

## ANALYSIS

March 2020

---

### Prepared by

Mark Zandi  
[Mark.Zandi@moodys.com](mailto:Mark.Zandi@moodys.com)  
Chief Economist

Chris Lafakis  
[Chris.Lafakis@moodys.com](mailto:Chris.Lafakis@moodys.com)  
Director

### Contact Us

Email  
[help@economy.com](mailto:help@economy.com)

U.S./Canada  
+1.866.275.3266

EMEA  
+44.20.7772.5454 (London)  
+420.224.222.929 (Prague)

Asia/Pacific  
+852.3551.3077

All Others  
+1.610.235.5299

Web  
[www.economy.com](http://www.economy.com)  
[www.moodysanalytics.com](http://www.moodysanalytics.com)

# 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 bot-

tom 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&amp;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 captured 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<sub>2</sub> 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<sub>2</sub> emissions were also included, with the historical data derived using the Environmental Protection Agency's data on total CO<sub>2</sub> emissions and the Energy Information Administration's data on energy-related CO<sub>2</sub> 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<sub>2</sub> coefficients are constant, CO<sub>2</sub> 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 CO<sub>2</sub> 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<sub>2</sub> emissions. Non-energy CO<sub>2</sub> 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 govern-

ment 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 360° 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.

## About Moody's Analytics

Moody's Analytics provides financial intelligence and analytical tools supporting our clients' growth, efficiency and risk management objectives. The combination of our unparalleled expertise in risk, expansive information resources, and innovative application of technology helps today's business leaders confidently navigate an evolving marketplace. We are recognized for our industry-leading solutions, comprising research, data, software and professional services, assembled to deliver a seamless customer experience. Thousands of organizations worldwide have made us their trusted partner because of our uncompromising commitment to quality, client service, and integrity.

Concise and timely economic research by Moody's Analytics supports firms and policymakers in strategic planning, product and sales forecasting, credit risk and sensitivity management, and investment research. Our economic research publications provide in-depth analysis of the global economy, including the U.S. and all of its state and metropolitan areas, all European countries and their subnational areas, Asia, and the Americas. We track and forecast economic growth and cover specialized topics such as labor markets, housing, consumer spending and credit, output and income, mortgage activity, demographics, central bank behavior, and prices. We also provide real-time monitoring of macroeconomic indicators and analysis on timely topics such as monetary policy and sovereign risk. Our clients include multinational corporations, governments at all levels, central banks, financial regulators, retailers, mutual funds, financial institutions, utilities, residential and commercial real estate firms, insurance companies, and professional investors.

Moody's Analytics added the economic forecasting firm Economy.com to its portfolio in 2005. This unit is based in West Chester PA, a suburb of Philadelphia, with offices in London, Prague and Sydney. More information is available at [www.economy.com](http://www.economy.com).

Moody's Analytics is a subsidiary of Moody's Corporation (NYSE: MCO). Further information is available at [www.moodyanalytics.com](http://www.moodyanalytics.com).

DISCLAIMER: Moody's Analytics, a unit of Moody's Corporation, provides economic analysis, credit risk data and insight, as well as risk management solutions. Research authored by Moody's Analytics does not reflect the opinions of Moody's Investors Service, the credit rating agency. To avoid confusion, please use the full company name "Moody's Analytics", when citing views from Moody's Analytics.

## About Moody's Corporation

Moody's Analytics is a subsidiary of Moody's Corporation (NYSE: MCO). MCO reported revenue of \$4.8 billion in 2019, employs more than 11,000 people worldwide and maintains a presence in more than 40 countries. Further information about Moody's Analytics is available at [www.moodyanalytics.com](http://www.moodyanalytics.com).

© 2020 Moody's Corporation, Moody's Investors Service, Inc., Moody's Analytics, Inc. and/or their licensors and affiliates (collectively, "MOODY'S"). All rights reserved.

**CREDIT RATINGS ISSUED BY MOODY'S INVESTORS SERVICE, INC. AND ITS RATINGS AFFILIATES ("MIS") ARE MOODY'S CURRENT OPINIONS OF THE RELATIVE FUTURE CREDIT RISK OF ENTITIES, CREDIT COMMITMENTS, OR DEBT OR DEBT-LIKE SECURITIES, AND MOODY'S PUBLICATIONS MAY INCLUDE MOODY'S CURRENT OPINIONS OF THE RELATIVE FUTURE CREDIT RISK OF ENTITIES, CREDIT COMMITMENTS, OR DEBT OR DEBT-LIKE SECURITIES. MOODY'S DEFINES CREDIT RISK AS THE RISK THAT AN ENTITY MAY NOT MEET ITS CONTRACTUAL, FINANCIAL OBLIGATIONS AS THEY COME DUE AND ANY ESTIMATED FINANCIAL LOSS IN THE EVENT OF DEFAULT. CREDIT RATINGS DO NOT ADDRESS ANY OTHER RISK, INCLUDING BUT NOT LIMITED TO: LIQUIDITY RISK, MARKET VALUE RISK, OR PRICE VOLATILITY. CREDIT RATINGS AND MOODY'S OPINIONS INCLUDED IN MOODY'S PUBLICATIONS ARE NOT STATEMENTS OF CURRENT OR HISTORICAL FACT. MOODY'S PUBLICATIONS MAY ALSO INCLUDE QUANTITATIVE MODEL-BASED ESTIMATES OF CREDIT RISK AND RELATED OPINIONS OR COMMENTARY PUBLISHED BY MOODY'S ANALYTICS, INC. CREDIT RATINGS AND MOODY'S PUBLICATIONS DO NOT CONSTITUTE OR PROVIDE INVESTMENT OR FINANCIAL ADVICE, AND CREDIT RATINGS AND MOODY'S PUBLICATIONS ARE NOT AND DO NOT PROVIDE RECOMMENDATIONS TO PURCHASE, SELL, OR HOLD PARTICULAR SECURITIES. NEITHER CREDIT RATINGS NOR MOODY'S PUBLICATIONS COMMENT ON THE SUITABILITY OF AN INVESTMENT FOR ANY PARTICULAR INVESTOR. MOODY'S ISSUES ITS CREDIT RATINGS AND PUBLISHES MOODY'S PUBLICATIONS WITH THE EXPECTATION AND UNDERSTANDING THAT EACH INVESTOR WILL, WITH DUE CARE, MAKE ITS OWN STUDY AND EVALUATION OF EACH SECURITY THAT IS UNDER CONSIDERATION FOR PURCHASE, HOLDING, OR SALE.**

MOODY'S CREDIT RATINGS AND MOODY'S PUBLICATIONS ARE NOT INTENDED FOR USE BY RETAIL INVESTORS AND IT WOULD BE RECKLESS AND INAPPROPRIATE FOR RETAIL INVESTORS TO USE MOODY'S CREDIT RATINGS OR MOODY'S PUBLICATIONS WHEN MAKING AN INVESTMENT DECISION. IF IN DOUBT YOU SHOULD CONTACT YOUR FINANCIAL OR OTHER PROFESSIONAL ADVISER.

ALL INFORMATION CONTAINED HEREIN IS PROTECTED BY LAW, INCLUDING BUT NOT LIMITED TO, COPYRIGHT LAW, AND NONE OF SUCH INFORMATION MAY BE COPIED OR OTHERWISE REPRODUCED, REPACKAGED, FURTHER TRANSMITTED, TRANSFERRED, DISSEMINATED, REDISTRIBUTED OR RESOLD, OR STORED FOR SUBSEQUENT USE FOR ANY SUCH PURPOSE, IN WHOLE OR IN PART, IN ANY FORM OR MANNER OR BY ANY MEANS WHATSOEVER, BY ANY PERSON WITHOUT MOODY'S PRIOR WRITTEN CONSENT.

All information contained herein is obtained by MOODY'S from sources believed by it to be accurate and reliable. Because of the possibility of human or mechanical error as well as other factors, however, all information contained herein is provided "AS IS" without warranty of any kind. MOODY'S adopts all necessary measures so that the information it uses in assigning a credit rating is of sufficient quality and from sources MOODY'S considers to be reliable including, when appropriate, independent third-party sources. However, MOODY'S is not an auditor and cannot in every instance independently verify or validate information received in the rating process or in preparing the Moody's publications.

To the extent permitted by law, MOODY'S and its directors, officers, employees, agents, representatives, licensors and suppliers disclaim liability to any person or entity for any indirect, special, consequential, or incidental losses or damages whatsoever arising from or in connection with the information contained herein or the use of or inability to use any such information, even if MOODY'S or any of its directors, officers, employees, agents, representatives, licensors or suppliers is advised in advance of the possibility of such losses or damages, including but not limited to: (a) any loss of present or prospective profits or (b) any loss or damage arising where the relevant financial instrument is not the subject of a particular credit rating assigned by MOODY'S.

To the extent permitted by law, MOODY'S and its directors, officers, employees, agents, representatives, licensors and suppliers disclaim liability for any direct or compensatory losses or damages caused to any person or entity, including but not limited to by any negligence (but excluding fraud, willful misconduct or any other type of liability that, for the avoidance of doubt, by law cannot be excluded) on the part of, or any contingency within or beyond the control of, MOODY'S or any of its directors, officers, employees, agents, representatives, licensors or suppliers, arising from or in connection with the information contained herein or the use of or inability to use any such information.

NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE ACCURACY, TIMELINESS, COMPLETENESS, MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE OF ANY SUCH RATING OR OTHER OPINION OR INFORMATION IS GIVEN OR MADE BY MOODY'S IN ANY FORM OR MANNER WHATSOEVER.

Moody's Investors Service, Inc., a wholly-owned credit rating agency subsidiary of Moody's Corporation ("MCO"), hereby discloses that most issuers of debt securities (including corporate and municipal bonds, debentures, notes and commercial paper) and preferred stock rated by Moody's Investors Service, Inc. have, prior to assignment of any rating, agreed to pay to Moody's Investors Service, Inc. for appraisal and rating services rendered by it fees ranging from \$1,000 to approximately \$2,700,000. MCO and MIS also maintain policies and procedures to address the independence of MIS's ratings and rating processes. Information regarding certain affiliations that may exist between directors of MCO and rated entities, and between entities who hold ratings from MIS and have also publicly reported to the SEC an ownership interest in MCO of more than 5%, is posted annually at [www.moody's.com](http://www.moody's.com) under the heading "Investor Relations — Corporate Governance — Director and Shareholder Affiliation Policy."

Additional terms for Australia only: Any publication into Australia of this document is pursuant to the Australian Financial Services License of MOODY'S affiliate, Moody's Investors Service Pty Limited ABN 61 003 399 657AFSL 336969 and/or Moody's Analytics Australia Pty Ltd ABN 94 105 136 972 AFSL 383569 (as applicable). This document is intended to be provided only to "wholesale clients" within the meaning of section 761G of the Corporations Act 2001. By continuing to access this document from within Australia, you represent to MOODY'S that you are, or are accessing the document as a representative of, a "wholesale client" and that neither you nor the entity you represent will directly or indirectly disseminate this document or its contents to "retail clients" within the meaning of section 761G of the Corporations Act 2001. MOODY'S credit rating is an opinion as to the creditworthiness of a debt obligation of the issuer, not on the equity securities of the issuer or any form of security that is available to retail investors. It would be reckless and inappropriate for retail investors to use MOODY'S credit ratings or publications when making an investment decision. If in doubt you should contact your financial or other professional adviser.

Additional terms for Japan only: Moody's Japan K.K. ("MJKK") is a wholly-owned credit rating agency subsidiary of Moody's Group Japan G.K., which is wholly-owned by Moody's Overseas Holdings Inc., a wholly-owned subsidiary of MCO. Moody's SF Japan K.K. ("MSFJ") is a wholly-owned credit rating agency subsidiary of MJKK. MSFJ is not a Nationally Recognized Statistical Rating Organization ("NRSRO"). Therefore, credit ratings assigned by MSFJ are Non-NRSRO Credit Ratings. Non-NRSRO Credit Ratings are assigned by an entity that is not a NRSRO and, consequently, the rated obligation will not qualify for certain types of treatment under U.S. laws. MJKK and MSFJ are credit rating agencies registered with the Japan Financial Services Agency and their registration numbers are FSA Commissioner (Ratings) No. 2 and 3 respectively.

MJKK or MSFJ (as applicable) hereby disclose that most issuers of debt securities (including corporate and municipal bonds, debentures, notes and commercial paper) and preferred stock rated by MJKK or MSFJ (as applicable) have, prior to assignment of any rating, agreed to pay to MJKK or MSFJ (as applicable) for appraisal and rating services rendered by it fees ranging from JPY125,000 to approximately JPY250,000,000.

MJKK and MSFJ also maintain policies and procedures to address Japanese regulatory requirements.