Implement a $12 per ton carbon price
3. Implement a $15 per ton carbon price with rebate checks to the households in the bottom two quintiles that would exactly equal their carbon price liability

That is, increasing the corporate income tax rate to 25% raises the same amount of revenue as a $12 per ton carbon price as well as a $15 per ton carbon price net of rebate checks to the households in the bottom two quintiles that would exactly equal their carbon price liability. Both carbon price policy options are estimated to have significantly less of a negative effect on gross domestic product (GDP) than the increase in the corporate income tax rate. This analysis does not consider the potential benefits of the carbon pricing on climate change mitigation, which would have additional benefits.

II. Carbon pricing

Carbon prices are a relatively simple and efficient mechanism for reducing greenhouse gas (GHG) emissions. Specifically, carbon pricing makes goods and services that are carbon intensive relatively more expensive than other goods and services that are less carbon intensive. Businesses and households respond by purchasing less of the more expensive carbon-intensive goods and services, thus generally reducing GHG emissions.[2]

There are two main strategies for implementing a price on carbon: the first sets a price on GHG emissions and allows the quantity of GHG emissions to adjust (i.e., a carbon tax) and the second limits the quantity of GHG emissions and allows the price to adjust (i.e., a cap-and-trade system or emissions trading scheme (ETS)).[3]

Additional Considerations

Carbon taxes and cap-and-trade systems could both raise a significant amount of revenue. The Congressional Budget Office (CBO) reports that a $25 per ton tax on carbon would raise around $1 trillion over the 10-year budget window.[4]

When designing a carbon pricing policy, there are several key points to be considered:

1. Whether the carbon price should be levied on stationary sources, mobile sources, or both. Stationary sources of carbon include facilities, such as factories and plants, while mobile sources include motor and off-road vehicles and engines.

2. The initial carbon price and the rate by which it increases over time. Carbon pricing bills introduced in the 116th and 117th Congress would have set an initial tax rate within a range of $15 per ton (Energy Innovation and Carbon Dividend Act) to $59 per ton (America Wins Act). These bills vary in how the price escalates. Examples of price escalation include increasing the price by a fixed dollar amount, a fixed dollar amount and an adjustment for inflation, and a percent increase with an inflation adjustment.[5]

3. The stage of the energy supply chain at which to apply the price (e.g., upstream versus downstream). Generally, the simplest administrative point at which to levy a carbon price is at the source of the energy supply chain. This is because there are fewer entities covering a large portion of GHG emissions sources. For instance, the Congressional Research Service estimates that applying the tax to suppliers of coal and fossil fuels would cover nearly 80% of total US GHG emissions while applying it to fewer than 2,200 entities.[6]

4. Accounting for differences in carbon pricing regime burdens across the globe. This requires a border adjustment or other mechanisms to account for the price on carbon on US products relative to competing products from other countries with different decarbonization regimes. This can be achieved through taxing imports and subsidizing exports.

5. Lastly, a key determinant of the long-run economic impact of a carbon price is the use of the revenue generated. A carbon price net of how the revenue generated is used can be – but is not necessarily – pro-growth. This could occur, for instance, if the revenue raised is used for investment in productivity-enhancing public infrastructure or to reduce capital

taxes. In contrast, rebating the revenue to households would offset the impact of the carbon price on household income but would generally not be a pro-growth policy (excluding the benefits of mitigating the physical impacts of climate change).[7]

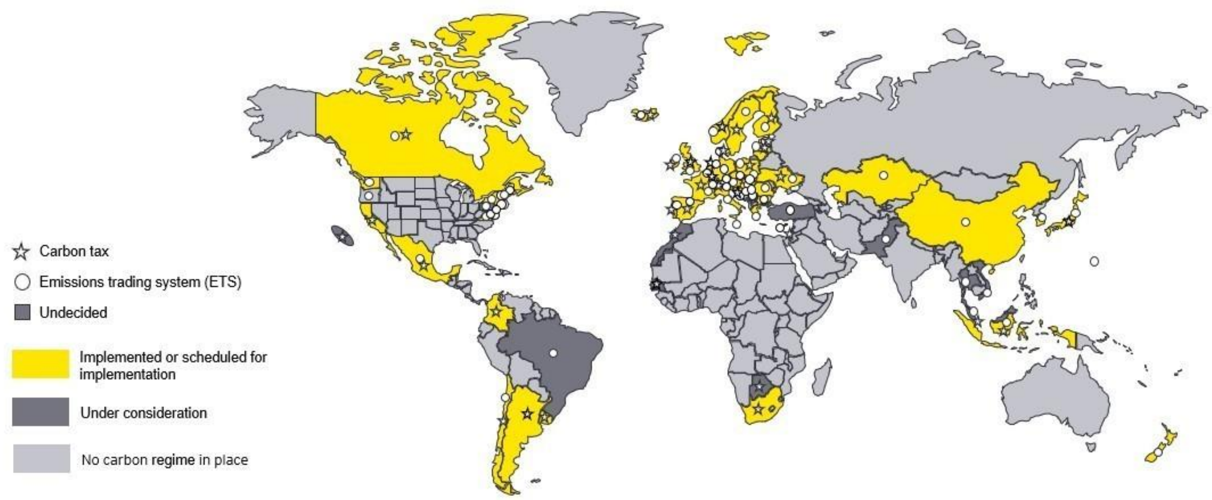
Global carbon pricing

Based on a report released by the World Bank, there are 68 implemented carbon pricing regimes (i.e., carbon taxes or cap-and-trade system/emissions trading schemes), covering 47 national jurisdictions and 36 subnational jurisdictions.[8] These are displayed in Figure 1. The regimes currently in place cover approximately 23% of global GHG emissions.

There are 36 carbon taxes globally covering 28 national jurisdictions and 8 subnational jurisdictions. These carbon taxes cover approximately 5% of global GHG emissions. The highest carbon tax in place (as of April 2022) is in Uruguay ($137 per tCO_2e emissions), followed by Sweden ($130 per tCO_2e emissions).

There are 32 cap-and-trade or ETS regimes globally covering 38 national jurisdictions and 31 subnational jurisdictions. These ETS regimes cover approximately 17% of global GHG emissions. The highest ETS (as of April 2022) is the UK ETS ($99 per tCO_2e emissions), followed by the ETS in Switzerland ($64 per tCO_2e emissions).

Figure 1. Global carbon pricing, 2022



Source: World Bank.

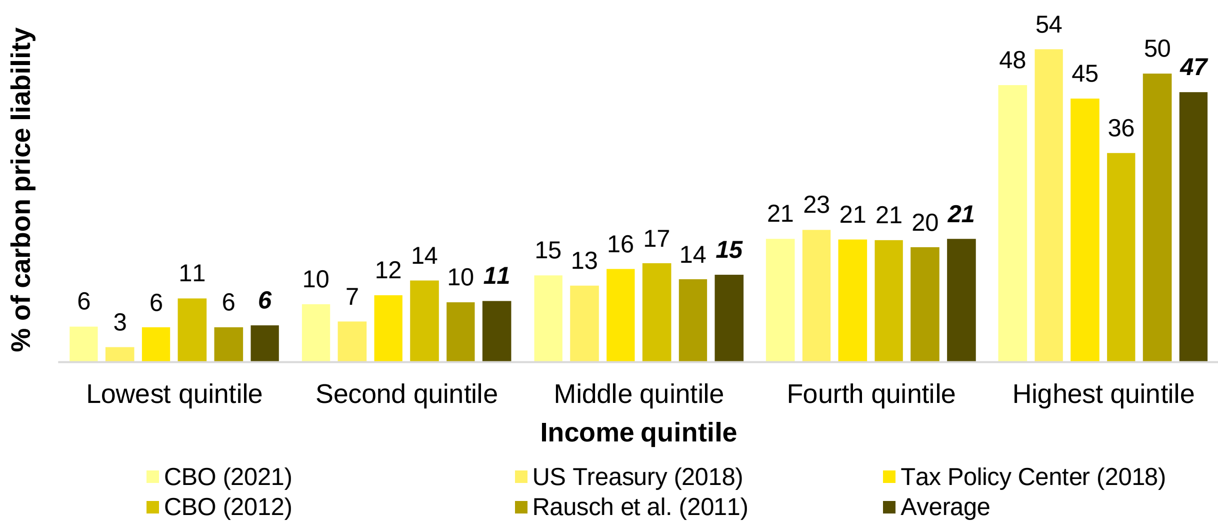
III. Addressing regressivity

Carbon pricing, and consumption taxes more broadly, are often regressive taxes. This is because low-income households, on average, spend a higher proportion of their income on consumption, while high-income households, on average, save a larger portion of their income. Most of the revenue raised from a carbon price, however, comes from higher-income households as even though they spend a lower share of their income they have more income.

Figure 2 displays the share of carbon price liability by household income quintile as estimated from five prominent studies.[9] Depending on the study, the top quintile pays between 36% and 54% of total carbon price liability, while the combined bottom two quintiles pay between 10% and 25%. While the top quintile would pay the largest share of carbon price liability, the liability as a share of after-tax income would generally be lower for the top quintile as compared to the other four quintiles.

Figure 2. Estimated carbon pricing revenue share by quintile

Shares sum to 100%



Note: Revenue shares from the cited studies are used when available. When not available this analysis estimated the revenue share using income changes in the cited paper and Congressional Budget Office (CBO) "Distribution of Income" data.[10] Average is a simple average. Figures are rounded.
Source: CBO, OTA, Tax Policy Center, and EY analysis.

Addressing carbon price regressivity

This report, as an illustration, simulates providing cash grants or rebate checks to households in the bottom two quintiles that would exactly equal their carbon price liability. This would leave these households in a net neutral position (i.e., hold them harmless from a cash tax perspective). Across the studies summarized in Figure 2, the average amount of carbon price liability paid by the bottom two quintiles is 17% with a range of 10% to 25%. This analysis assumes 17% of the revenue raised would be required for the bottom two quintiles to be held unharmed. Since the bottom two quintiles would be receiving a full rebate, the burden of the tax would be entirely shifted to those in the top three quintiles.

It should be noted that this analysis does not take into account other societal benefits from the carbon price. For example, the carbon price will help mitigate the adverse effects of climate change. Additionally, lower-income households may benefit from how the revenues from the carbon price are used in ways other than the cash grants or rebate checks.[11]

Notably, cash grants or rebate checks are only one of many potential policy mechanisms that can address the regressivity of carbon pricing.[12] The revenue could, instead, be used to support programs such as the Supplemental Nutrition Assistance Program (SNAP), the Earned Income Tax Credit (EITC), the Low-Income Housing Tax Credit (LIHTC), or Temporary Assistance to Needy Families (TANF). Each of these approaches would use only a portion of the revenue from the carbon price and would aim to compensate lower income households for their carbon price liability. This would shift the burden of the policy onto higher income households.

IV. Results

This report compares the macroeconomic impacts of a carbon price (i.e., a consumption tax) to an increase in the corporate income tax rate (i.e., a business tax and capital tax). Specifically, three revenue-equivalent policies are simulated using the EY Macroeconomic Model:[13]

1. Increase the corporate income tax rate to 25%
2. Implement a $12 per ton carbon price
3. Implement a $15 per ton carbon price with rebate checks to the households in the bottom two quintiles that would exactly equal their carbon price liability

That is, increasing the corporate income tax rate to 25% raises the same amount of revenue as a $12 per ton carbon price as well as a $15 per ton carbon price net of rebate checks to the households in the bottom two quintiles that would exactly equal their carbon price liability. Both carbon price policy options are estimated to have significantly less of a negative effect on GDP growth. This analysis does not consider the potential benefits of the carbon pricing on climate change mitigation, which would have additional benefits.

EY Macroeconomic Model

The economic impacts are estimated using the EY Macroeconomic Model, an overlapping generations model similar to models used by the CBO, Environmental Protection Agency, Joint Committee on Taxation, and US Department of the Treasury to analyze changes in energy and tax policy.[14]

The EY Macroeconomic Model includes a detailed modeling of industries and inter-industry linkages. Businesses choose the optimal mix of price of capital, labor, and energy based on relative prices and industry-specific characteristics. Each industry has a different relative size of capital, labor, energy inputs, and CO_2 emissions associated with its output. This model is designed to include key economic decisions of businesses and households affected by energy and tax policy, as well as major features of the US economy. The post-tax returns from work and savings are incorporated into business and households' decisions on how much to produce, save, and work.

A description of the EY Macroeconomic Model can be found in Appendix A.

Use of revenues

Tax increases, such as increases in the corporate income tax or the carbon price, produce revenue. Depending on government priorities, the newly generated revenue could be used in a variety of ways. The revenue could be used to cut taxes, increase spending, reduce the deficit, or a combination thereof. For the purposes of this analysis, the revenue generated is spent on government transfer programs. Government transfer programs are assumed not to boost private sector productivity or private sector output but could achieve other policy objectives.[15]

Note that assuming different uses of the revenue could produce different results than those obtained in this analysis (i.e., absolute changes would be affected). However, the relative economic efficiency with which a corporate income tax rate increase or carbon price would raise revenue will generally be unaffected by this assumption. Appendix B includes results assuming half of the revenue generated is spent on infrastructure investment and the other half on government transfer programs. Investment in public infrastructure boosts private sector productivity and, consequently, private sector output.[16]

Results

In both comparisons the carbon price policy option has significantly less of a negative effect on GDP growth. This finding would have generally occurred regardless of the spending decisions of the newly generated revenue, but the results are all presented net of the additional spending. These results do not consider the additional benefit of minimizing GHGs associated with a carbon price.

Figure 3 displays the economic impact of the revenue equivalent policies: (1) increasing the corporate rate from 21% to 25%, (2) $12 per ton carbon price, and (3) $15 per ton carbon price net of the cash grants or rebate checks to the households in the bottom two quintiles that would exactly equal their carbon price liability. The baseline is defined as current law, a 21% corporate income tax rate with no federal carbon price.

Increasing the corporate tax from 21% to 25% reduces GDP compared to the baseline projections, but the revenue-equivalent $12 per ton carbon price decreases GDP by significantly less. Taxing in a relatively efficient manner can significantly reduce the drag on GDP growth. Specifically, in the long run, the increase in the corporate income tax rate reduces GDP relative to the level in the baseline by 0.25% ($60 billion annually when scaled to the 2022 US economy), whereas the $12 per ton carbon price decreases GDP by only 0.05% ($10 billion annually when scaled to the 2022 US economy).

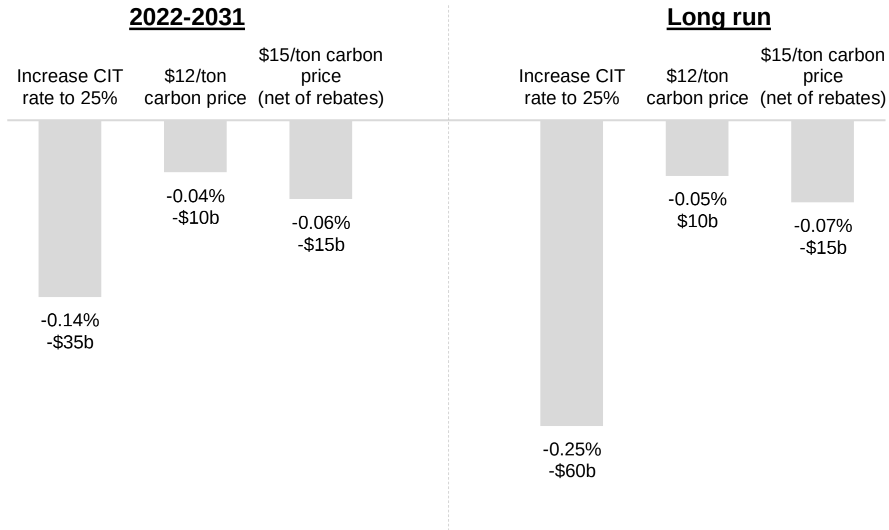
When setting a higher carbon price ($15 per ton in lieu of $12 per ton) so as to offset the impact on the bottom two quintiles of households but still raise the same amount of revenue as a 25% corporate income tax rate, the carbon price is still preferable to raising the corporate income tax rate in terms of the relative effect on GDP. In the long run, the increase in the corporate income tax rate reduces GDP relative to the level in the baseline by 0.25% ($60 billion annually when scaled to the 2022 US economy), whereas the $15 per ton carbon price decreases GDP by only 0.07% ($15 billion annually when scaled to the 2022 US economy).

More detailed results are presented in Table 1. Notably, labor income can rise even when GDP declines due to changes within industries (i.e., capital-labor substitution) and between industries (i.e., shifting of economic activity between more and less capital-intensive industries). This dynamic is captured in the EY Macroeconomic Model.[17] As seen in Table 1, although the level of GDP declines relative to the baseline in each of the three policy simulations, in the long run, labor income declines by $45 billion annually when increasing the corporate income tax rate to 25% but increases by $10 billion and $15 billion in the $12 per ton and $15 per ton carbon price simulations, respectively. These annual reductions are scaled to the size of the 2022 US economy.

Figure 3. Economic impact of revenue-equivalent policies

Percent change in level relative to baseline | Annual impact relative to 2022 US economy

Gross domestic product (GDP)



Note: Results assume the revenue raised is used to fund government transfer payments. While dedicating the revenue to a different use (e.g., reducing the deficit, spending on productivity-enhancing infrastructure, reducing other taxes) would have different macroeconomic impacts, the relative economic efficiency of the two broad policy options – carbon pricing versus higher corporate income taxes – would generally be unaffected. Figures are rounded.
Source: EY analysis.

Table 1. Economic impact of revenue-equivalent policies

Percent change in level relative to baseline | Annual impact relative to 2022 US economy

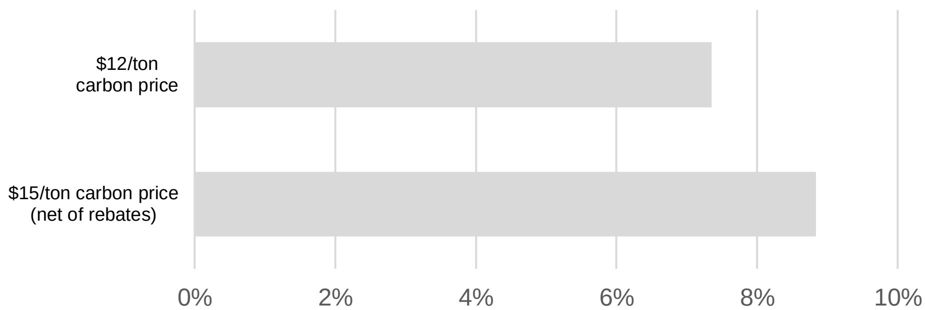
	2022-2031	Long run	2022-2031	Long run	2022-2031	Long run
	25% CIT rate		*$12 per ton carbon price*		*$15 per ton carbon price*	
GDP	-0.1%	-0.2%	*	*	-0.1%	-0.1%
Consumption	0.2%	-0.2%	*	-0.1%	*	-0.1%
Private investment	-1.4%	-0.5%	-0.2%	*	-0.3%	*
Labor income	-0.1%	-0.3%	0.1%	0.1%	0.1%	0.1%
Private capital	-0.2%	-0.5%	*	*	-0.1%	*
GDP ($bil)	-$35	-$60	-$10	-$10	-$15	-$15
Labor income ($bil)	-$20	-$45	$10	$10	$10	$15
Job equivalents (000s)	-225	-530	115	150	120	165

*Less than 0.05% in magnitude.
Note: Results assume the revenue raised is used to fund government transfer payments. While dedicating the revenue to a different use (e.g., reducing the deficit, spending on productivity-enhancing infrastructure, reducing other taxes) would have different macroeconomic impacts, the relative economic efficiency of the two broad policy options – carbon pricing versus higher corporate income taxes – would generally be unaffected. Job equivalents summarize the impact of both the reduction in hours worked and reduced wages. Figures are rounded.
Source: EY analysis.

Carbon emissions

GHGs trap heat in the atmosphere, leading to climate change. Although there are natural processes by which GHGs can be absorbed from the atmosphere, these processes are not able to neutralize the effect of the recent increase in carbon concentration levels in the atmosphere. Limiting human-induced CO_2 emissions down to at least net zero emissions, along with reductions in other GHG emissions, is necessary for limiting climate change and its associated physical risks.[18] Although these results do not take into account the impact of the reduced physical risk of climate change, this report does estimate the change in carbon emissions relative to the level in the baseline. As seen in Figure 4, in the long run, the $12 per ton and $15 per ton carbon prices are estimated to reduce emissions by 7.4% and 8.8%, respectively, relative to baseline projections.

Figure 4. Impact of carbon pricing on carbon emissions
Percent decline in level relative to baseline



Source: EY analysis.

V. Caveats and limitations

Any modeling effort is only an approximate depiction of the economic forces it seeks to represent, and the economic model developed for this analysis is no exception. Although various limitations and caveats might be listed, several are particularly noteworthy.

- **Estimated macroeconomic impacts based on a stylized depiction of the US economy.** The general equilibrium model used for this analysis is, by its very nature, a stylized depiction of the US economy. As such, it cannot capture all of the detail of the US economy, the existing US tax system, or the proposed tax changes.
- **Macroeconomic estimates are sensitive to the particular way that tax revenue is used.** Because of the government's budget constraint, it is not possible to separate entirely the impact of a given tax increase from the impact of the use of the revenues it may generate. Revenue raised in this analysis must be used in some way and how the revenue is used can affect the estimated impacts. Typical uses of the revenue in analyses like this have included deficit reduction, government spending or transfer increases, tax reductions, or a combination thereof. Assuming different uses of the revenue could produce results that differ from those obtained in this analysis. However, the relative economic efficiency by which a corporate income tax rate increase or carbon price would raise revenue will generally be unaffected by this assumption.
- **Full employment model.** The EY Macroeconomic Model, like many general equilibrium models, focuses on the longer-term incentive effects of policy changes. It also assumes that all resources throughout the economy are fully employed; that is, there is no slackness in the economy (i.e., a full employment assumption with no involuntary unemployment). Any increase in labor supply is a voluntary response to a change in income or the return to labor that makes households choose to substitute between consumption and leisure. To provide a high-level measure of the potential employment impacts, a job equivalents measure has been included in this analysis' results. Job equivalent impacts are defined as the change in total labor income divided by the baseline average labor income per job.
- **Estimated macroeconomic impacts limited by calibration.** This model is calibrated to represent the US economy and then forecast forward. However, because any particular year may reflect unique events and also may not represent the economy in the future, no particular baseline year is completely generalizable.
- **Estimates are limited by available public information.** The analysis relies on information reported by government agencies (primarily the Bureau of Economic Analysis, US Energy Information Administration, Environmental Protection Agency, and Internal Revenue Service). The analysis did not attempt to verify or validate this information using sources other than those described in the analysis.
- **State policies are not modeled.** The simulations do not account for interactions with or potential changes in state policies. This includes, for example, state renewable portfolio standards that require a certain percentage of electricity generation in the state to be met by renewable sources (e.g., wind and solar power).
- **Results do not take into account the impact of the reduced physical risk of climate change from carbon pricing.** These impacts would be in addition to the results shown in this analysis.

Appendix A. EY Macroeconomic Model

The EY Macroeconomic Model was used for this analysis. This model, which is an overlapping generations computable general equilibrium model, is similar to economic models used by the Congressional Budget Office, Environmental Protection Agency, Joint Committee on Taxation, and US Department of the Treasury for estimating the potential economic impacts of various energy and tax policies.[19]

Behavioral responses are modeled in a general equilibrium framework whereby representative firms and individuals incorporate changes in current and future prices when deciding how much to produce, save, and consume in each period. In this framework, individuals are assumed to be responsive to changes in the prices of consumer goods. Thus, as the prices of CO_2-intensive consumer goods increase, consumers substitute their consumption toward other goods and services. Similarly, firms alter their mix of capital, labor, and energy used in production in response to regulatory and tax policies.

An overview of the model follows:

Production

Firm production is modeled with the constant elasticity of substitution (CES) functional form in which firms choose the optimal level of capital and labor subject to the gross-of-tax cost of capital and gross-of-tax wage. The model includes industry-specific detail through use of differing costs of capital, factor intensities, and production function scale parameters. Such a specification accounts for differential use of capital and labor across industries, as well as distortions in factor prices introduced by the tax system. The cost of capital measure models the extent to which the tax code discriminates by asset type, organizational form, and source of finance. Estimates of the cost of capital generally follow the formulation from Hall and Jorgenson (1967), expanded by Fullerton and Mackie (1987), and described in detail by Gravelle (1994) and Mackie (2002).

Each industry differs in its relative use of capital, labor, and energy inputs, as well as in the CO_2 content of its outputs. Each industry is responsive to the price of capital, labor, and energy, and chooses the optimal mix based on relative prices and industry-specific characteristics. The inclusion of inter-industry linkages is important for this type of analysis because CO_2 abatement policies have both direct and indirect effects that increase the costs of production. The direct effects are reflected in the increased costs created by the imposition of the policy on the use of CO_2-emitting industries. Indirect costs are incurred through the use of inputs or processes in production that have previously been subject to the policy. This means that even industries that are not directly impacted by a policy are subject to potentially significant cost increases through increased prices of intermediate inputs from other industries used in their production processes.

Consumers

The overlapping generations framework is modeled with 55 generational cohorts. That is, in any one year, the model includes a representative household optimizing lifetime consumption and savings decisions for each age 21 through 75 (i.e., 55 representative cohorts). For each generational cohort, the endowment of human capital exogenously changes with age – growing early in life and declining later in life. This overlapping generations framework is especially well-suited for estimating both the short-run transitional and long-run effects of a policy change.

The utility of representative individuals is modeled as a CES function allocating a composite good consisting of consumer goods and leisure over their lifetimes. Representative individuals optimize their lifetime utility through their decisions of how much to consume, save, and work in each period subject to their preference parameters and the after-tax returns from work and savings in each period. In determining their labor supply, representative individuals respond to the after-tax return to labor, as well as their overall income levels, in determining whether to work and thereby earn income that is used to purchase consumer goods or to consume leisure by not working.

Other features

The model includes a simple characterization of the government. The model includes a sector representing state and local governments, as well as a sector representing the US federal government. Government spending is assumed to be used for either (1) transfer payments to representative individuals, or (2) the provision of public goods. Public goods are assumed to be provided by the government in fixed quantities through the purchase of industry outputs as specified in a Leontief function. This spending is financed in the model by collecting taxes.

Table A-1. Key model parameters

Intertemporal substitution elasticity	0.4
Intratemporal substitution elasticity	0.6
Leisure share of time endowment	0.4
International capital flow elasticity	3.0
Capital-labor substitution elasticity	0.8

Source: Central key model parameters are generally from Joint Committee on Taxation, Macroeconomic Analysis Of The Conference Agreement For H.R. 1, The “Tax Cuts And Jobs Act,” December 22, 2017 (JCX-69-17), Congressional Budget Office, The Macroeconomic and Budgetary Effects of Federal Investment, June 2016, and Jane Gravelle and Kent Smetters, “Does the Open Economy Assumption Really Mean That Labor Bears the Burden of a Capital Income Tax?,” Advances in Economic Analysis and Policy 6(1) (2006): Article 3.

Appendix B. Additional results

Tax increases, such as increases in the corporate income tax or the carbon price, produce revenue. Depending on government priorities, the newly generated revenue could be used in a variety of ways. The revenue could be used to cut taxes, increase spending, reduce the deficit, or a combination thereof. These additional results assume half of the revenue generated is spent on infrastructure investment and the other half on government transfer programs. Investment in public infrastructure boosts private sector productivity and, consequently, private sector output. This contrasts to the results presented in the body of the report that assume the revenue generated is spent on government transfer programs. Government transfer programs are assumed not to boost private sector productivity or private sector output but could achieve other policy objectives.

Note that assuming different uses of the revenue could produce different results than those obtained in this analysis (i.e., absolute changes would be affected). However, the relative economic efficiency with which a corporate income tax rate increase or carbon price would raise revenue will generally be unaffected by this assumption.

<u>Results</u>

In both comparisons the carbon price policy option has significantly less of a negative effect on GDP growth. This finding would have generally occurred regardless of the spending decisions of the newly generated revenue, but the results are all presented net of the additional spending. In certain cases, GDP increases due to the combination of the relatively efficient tax collection through the carbon price and productivity-increasing infrastructure spending. Results do not take into account the impact of the reduced physical risk of climate change from carbon pricing.

Figure B-1 displays the economic impact of the revenue equivalent policies: (1) increasing the corporate rate from 21% to 25%, (2) $12 per ton carbon price, and (3) $15 per ton carbon price net of the cash grants or rebate checks to the households in the bottom two quintiles that would exactly equal their carbon price liability. The baseline is defined as current law, a 21% corporate income tax rate with no federal carbon price.

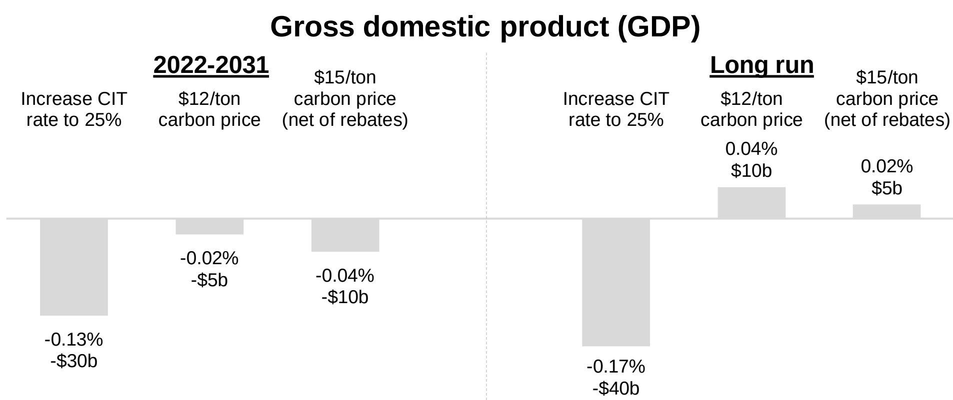
Over the 10-year budget window, the increase in the corporate income tax to 25% is estimated to decrease GDP relative to the level in the baseline by 0.13%, or $30 billion annually. The implementation of the $12 per ton carbon price is estimated to result in a negligible GDP decrease relative to the level in the baseline (i.e., less than 0.05% in magnitude). A $15 per ton carbon price also negligibly decreases GDP relative to the level in the baseline between 2022 and 2031 (i.e., less than 0.05% in magnitude).

In the long run, the 25% corporate rate reduces GDP relative to the level in the baseline by 0.17% or $40 billion annually. The $12 per ton and $15 per ton carbon prices, in contrast, both result in a negligible increase in GDP. GDP increases above the level in the baseline for two reasons. First, the carbon price is a relatively efficient means of generating revenue. Second, this revenue is used in part to fund productivity-enhancing public infrastructure spending. Because infrastructure investment does not immediately increase productivity (i.e., physical infrastructure improvements can take years), the productivity gains are amplified in the long run when the infrastructure projects have been completed. This results in the long-run net gain to GDP relative to the level in the baseline.

More detailed results are displayed in Table B-1. In the long run, increasing the corporate income tax rate to 25% decreases GDP relative to the level in the baseline by 0.2% ($40 billion annually when scaled to the 2022 US economy), labor income by 0.3% ($35 billion annually when scaled to the 2022 US economy), and job equivalents by 0.3% (405,000 job equivalents when scaled to the 2022 US economy). The $12 per ton carbon price, in the long run, increases GDP relative to the level in the baseline negligibly (less than 0.05% in magnitude), labor income by 0.2% ($25 billion annually when scaled to the 2022 US economy), and job equivalents by 0.2% (280,000 job equivalents when scaled to the 2022 US economy). The $15 per ton carbon price, in the long run, increases GDP relative to the level in the baseline negligibly (less than 0.05% in magnitude), labor income by 0.2% ($25 billion annually when scaled to the 2022 US economy), and job equivalents by 0.2% (295,000 job equivalents when scaled to the 2022 US economy).

Figure B-1. Economic impact of revenue-equivalent policies

Percent change in level relative to baseline | Annual impact relative to 2022 US economy



*Less than 0.05% in magnitude.
Note: All results are the net impact of raising revenue (either through a corporate income tax rate increase or carbon price) and using that revenue to increase government spending (one half to fund productivity-enhancing public infrastructure and one half to fund government transfers). In some cases, this results in an increase in economic activity because of spending on productivity-enhancing infrastructure; a tax by itself will not increase GDP. Figures are rounded.
Source: EY analysis.

Table B-1. Economic impact of revenue-equivalent policies

Percent change in level relative to baseline | Annual impact relative to 2022 US economy

	2022-2031	Long run	2022-2031	Long run	2022-2031	Long run
	25% CIT rate		*$12 per ton carbon price*		*$15 per ton carbon price*	
GDP	-0.1%	-0.2%	*	*	*	*
Consumption	0.2%	-0.1%	*	*	*	*
Private investment	-1.4%	-0.4%	*	0.1%	-0.1%	0.1%
Labor income	-0.1%	-0.3%	0.1%	0.2%	0.1%	0.2%
Private capital	-0.2%	-0.4%	*	0.1%	-0.1%	0.1%
GDP ($bil)	-$30	-$40	-$5	$10	-$10	$5
Labor income ($bil)	-$20	-$35	$10	$25	$10	$25
Job equivalents (000s)	-225	-405	115	280	120	295

*Less than 0.05% in magnitude.

Note: All results are the net impact of raising revenue (either through a corporate income tax rate increase or carbon price) and using that revenue to increase government spending (one half to fund productivity-enhancing public infrastructure and one half to fund government transfers). In some cases, this results in an increase in economic activity because of spending on productivity-enhancing infrastructure; a tax by itself will not increase GDP. Job equivalents summarize the impact of both the reduction in hours worked and reduced wages. Figures are rounded.

Source: EY analysis.

Endnotes

[1] Revenue-equivalent refers to the revenue raised over the 10-year budget window by a conventional revenue estimate.
[2] Of course, nearly all goods and services have at least some embedded carbon emissions in them somewhere in their production. For example, even if a particular company producing a good or service has no direct carbon emissions, the goods and services that companies purchase from their suppliers or, in turn, the goods and services their suppliers purchase from other companies may have resulted in carbon being emitted when being produced.
[3] From a stylized modeling perspective, an ETS and a carbon tax have equivalent effects when the ETS allowances are sold. However, real-world considerations such as implementation and administration differ between the policies. See, for example, Avi-Yonah, R. S., & Uhlmann, D. M. (2009). Combating global climate change: Why a carbon tax is a better response to global warming than cap and trade. *Stan. Envtl. LJ*, *28*, 3.
[4] Congressional Budget Office. (2020). *Options for Reducing the Deficit: 2021 to 2030*. Congressional Budget Office.
[5] See, Resources for the Future, Hafstead, M. (2022). *Carbon Pricing Bill Tracker*, Resources for the Future. Retrieved from https://www.rff.org/publications/data-tools/carbon-pricing-bill-tracker/
[6] See, Ramseur, J., Leggett, J., Sherlock, M. (2012). *Carbon Tax: Deficit Reduction and Other Considerations*. CRS Report for Congress R42731. Washington, DC: Congressional Research Service.
[7] EY. (2018). *Carbon regulations vs. a carbon tax: A comparison of the macroeconomic impacts, Prepared for the Alliance for Market Solutions*, EY
[8] See, The World Bank. (2022). *Carbon Pricing Dashboard*. Retrieved from http://carbonpricingdashboard.worldbank.org
[9] The papers reviewed are: Carloni, D., & Dinan, T. (2021). *Distributional Effects of Reducing Carbon Dioxide Emissions With a Carbon Tax: Working Paper 2021-11* (No. 57399).; Dinan, T. (2012). Offsetting a Carbon Tax's Costs on Low-Income Households," CBO, Working Paper 2012-16, November 2012 & CBO, "The Estimated Costs to Households from the Cap-and Trade Provisions of H.R. 2454," Letter to the Honorable Dave Camp, June 19, 2009; Horowitz, J., Cronin, J. A., Hawkins, H., Konda, L., & Yuskavage, A. (2017). Methodology for analyzing a carbon tax. *US Department of the Treasury, Washington, DC*.; Rausch, S., Metcalf, G. E., & Reilly, J. M. (2011). Distributional impacts of carbon pricing: A general equilibrium approach with micro-data for households. *Energy economics*, *33*, S20-S33.
[10] For Carloni & Dinan (CBO, 2021), the analysis uses estimates of tax burden before transfers and taxes to generate the share of revenue using the CBO's "Distribution of Household Income." If the analysis used estimates of tax burden after transfers and taxes the distributional effects would be less regressive, and the share of revenue would be higher for the bottom two quintiles and highest quintile but lower for the middle and second highest. For Horowitz et al. (OTA, 2018), the analysis uses revenue estimates as provided and converts deciles to quintiles. For Rosenberg et al. (Tax Policy Center, 2018), the analysis uses the 2020 central estimates from the pre-tax income with no burden on normal return and generates revenue estimates from CBO's "Distribution of Household Income" for 2018 grown by CBO projections to 2020. Using the similar methodology until 2030 would yield slightly more regressive results. For Dinan (CBO, 2012), the analysis uses estimates of the gross costs of the bill as a percentage of after-tax income and shares of gross cost of the bill from the 2009 estimates from the cap-and-trade estimate. Indexing for transfer payments, as done in the 2012 working paper, would lower the after-tax burden across the distribution. For Rausch et al. (2011), the analysis uses the combined source and use side effects on full income converted to quintiles and CBO's "Distribution of Household Income" for 2006 to estimate revenue shares. Different specifications and estimates may lead to different results.
[11] It should also be noted that while the bottom two quintiles will not be worse off from a cash tax perspective, their consumption patterns will change because of the change in the relative price of goods and services from the carbon price. This is one of the primary goals of the carbon price: to increase the price of goods and services based on their carbon content. That said, the carbon price does make consumers worse off even after returning the 17% of taxes as a rebate from the perspective of their consumer welfare because

the carbon price incentivizes them to choose a different bundle of goods and services than they would absent the carbon price.

[12] In addition to policies listed, indexed transfer payments and income effects already help mitigate regressivity. Means tested-transfer programs such as Medicaid or Supplemental Nutritional Assistance Program (SNAP) are indexed to inflation. Therefore, if average prices rose, the payments to/from these programs would rise to match. This would keep the benefits received from these programs constant even if prices rise. Many beneficiaries for these programs are lower-income, and indexing helps reduce the regressivity of the carbon prices.

[13] Revenue-equivalent refers to the revenue raised over the 10-year budget window by a conventional revenue estimate.

[14] See, for example, Nishiyama, S. (2013). *Fiscal Policy Effects in a Heterogeneous-Agent Overlapping-Generations Economy With an Aging Population: Working Paper 2013-07* (No. 44941).; Joint Committee on Taxation*, (2014) Macroeconomic Analysis of the "Tax Reform Act of 2014,"* (JCX-22-14); Joint Committee on Taxation, (2005). *Macroeconomic Analysis of Various Proposals to Provide $500 Billion in Tax Relief*, (JCX-4-05); Carroll, R., Diamond, J., Johnson, C., Mackie, J, III. (2006). *A Summary of the Dynamic Analysis of the Tax Reform Options Prepared for the President's Advisory Panel on Federal Tax Reform*, Office of Tax Analysis, US Department of the Treasury; Ross, M. (2009). *Documentation of the Applied Dynamic Analysis of the Global Economy (ADAGE) Model.* Research Triangle Institute; Goettle, R., Ho, M., Jorgenson, D., Wilcoxen, P., (2013) Energy, *The Environment, and U.S. Economic Growth,* in *Handbook of Computable General Equilibrium Modeling*, edited by Peter Dixon and Dale Jorgenson.

[15] This analysis includes a stylized modeling of government transfer programs via a rebate to households. Any particular policy proposal should be explicitly modeled to estimate its effects.

[16] This analysis includes a stylized modeling of productivity-enhancing infrastructure spending. The productivity increases included in the productivity-enhancing government spending scenarios are consistent with estimates of productivity found in the economic literature on public infrastructure. The approach used is to assume productivity increases that are consistent with those found in the literature on the effects of increases in the stock of public capital, such as roads, bridges, and other types of public infrastructure. There is no consensus in the academic literature on the responsiveness of private output with respect to changes in the stock of public capital. However, this report is consistent with the Congressional Budget Office's review of the academic literature and related analysis that estimated a 1% increase in public capital would be associated with an increase in private output of 0.08%. See Congressional Budget Office, *Effects of Physical Infrastructure Spending on the Economy and the Budget Under Two Illustrative Scenarios*, 2021 and Valerie Ramey, (2020), The Macroeconomic Consequences of Infrastructure Investment, NBER Working Paper 27625.

Depending on the specifics of a policy proposal, the effects could be significantly different from those reported in this analysis. That is, specific policy proposals could result in differences in the overall magnitude of the impact, the adjustment costs associated with the investment, and the sector-specific impact resulting from the investment. Additionally, a proposal funding green infrastructure would likely have interactions with the carbon pricing policy modeled. Overall, the results of this analysis should be viewed as illustrative of the potential impact of a stylized increase in productivity associated with government spending. Any specific policy proposal should be explicitly modeled to examine its economic impact.

An additional area of uncertainty is the time horizon within which funding for public infrastructure investment is spent and when this public infrastructure investment, in turn, impacts productivity in the private sector. Specifically, while public infrastructure can generally be used and impact the productivity of the private sector once it is built, large increases in federal infrastructure can be subject to significant delays. For example, in the aftermath of the American Recovery and Reinvestment Act of 2009, less than 10% of infrastructure funds had been spent by the end of fiscal year 2009. This analysis assumes that investment in public infrastructure is spent ratably over five years. See Congressional Budget Office, "Policies for Increasing Economic Growth and Employment in 2012 and 2013," Testimony/statement by Douglas W. Elmendorf, CBO Director, November 15, 2011. Recent CBO analyses have assumed that 75% being spent within five years of being authorized and 94% being spent within five years of being authorized. See Congressional Budget Office, *The Macroeconomic and Budgetary Effects of Federal Investment*, 2016 and Congressional Budget Office, *Effects of Physical Infrastructure Spending on the Economy and the Budget Under Two Illustrative Scenarios*, 2021.

There is also uncertainty surrounding how spending policy will evolve outside of the 10-year budget window. This analysis assumes that productivity-enhancing spending will continue at the level necessary to maintain the increase in productivity obtained by the end of the 10-year budget window. That is, the increase in productivity obtained by the end of the 10-year budget window is assumed to be maintained permanently.

[17] In the EY Macroeconomic Model each industry differs in its relative use of capital, labor, and energy inputs, as well as in the CO_2 content of its outputs. Each industry is responsive to the price of capital, labor, and energy, and chooses the optimal mix based on relative prices and industry-specific characteristics. The inclusion of inter-industry linkages is important for this type of analysis because CO_2 abatement policies have both direct and indirect effects that increase the costs of production. The direct effects are reflected in the increased costs created by the imposition of the policy on the use of CO_2-emitting industries. Indirect costs are incurred through the use of inputs or processes in production that have previously been subject to the policy. This means that even industries that are not directly impacted by a policy are subject to potentially significant cost increases through increased prices of intermediate inputs from other industries used in their production processes.

[18] Also known as carbon neutrality, net zero emissions are achieved when emissions of greenhouse gases into the atmosphere are balanced by their removal over as specific period of time. For more, see IPCC, 2018: Annex I: Glossary [Matthews, J.B.R. (ed.)]. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)].

[19] See, for example, Nishiyama, S., (2013) *Fiscal Policy Effects in a Heterogeneous-Agent Overlapping-Generations Economy With an Aging Population*, Congressional Budget Office, Working Paper 2013-07; Joint Committee on Taxation, (2014) *Macroeconomic Analysis of the "Tax Reform Act of 2014,"* (JCX-22-14); Joint Committee on Taxation, (2005) *Macroeconomic Analysis of Various Proposals to Provide $500 Billion in Tax Relief*, (JCX-4-05); Carroll, R., Diamond, J., Johnson, C., & Mackie, J, III, *A Summary of the Dynamic Analysis of the Tax Reform Options Prepared for the President's Advisory Panel on Federal Tax Reform*, (2006) Office of Tax Analysis, US Department of the Treasury; Ross, M., (2009*), Documentation of the Applied Dynamic Analysis of the Global Economy (ADAGE) Model*, Research Triangle Institute; Goettle, R., Ho, M., Jorgenson, D., & Wilcoxen, P., (2013) *Energy, The Environment, and U.S. Economic Growth*, in *Handbook of Computable General Equilibrium Modeling*, edited by Peter Dixon and Dale Jorgenson.