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The Impact of COVID-19 on California Transportation Revenue

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Abstract

The COVID-19 public health emergency has affected every aspect of life in California, and the severe reductions in social and economic activity have dramatically reduced travel. Transportation revenue has plummeted because user fees produce a large share of resources needed to operate California's transportation system. As we emerge from the crisis and return to normal levels of activity, the state must plan transportation system operations and maintenance in the context of deep uncertainty regarding available resources.

This research used simple spreadsheet models to estimate the impact that different scenarios for economic recovery from the COVID-19 pandemic would have on state-generated transportation revenues. Because it is not possible to state with certainty future economic conditions, travel volumes, and vehicle markets, we created five potential economic recovery scenarios and projected future transportation revenue in California through 2030 under each. The differences among the scenarios illuminate a range of possible futures for which the state can prepare.

Key findings include that (1) the total revenue raised varies considerably among the scenarios; (2) fuel taxes generate the lion's share of revenues in all scenarios; and (3) should the number of zero emission vehicles (ZEVs) dramatically increase, then the registration fees levied on them can replace and potentially even exceed the state revenue that will be lost because of declining gasoline sales tax revenue.

1. Introduction

The COVID-19 crisis has generated an unprecedented shock to travel as well as to economic activity. Government agencies have reported plummeting declines in vehicle miles traveled and the associated fuel sales that generate fuel tax revenues. Further, the economic contraction triggered by the shelter-in-place order seems destined to produce at the very least short-term reductions in vehicle sales, as consumers suffer financial hardships and hesitate to make major purchases in the face of tremendous uncertainty.

There is widespread recognition in the transportation industry that these changes to travel behavior will lead to plummeting fuel tax revenues. For example, IHS Markit reported on April 21, 2020, that national gasoline sales in late March were 47% down from sales one year earlier,[1] and traffic data firm Inrix reported that personal travel had dropped almost in half between late February (before most social distancing measures were in place) and early April.[2] And on April 6, 2020, the American Association of State Highway and Transportation Officials (AASHTO) sent a memo to the U.S

Congress predicting "what will average at least a 30 percent loss in state transportation revenues in the next 18 months."[3]

What remains unclear is *how much* transportation revenue will be lost to California in both the short and medium term. To explore that question, we applied an established spreadsheet model to project California transportation revenues to 2030 under five scenarios that vary by the length of the downturn in travel and economic activity, as well as different state policy choices related to vehicle purchases. We chose this scenario approach because the immense uncertainly of the moment suggests that California would be wise to prepare for a range of possible futures with respect to the level of transportation revenues.

The projections made for this study look only at transportation revenues collected directly by the state. These revenues are an important part of transportation program funding in California, but still only one portion of total funding, and other sources of revenue stand to drop along with those projected in this report. Revenue from transit fares and bridge and road tolls has also plummeted during the current emergency, along with the drop in vehicle miles traveled. Federal transportation funds are crucial, too. At the local level, county transportation sales taxes provide some counties with as much as a third of their transportation funding, and many jurisdictions devote general fund revenues to transportation programs.[4]

The remaining sections of the report are as follows. Section 2 presents the methodology, including the models and the five scenarios tested. Section 3 presents the results from applying the model to the five scenarios. Technical appendices present methodological details, including the formulas used to project revenues and details on the data used as model inputs, as well as projected revenues by individual taxes and fees.

2. Methodology

We projected revenues produced by taxes and fees collected by the State of California that meet three criteria: they are collected from vehicle owners and users; the state dedicates the proceeds for transportation programs; and the amount of revenue collected corresponds at least in part to the vehicle's fuel source—internal combustion engine (ICE) or a Zero Emission Vehicle (ZEV). The relevant taxes are gasoline excise taxes, diesel excise taxes, diesel sales taxes, the state's Transportation Improvement Fee (TIF), and the state's Road Improvement Fee (RIF) charged annually on ZEVs.[5] Table 1 shows the rate for each tax or fee, as established by California Senate Bill 1: The Road Repair and Accountability Act of 2017.

Table 1. State of California Transportation Taxes and Fees Projected

Tax/fee	Rate [a]
Fuel taxes	
Gasoline excise tax	Base excise tax of 30¢ per gallon + swap[b] excise tax of 17.3¢ per gallon (effective 7/1/2019)
Diesel excise tax	36¢ per gallon
Diesel swap[b] sales tax	5.75% on purchase price
Vehicle fees (annual)	
Transportation Improvement Fee (TIF)	$25 to $175 per vehicle Rate depends on vehicles value
Road Improvement Fee (RIF)	$100 per ZEV of model year 2020 or later (effective 7/1/2020)

Source: Adapted from California Legislative Analyst's Office, *Overview of 2017 Transportation Funding Package* (2017), http://www.lao.ca.gov/Publications/Report/3688 (accessed May 8, 2020).

[a] Rates will be adjusted for inflation starting July 1, 2020 for the gasoline and diesel excise taxes, January 1, 2020 for the Transportation Improvement Fee, and January 1, 2021 for the Road Improvement Fee on ZEVs. The diesel sales taxes are not adjusted for inflation.

[b] For details about the fuel tax swap, including tax and fee rates prior to the swap, see Anne Brown, Mark Garrett, and Martin Wachs, "Assessing the California Fuel Tax Swap of 2010," *Transportation Research Record: The Journal of the Transportation Research Board*, no. 2670 (2017), pp. 16–23.

The Projection Model

The projections were calculated using an existing spreadsheet model that estimates annual transportation revenues collected by the State of California. The authors developed the model and used it to produce two earlier research reports that projected revenues under different tax and fee rates,[6] as well as under different ZEV adoption scenarios.[7] The spreadsheet model was adapted for the current project to compare revenues under different economic recovery scenarios.

The model calculates revenues by applying California's current tax and fee rates to projected sales of motor fuel for transportation purposes and projected registrations of both light-duty internal combustion engine (ICE) vehicles and ZEVs. Key independent variables used to project fuel consumption and vehicle ownership include gasoline and diesel fuel prices, the number of registered vehicles, ZEV adoption rates, and vehicle values. Technical Appendix A presents the formulas used to project revenues.

The projections used inputs derived from authoritative sources, such as revenue data from the State of California and a widely-used set of national projections of transportation energy prepared by the US Energy Information Administration (EIA) of the US Department of Energy.[8] Complete details about the data sources and assumptions employed to operationalize the model are available in Technical Appendix B.

The Scenarios

We constructed five recovery scenarios by creating a set of three possible revenue trajectories for each of four transportation-specific variables that have a major impact on revenue and are most likely to be affected over time by COVID-19. The variables are gasoline consumption—which directly influences excise tax revenues—and three variables that directly affect the amount of RIF and TIF revenue: total light-duty vehicle registrations, ZEV registrations, and vehicle prices.

Table 2 presents three possible revenue trajectories through 2030 for each key variable. The "high-revenue" trajectory for each assumes that the economy recovers from the COVID-19 shock quickly and that government implements proactive policies like tax credits to stimulate vehicle purchases in general and electric vehicles in particular. The medium-revenue trajectories assume a somewhat slower rate of economic recovery and less aggressive government policies to stimulate the vehicle market. The low-revenue trajectories assume that the economy takes ten years to reach recovery and government does not adopt policies to stimulate the vehicle market. Technical Appendix C shows the growth of each variable under the three trajectories.

To assign the values used to construct these trajectories, we analyzed media reports from the past month (e.g., reports on falling VMT rates), chose hypothetical state policy choices, and analyzed rates of year-to-year change since 2008 (or since the first year for which data was available). The analysis of past trends takes particular note of patterns following 2008, the year the Great Recession began. The recovery trajectory from that economic shock seems a more reasonable basis for predicting the recovery from COVID-19 than would trends based on a much longer time frame that included economic highs.

The rationale for choosing high, medium, and low revenue trajectories for each of the four key variables used to build the recovery scenarios is as follows:

- ***Gasoline consumption***: Starting in March of 2020, there have been numerous indicators that VMT has fallen dramatically as soon as states imposed shelter-in-place rules, dropping by 40%, 50%, and even 60% in some areas.[9] We assumed a 50% drop in gasoline consumption across all three cases, but varied the length of time the decline persists by changing the date the recovery begins and ends, as well as how close the recovery comes to the resumption of pre-emergency conditions. The high-revenue trajectory assumes that recovery begins on June 1, and that consumption returns to pre-COVID-19 levels after 18 months (the end of 2021). The medium and low-revenue trajectories assume that recovery begins later in the summer of 2020 and that consumption does not reach recovery until the end of 2024 (medium) or 2030 (low). The low-revenue case also assumes that the eventual recovery level reaches only 90% of pre-COVID-19 levels. Despite a return to economic and population growth, some short-term changes could linger. For example, declining attendance at movies, working from home, and telemedicine conceivably could become long-term trends, and some businesses closures could be permanent.

- ***Vehicle registrations***: The values for the three revenue cases were set in relation to year-to-year trends since 2012, the earliest year for which we had data. The high-revenue case assumed the highest growth rate from that period (2%), the medium-revenue cases assumed the average growth rate from 2008 to 2017 (0.8%), and the low-revenue case assumed the lowest year's growth since 2008 (0.5%). An economic shock could well depress vehicle sales, so the high-revenue scenario assumed only that the mean growth rate from 2008-2017 continues.

- ***ZEV registrations***: The high-revenue trajectory has the number of ZEVs in California meeting the state's target of 1.5 million registered ZEVs by 2025 and 5 million by 2030. The other two trajectories used annual growth rates in ZEVs from 2008 through 2019. The medium-revenue trajectory assumed that ZEV numbers grow by 50,000 annually; this was the annual growth rate from 2018-2019, the year which experienced the highest growth rate between 2012 and 2019. Finally, the low-revenue trajectory assumed annual growth of 15,000 new ZEVs; this is the annual growth rate from 2014-2015, which saw the lowest rate over the period from 2008 to 2019. Both California and the federal government offer subsidies and tax credits to encourage consumers to purchase ZEVs. It is possible that the state or the federal government will increase subsidies for ZEV purchases as an economic stimulus in the wake of the COVID-19 emergency.

- ***Vehicle value***: The high-revenue trajectory assumed that vehicle values continue to grow at the rates predicted by the EIA. However, should the economic shock linger, we assumed that Californians will likely hold onto their vehicles longer, purchase used cars more than new ones, and purchase relatively less expensive new vehicles, dropping vehicle values below EIA projections by 5% (medium-revenue) or 10% (low-revenue).

Table 2. High, Medium, and Low-Revenue Trajectories for Each Key Variable in the Recovery Scenarios

Variables	High-revenue	Medium-revenue	Low-revenue
Gasoline consumption (volume)			
Depth of "bottom" (% of pre-COVID-19 weekly consumption)	50%	50%	50%
Date recovery begins	June 1, 2020	July 1, 2020	August 1, 2020
Date when recovery level is reached	Dec. 31, 2021	Dec. 31, 2024	Dec. 31, 2030
Recovery level, as % of pre-COVID-19 consumption	100%	100%	90%
Vehicle registrations annual growth rate	1.9% (highest year-to-year growth rate for 2008-2017)	0.8% (mean year-to-year growth rate for 2008 - 2017)	0.5% (lowest year-to-year growth rate for 2008-2017)
ZEV registrations annual growth rate	Meet CA target of 1.5 million ZEVs by 2025 and 5 million by 2030	+50,000 per year (2018-19 rate)	+15,000 per year (2014-15 rate)
Vehicle value	EIA rate (same as the baseline)	5% under EIA rate	10% under EIA rate

The models keep all other variables the same across the five scenarios, assuming:

1. COVID-19 will not have a major impact on the trajectory otherwise predicted by observed data from 2008 to 2017;
2. The revenue trajectory will be similar across all scenarios; and/or
3. The variable will have only a minimal impact on the total state revenue collected in any year.

For example, reports so far indicate that the COVID-19 crisis has not radically changed freight mileage,[10] and diesel fuel sales have a small impact on overall revenues. Therefore, we assumed the same rates of diesel fuel sales in every scenario, and California's share of the total gallons of diesel sold nationally will continue to increase at 4% annually, the mean annual rate of change from 2008 to 2017. Also, we assumed that inflation rates will stay low under all five scenarios (1.76%), and that vehicle value depreciates over 11 years, in a straight line, to a zero-dollar salvage value.

Table 3 shows how the five recovery scenarios each draw on the high, medium, or low trajectories laid out in Table 2.

Table 3. Trajectories Chosen for Each Key Variable in the Recovery Scenarios

Recovery scenarios	Gas consumption	Vehicle registrations	ZEV registrations	Vehicle value
Fast w/ZEV stimulus	High	High	High	High
Moderate w/ZEV stimulus	Medium	Medium	High	Low
Moderate	Medium	Medium	Medium	Medium
Moderate w/stagnated vehicle market	Medium	Low	Low	Medium
Slow	Low	Low	Low	Low

Note: See Table 2 for definitions of the high, medium, and low trajectories for each variable.

3. Findings

This section presents the results of the projections, looking first at total projected revenues under each scenario and then at the composition of total revenues for each scenario. Technical Appendix D shows the projected revenues for each individual tax and fee.

Total Projected Transportation Revenues

We projected total state transportation revenues from 2019 to 2030 for the five scenarios, compared with a "baseline" that is the projected revenues had COVID-19 not occurred. SB1 increased transportation revenue in comparison with earlier projections, but a steady trend toward increased fuel economy and the adoption of ZEVS results in baseline revenues that decline gradually over time. The figures below present the projections as bands that represent both the mean projection and the range of outcomes that result from using a plausible range of parameters drawn mostly from alternative EIA energy futures. For each of the baseline and five COVID-19 scenarios, we estimated an upper bound, a lower bound, and a mean between them. The range between the upper and lower bounds represents a set of plausible outcomes under different economic conditions. The high and low estimates result from numerous assumptions about reasonable ranges of the independent variables. The estimates result from combinations of various factors that cannot be individually associated with probabilities of occurrence, such as vehicle fleet fuel efficiency, the market price of gasoline, and annual VMT. For that reason, the bands do not indicate a particular level of statistical significance.

As with any projections, these rely on numerous assumptions about future trends—gasoline prices, inflation rates, fleet changes, and so on. Even in the most stable era, unforeseen changes in conditions undoubtedly will occur, and COVID-19 creates far more uncertainty than ever. For example, if population or per-capita VMT were to drop markedly, or the fuel efficiency of ICE vehicles to decrease greatly, then revenues could fall outside the gasoline consumption projection band. Also, future ZEV prices are of particular importance to the projections. If purchase prices fall much faster than assumed, perhaps in response to a state program to stimulate their purchase in the interest of an economic recovery, then revenues may fall outside the values projected in this report.

Figure 1 presents the total revenue that California would collect from 2019 to 2030 under the baseline and five COVID-19 recovery scenarios. For each scenario, a line shows the mean value, and the shaded band shows the range between the projected upper and lower bounds. Areas in the figure with darker shading indicate that the projections for two or more scenarios overlap. Figure 2 presents the same data but separates out the projections for each scenario.

Notably, by 2030 the projected annual revenue from all the scenarios has almost converged, with the exception of the slow-recovery scenario. For the fast-recovery-with-ZEV-stimulus scenario, the projected mean revenues in 2030 are $11.4 billion (2020$), while the projected mean revenues for the three moderate recovery scenarios range from $10.1 to $11.1 billion. The mean 2030 revenue from the slow-recovery scenario is only $9.4 billion.

Sustained losses over a number of years would significantly compound the impact of annual revenue losses. Therefore, we summed the mean projected revenues collected every year from 2020 through 2030 for the baseline and COVID-19 scenarios. The total revenue would be $118 billion for the baseline, while the COVID-19 scenarios have totals ranging from $98 billion (a loss of 17%) for the slow-recovery scenario, to $121 billion (a gain of 3%) for the fast-recovery-with-ZEV-stimulus scenario. The latter is projected to generate more revenue than even the baseline because it assumes an aggressive ZEV stimulus policy.

The trajectory of vehicle markets has a notable impact on total revenue collected over the decade. For the moderate-recovery scenario with the stagnated vehicle market, the cumulative mean projected revenue is $5 billion less than the moderate-recovery scenario with ZEV stimulus policies.

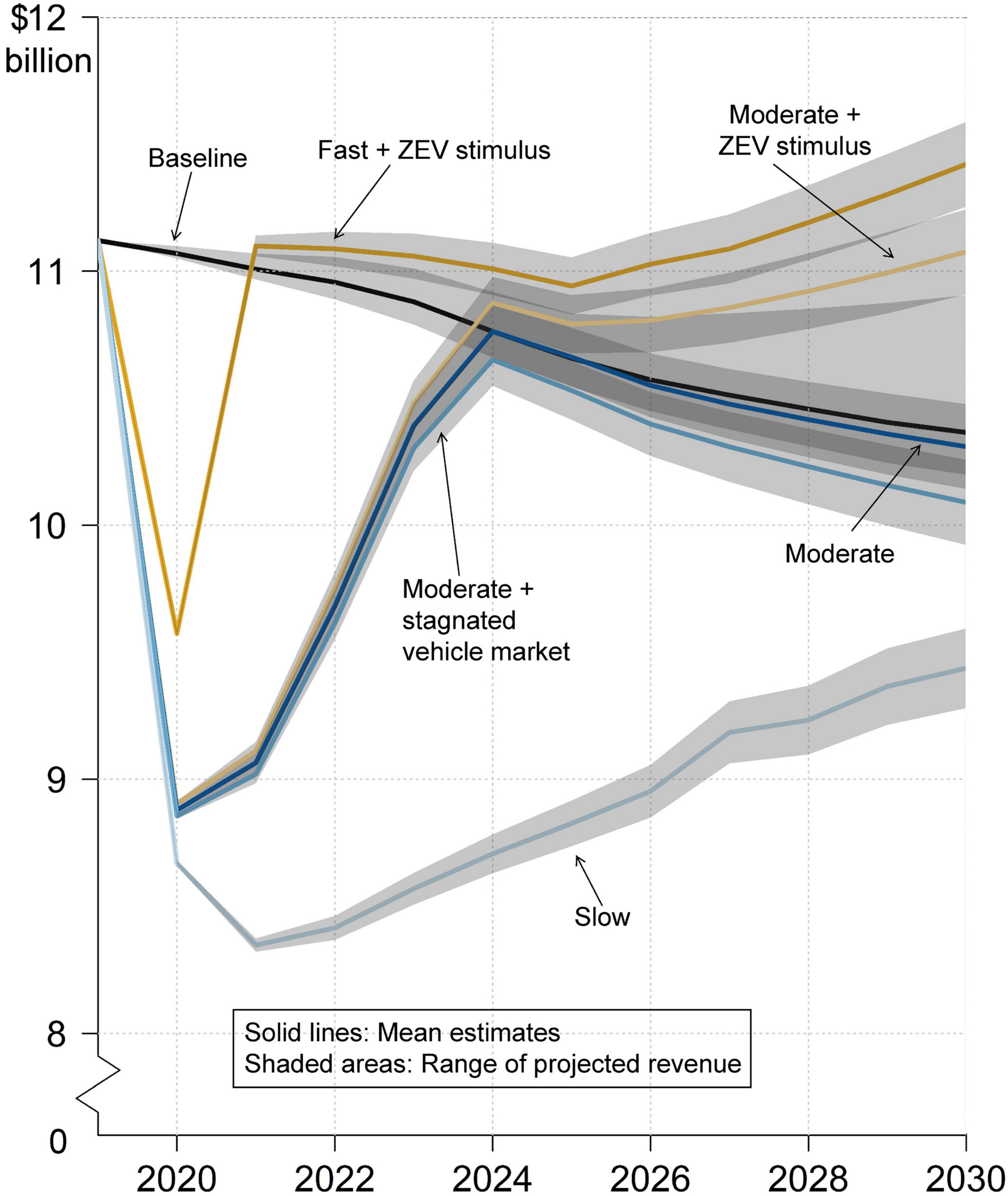

Figure 1. Composite Graph Comparing Total State Revenue under All Scenarios, 2019–2030 (in 2020 dollars)

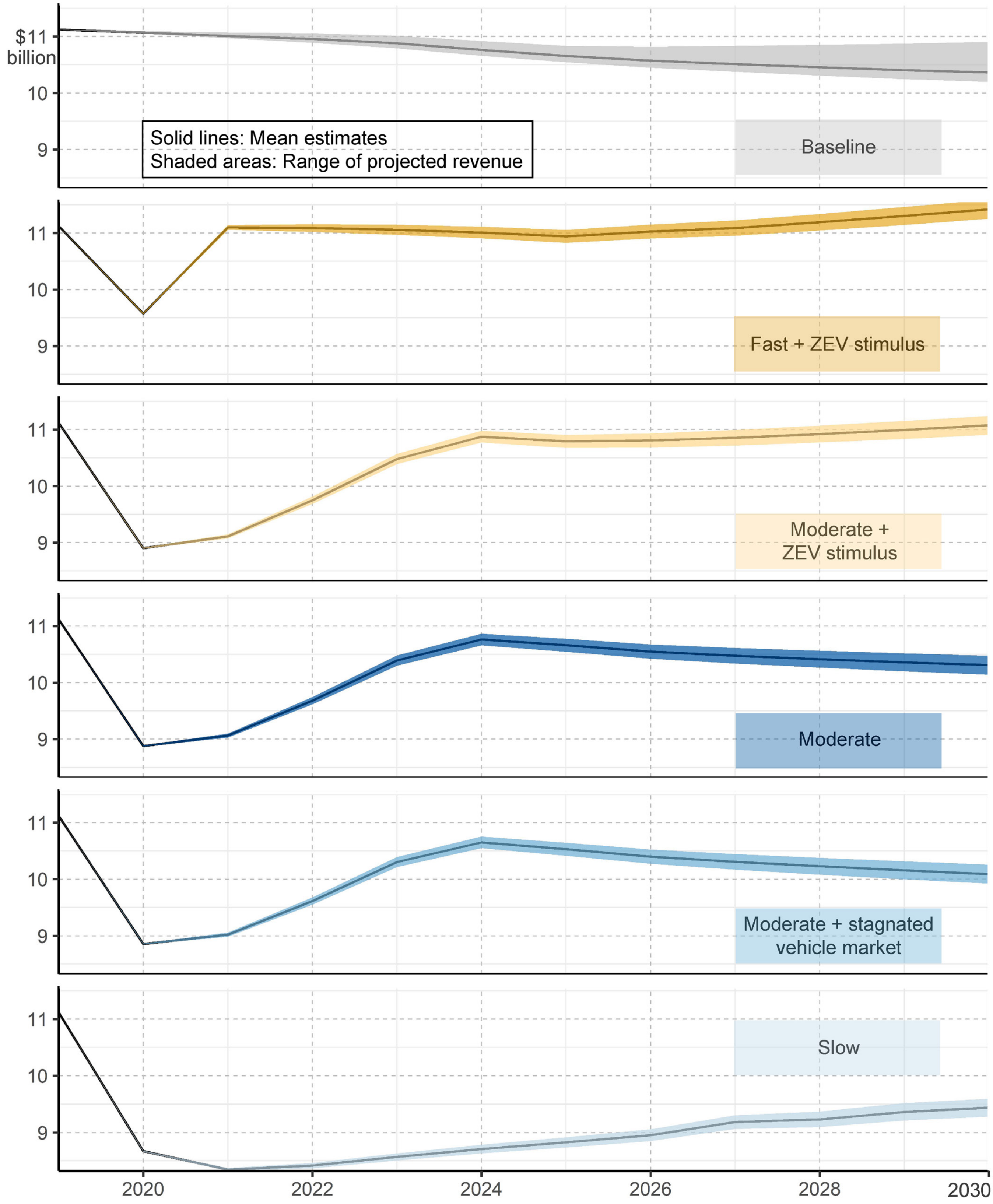

Figure 2. Total State Revenue for Each Scenario, 2019–2030 (in 2020 dollars)

The Composition of Total Revenues

Figure 3 shows how the proportion of revenues collected from each tax and fee will change over time for the baseline and COVID-19 scenarios.

Fuel taxes generate roughly three-quarters of revenues. Across all six scenarios, gasoline taxes remain about half of revenues through 2030. For the year 2030, the percentage ranges from a low of 48% in the fast-recovery-with-ZEV-stimulus scenario, to a high of 54% in the moderate-recovery-with-vehicle-market-stagnation scenario. Diesel excise and sales tax revenues, combined, provide from 21% to 30% of total revenues across all scenarios and all years.

The TIF assessed on all light-duty vehicles generates between 16% and 27% of revenues across all years and scenarios. The percentage rises over the years across every scenario. The percentage is also comparatively higher in the moderate-recovery-with-ZEV-stimulus scenario because the TIF rate is based on vehicle value, and ZEVs tend to have higher values than ICE vehicles.

The RIF, the annual fee applied just to ZEVs, generates revenues ranging from less than 1% to a high of 4% of total revenue. RIF contributes proportionately more in the two scenarios that include a major ZEV stimulus policy.

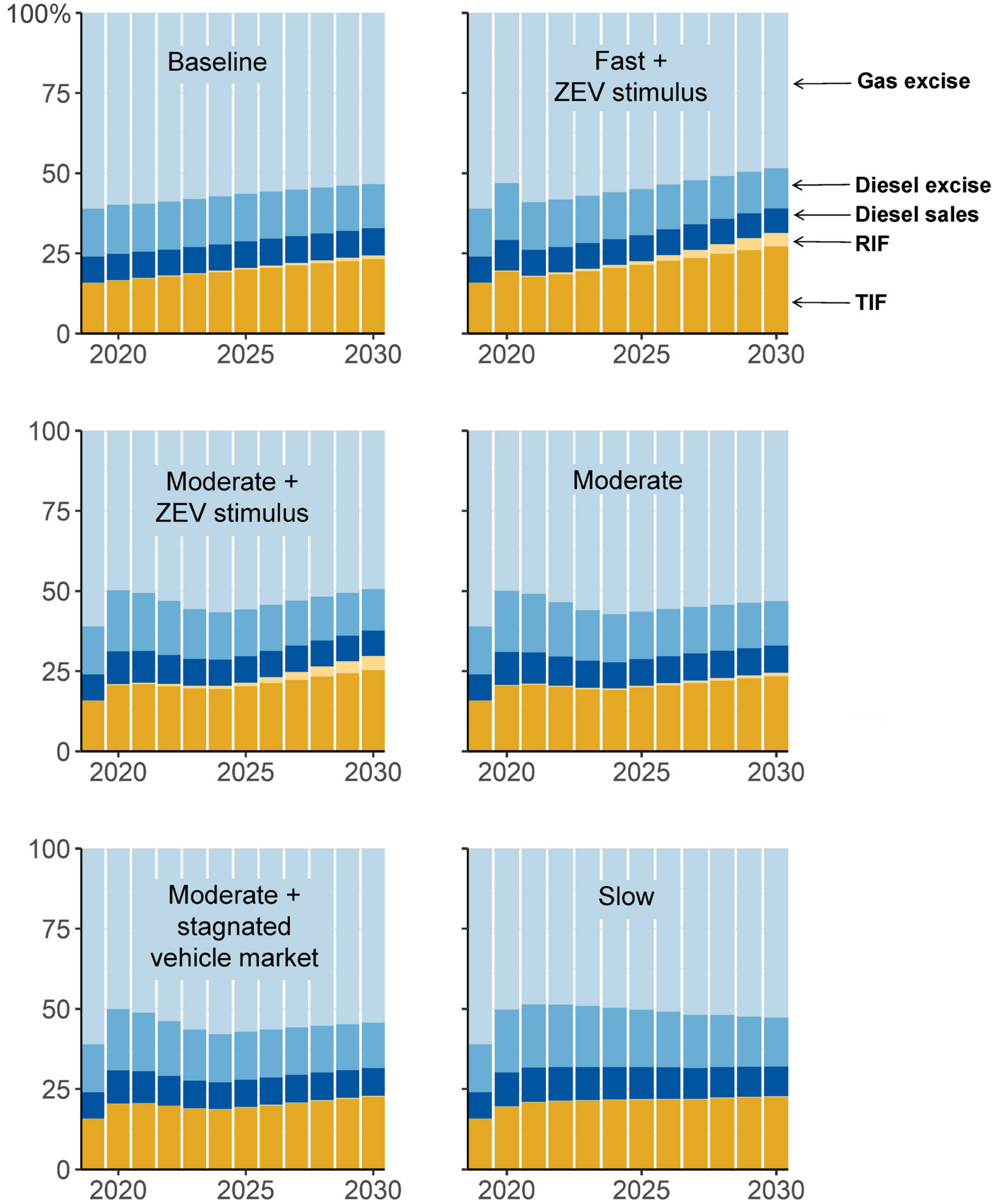

Figure 3. Breakdown of Total Revenue by Source under All Scenarios, 2019–2030

Note: In some scenarios, the RIF revenue is too small to be visible in the figures.

4. Conclusion

This research projected state-generated transportation revenues through 2030 using a tested spreadsheet model and well-known data sources. Recognizing that COVID-19 has created unprecedented uncertainly as to future economic conditions and travel volumes, we created five economic recovery scenarios and projected transportation revenue through 2030 under each. The differences among the scenarios illuminate a range of possible futures for which the state may wish to prepare.

Key study findings are as follows:

The total revenue raised varies considerably among the scenarios. Looking at revenues for 2030, the mean total projected revenues in 2030 range from $9.4 billion (2020$) in the slowest recovery scenario, to a high of $11.4 billion, where all model components return or exceed pre-COVID-19 levels in a relatively short amount of time. The total revenues from those scenarios for the years 2020 to 2030 produce a wide range of potential outcomes. The moderate-recovery-with-ZEV-stimulus scenario generates $17 billion more for 2020 to 2030 than does the slow-recovery scenario. The wide range is an indication that state policy choices have strong potential to influence transportation revenue, even in the wake of the COVID-19 emergency.

Fuel taxes generate the majority of revenues in all scenarios. Across all six scenarios, gasoline taxes remain at least half of revenues through 2030. Adding diesel excise and sales tax revenues, the sum of revenue from taxes on both fuels is roughly three-quarters of the total in all scenarios for all years.

The user fees levied on ZEVs can replace and potentially even exceed the state revenue that will be lost because of declining gasoline sales tax revenue.

RIF and TIF revenues both rise notably as the proportion of ZEVs in the light-duty fleet rises. This rise is most obvious with the RIF, since it is a fee levied only on ZEVs. RIF revenues vary from less than 1% under the slow-recovery and two moderate-recovery scenarios, rising to 4% of total revenues under the fast-recovery-with-ZEV-stimulus scenario and moderate recovery scenario that includes ZEV stimulus policy. However, TIF revenues also rise with more ZEVs because the TIF rate is based on vehicle value, and ZEVs tend to be more expensive than comparable ICE vehicles.

In conclusion, the study findings highlight the very real possibility that California’s policy leaders will need to prepare for a future with considerably less revenue than has been expected. At the same time, the different outcomes projected across the scenarios underscore the potential for policy choices to change the trajectory.

Endnotes

1. Rob Smith, "Coronavirus (COVID-19) Offering Retail Fuel Stations a 'Stress Test' for the Future," IHS Markit (April 21, 2020), https://ihsmarkit.com/research-analysis/coronavirus-offering-retail-fuel-stations-a-stress-test.html.

2. Ryan Beene, "America's Empty Roads: Fewer Deaths but a Blow to State Budgets," Bloomberg (April 15, 2020), https://www.bloomberg.com/news/articles/2020-04-15/america-s-empty-roads-fewer-deaths-but-a-blow-to-state-budgets.

3. American Association of State Highway and Transportation Officials, letter to Congressional leaders Nancy Pelosi, Mitch McConnell, Kevin McCarthy, and Charles E. Schumer (April 6, 2020), https://www.transportation.org/wp-content/uploads/2020/04/2020-04-06-AASHTO-Letter-to-Congress-on-COVID-19-Phase-4-FINAL.pdf.

4. For an overview of transportation revenues at all levels of government in California, see *Transportation Funding in California 2019,* from Caltrans, Division of Transportation Planning | Office of Transportation Economics.

5. Revenues from the state's base vehicle registration fee and vehicle license fee were not projected because the proceeds are not dedicated for transportation programs.

6. Martin Wachs, Hannah King, and Asha Weinstein Agrawal, *The Future of California Transportation Revenue* (San Jose: Mineta Transportation Institute, October 2018).

7. Wachs, Martin, Hannah King, and Asha Weinstein Agrawal, *The Impact of ZEV Adoption on California Transportation Revenue* (San Jose: Mineta Transportation Institute, July 2019).

8. US Energy Information Administration, *Alternative Fuel Infrastructure Expansion: Costs, Resources, Production Capacity, and Retail Availability for Low-Carbon Scenarios*, https://www.nrel.gov/docs/fy13osti/55640.pdf (accessed September 30, 2018).

9. Mark Burfiend, "INRIX U.S. National Traffic Volume Synopsis: Issue #5 (April 11 – 17, 2020)" (INRIX, April 20, 2020), https://inrix.com/blog/2020/04/covid19-us-traffic-volume-synopsis-5/.

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11. More information about the rate is provided by the International Fuel Tax Association, Inc., at https://www.iftach.org/.

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TECHNICAL APPENDIX A: FORMULAS USED TO PREDICT REVENUES

The following formulas were used to project revenue for each year from 2019 to 2030.

1. Projected gasoline excise tax revenues =

gallons of gasoline sold× CPI-adjusted gasoline excise tax rate

2. Diesel excise revenues =

(gallons of diesel sold × CPI-adjusted diesel sales tax rate) + IFTA Component B revenues[11]

3. Diesel sales tax revenues =

gallons of diesel sold × sales tax rate

4.Road Improvement Fee (RIF) revenues (from Zero Emission Vehicles (ZEVs))=

number of registered ZEVs with model years 2020 or later

× CPI-adjusted RIF tax rate

5a. Total TIF revenues =

sum of the TIF revenues for all light duty vehicles in the fleet

5b. TIF revenue for each light duty vehicle =

vehicle value × value-specific TIF rate

TECHNICAL APPENDIX B: DATA SOURCES AND ASSUMPTIONS USED AS MODEL INPUTS

The table below presents the variables used in the models, noting for each the data source and assumptions.

Variables highlighted in yellow are those for which we created the high-revenue, medium-revenue, and low-revenue trajectories that were used as building blocks to the five recovery scenarios.

Variable	Data Source	Assumptions
Tax and fee rates		
Rates under SB1 for the gasoline excise tax, diesel excise tax, diesel sales tax, Road Improvement Fee, and Transportation Improvement Fee levels.	California Legislative Information SB1 Transportation Funding Bill Text	We assumed that the gasoline excise tax rate, diesel excise tax rate, and the Road Improvement Fee will all be adjusted for inflation using the California Consumer Price Index (CPI), following the methodology specified in SB1.
Economic indicators		
California Consumer Price Index (2008-2019)	State of California Department of Industrial Relations California Consumer Price Index (1999–2019)	We assumed the CA Consumer Price Index (CPI) will continue to increase by 2.04% annually. This rate is the mean annual change in the CA CPI from 2008 to 2019.
Inflation rate (2008-2019)	Bureau of Labor Statistics Consumer Price Index (2000–2017)	We assumed inflation continues at 1.76% per year, which was the mean annual change from 2008 to 2019.
Motor fuel-related variables		
Gallons of gasoline sold in the United States (2019–2030)	United States Energy Information Administration Annual Outlook 2020 (Region: United States)	We predicted a range of values for each year. To do so, we used the mean of the EIA's 22 gasoline sales projection scenarios, creating upper and lower boundaries that are +/- 1 standard deviation from the mean.
California's share of total national gasoline sales (2008-2017)	United States Energy Information Administration State Energy Consumption Estimates 1960–2017 (Region: United States)	We assumed that California's share of the total number of gallons of gasoline sold nationally each year will decrease by 5.30% annually. That rate is the mean annual change in California's share of the national total of gasoline sold from 2008 to 2017.
Gallons of diesel sold in the United States (2019–2030)	United States Energy Information Administration Annual Outlook 2020 (Region: United States)	We predicted a range of values for each year by taking the mean of the EIA's 22 diesel-sales projection scenarios and creating upper and lower boundaries that are +/- 1 standard deviation from the mean.
California's share of total national diesel sales (2008-2017)	United States Energy Information Administration State Energy Consumption Estimates 1960–2017 (Region: United States)	We assumed that California's share of the total number of gallons of diesel sold nationally each year increases by 4% annually. That rate is the mean year-to-year change in California's share of the national total of gasoline sold from 2008 to 2017.

Variable	Data Source	Assumptions
Gallons of diesel covered under the International Fuel Tax Agreement (IFTA) (2008-2017)	California Board of Equalization Taxes and Fees (Annual Summaries 2006–2017) California Board of Equalization IFTA Tax Rates (2006–2016)	We were unable to obtain data on the number of gallons of diesel covered under IFTA historically in California. Therefore, we estimated gallons of diesel covered under IFTA by dividing California's annual IFTA tax revenue receipts by the IFTA tax rates.
IFTA Component B tax rate (2010-2017)	California Board of Equalization IFTA Tax Rates (2010–2017)	We assumed the IFTA Component B rate remains at $0.27 per gallon, which is the mean rate from 2010 to 2017. The IFTA Component B rate rose and fell slightly from year to year during the period from 2010 to 2017, but there was no obvious growth, so we assume no change in the IFTA Component B tax rate moving forward.
Diesel prices (2008-2020)	United States Energy Information Commission Gasoline and Diesel Fuel Prices (2012–2018) (Region: United States)	We predicted a range of values for each year. The upper bound is the highest price in the observed 2008-2017 data, and the lower bound is the lowest price in the observed data.
Vehicle-related variables		
Registered vehicles in California (2012-2019)	California Department of Motor Vehicles Forecasting Unit personal communication with the authors)	We used historical vehicle registration rates to estimate future vehicle registration rates. We model three trajectories for the rate of increase in the number of vehicle registrations: • 1.9% (highest year-to-year growth rate for 2008-2017) • 0.8% (mean year-to-year growth rate from 2018-2019) • 0.5% (lowest year-to-year growth rate for 2008 – 2017)

Variable	Data Source	Assumptions
Zero-Emission Vehicles (ZEVs) in California (2012-2019)	California Department of Motor Vehicles Vehicle Registrations by Type (personal communication with the authors)	We used historical ZEV registration rates to estimate future ZEV registration rates in California. The three trajectories used as inputs to the scenarios for the rate of increase are: • The number increases linearly such that the state of California reaches its goals of 1.5 million ZEVs by 2025 and 5 million ZEVs by 2030. • The number increases at the rate seen from 2018-2019 (94,112 vehicles per year) • The number increases by the lowest annual increase amount observed in the available data (15,424 vehicles per year)
Age of the vehicle fleet in California (2013)	Oak Ridge National Laboratory Transportation Energy Data Book Light Duty Vehicles in Operation by Age (2013)	We assume that, through 2030, the age composition of the vehicle fleet mirrors the age composition in 2013.
Average new vehicle purchase price (2019-2020)	United States Energy Information Administration Annual Outlook 2020 (Region: United States)	We project the purchase price of new ICE vehicles and ZEVs based on EIA projections. We model three scenarios for each vehicle energy class, with new vehicle purchase prices: • Following EIA projections • Falling 5% below EIA projections • Falling 10% below EIA projections

TECHNICAL APPENDIX C: PROJECTED TRAJECTORIES OF THE KEY VARIABLES USED TO CONSTRUCT THE RECOVERY SCENARIOS

This appendix shows the trajectories assumed for the four variables used to construct the scenarios:

- Gasoline consumption
- Vehicle registrations
- ZEV registrations
- Vehicle value

For each variable, the figure shows the high-revenue, medium-revenue, and low-revenue trajectory.

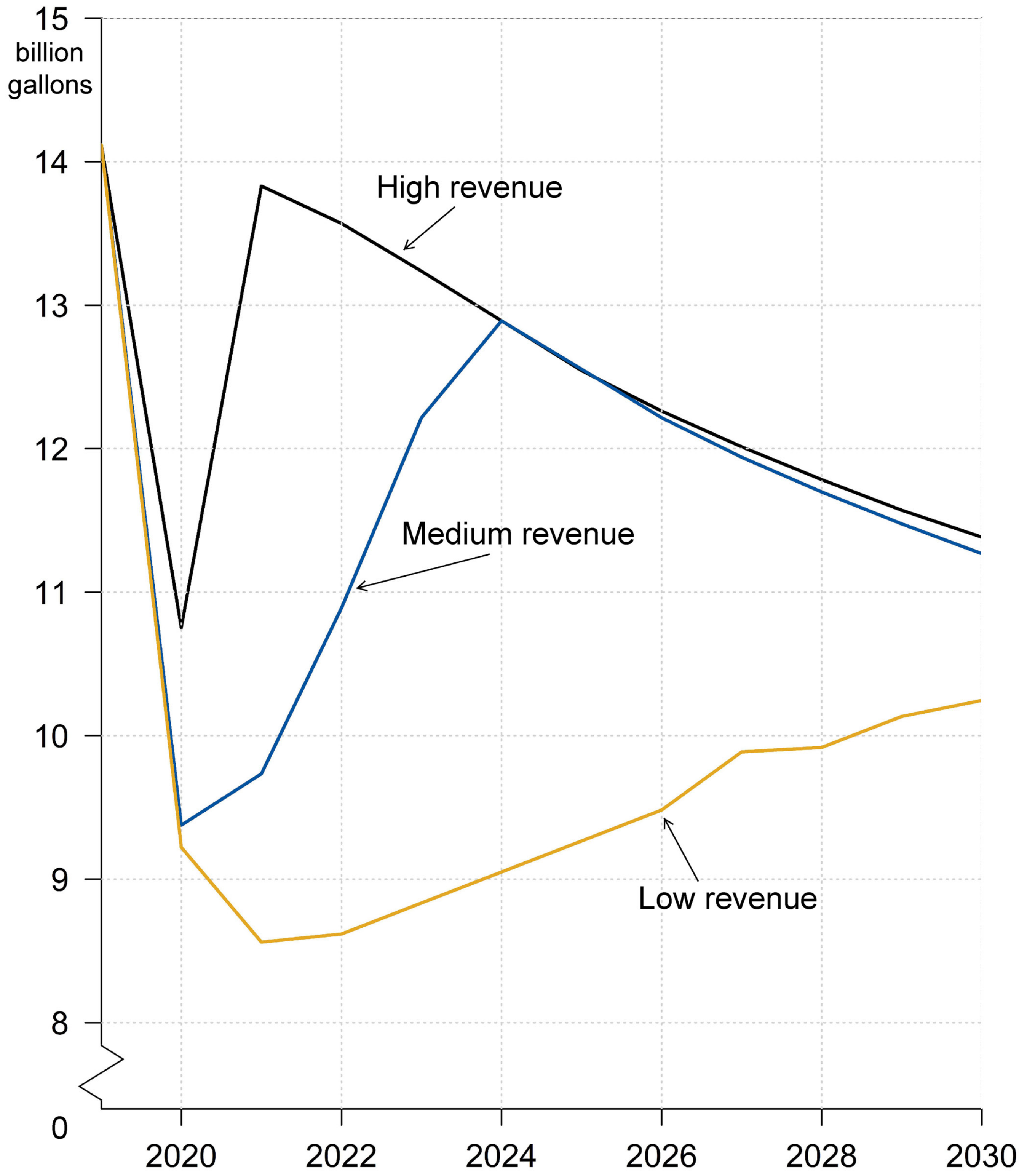

Figure 4. Gasoline Consumption: High, Medium, and Low-Revenue Trajectories Used to Construct the Scenarios

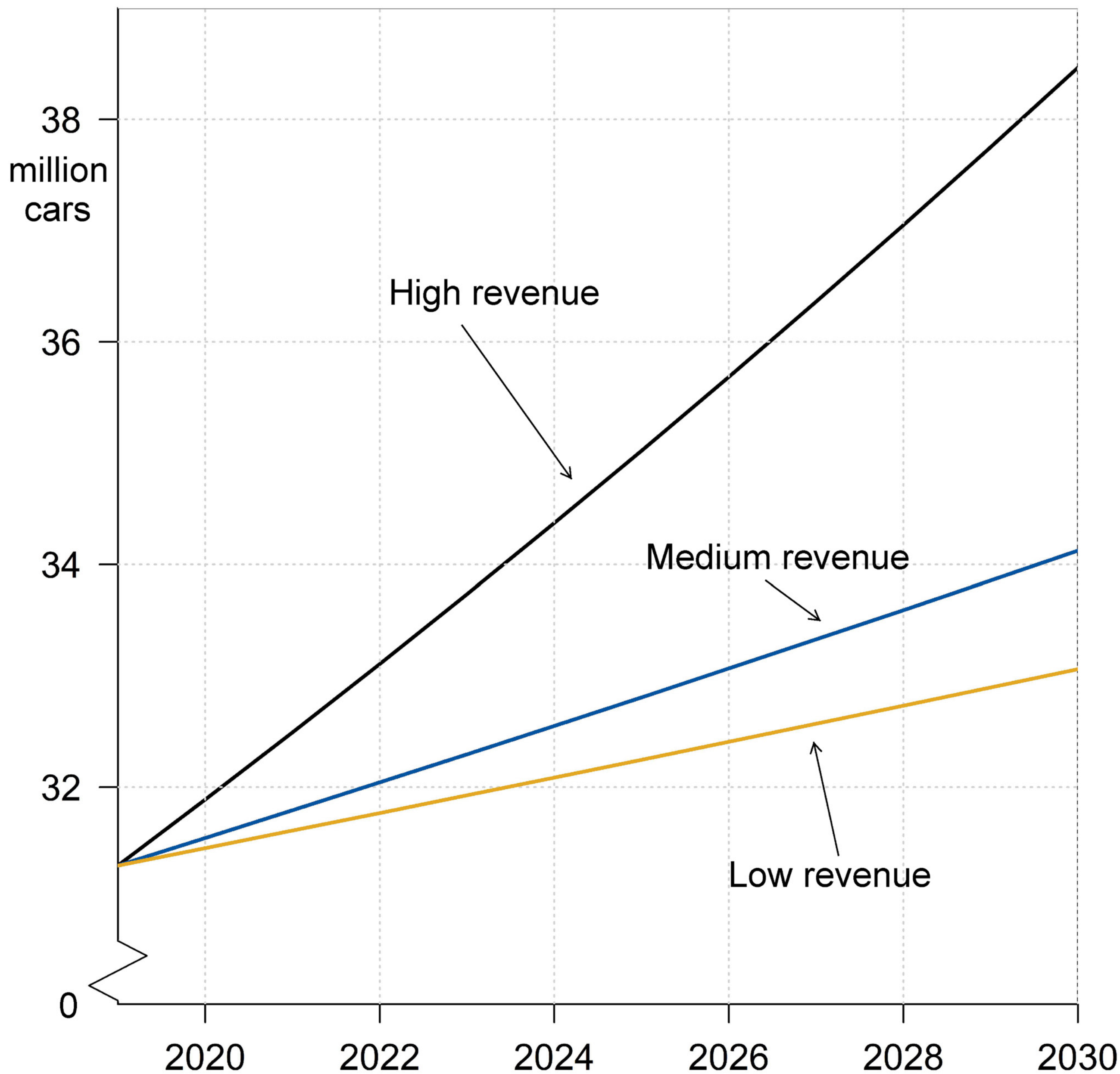

Figure 5. Vehicle Registrations: High, Medium, and Low-Revenue Trajectories Used to Construct the Scenarios

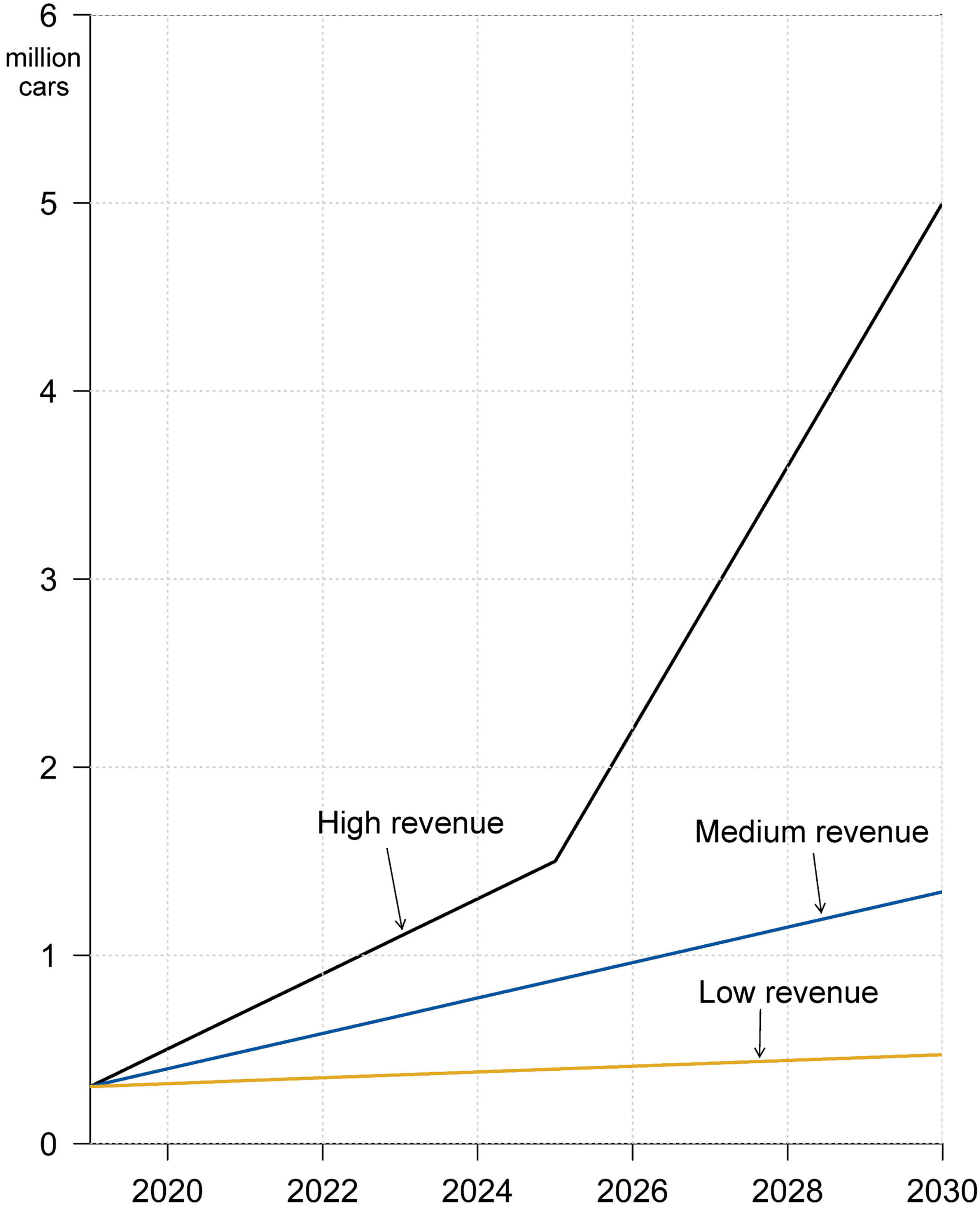

Figure 6. ZEV Registrations: High, Medium, and Low-Revenue Trajectories Used to Construct the Scenarios

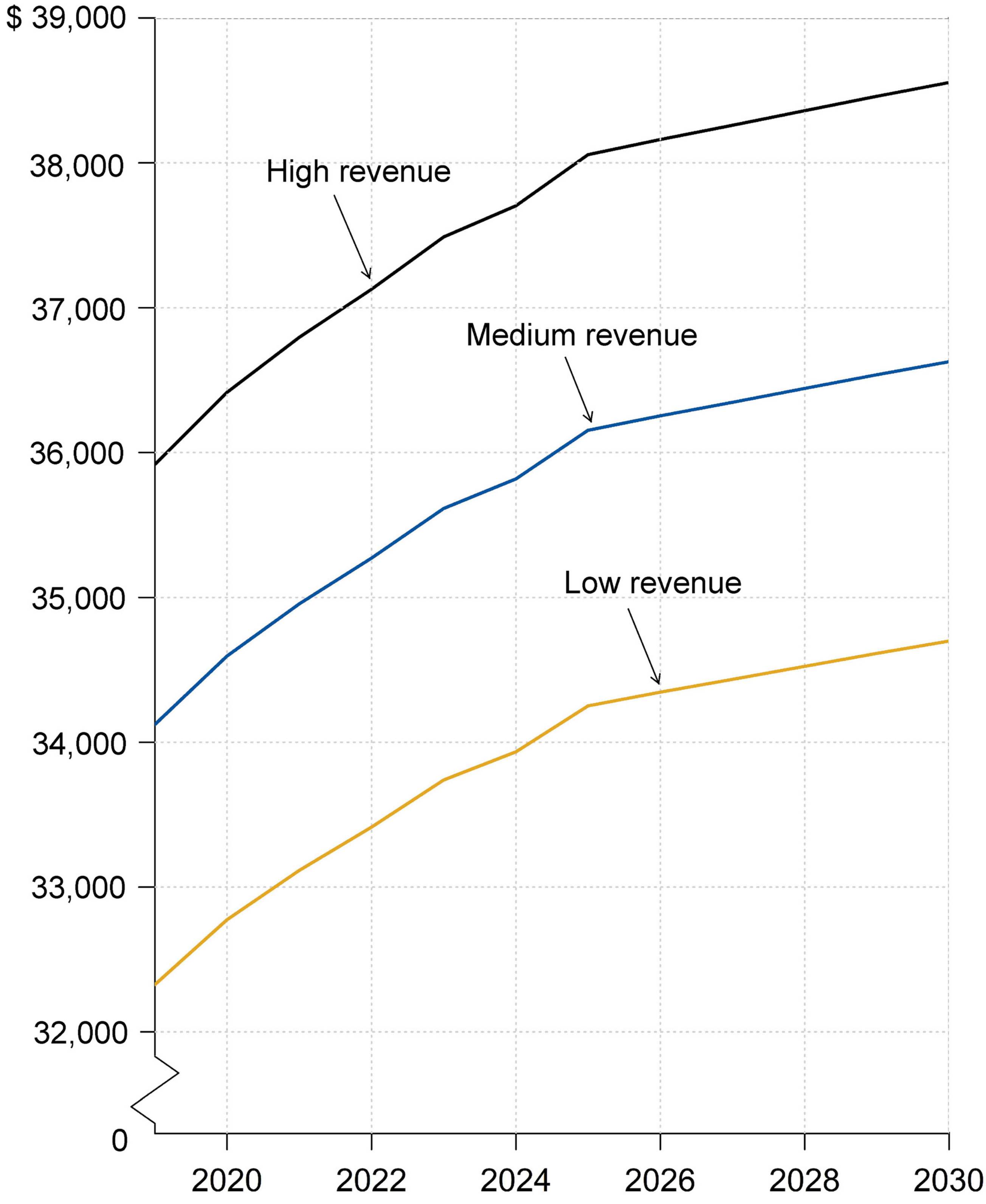

Figure 7. Mean ICE Vehicle Value: High, Medium, and Low-Revenue Trajectories Used to Construct the Scenarios

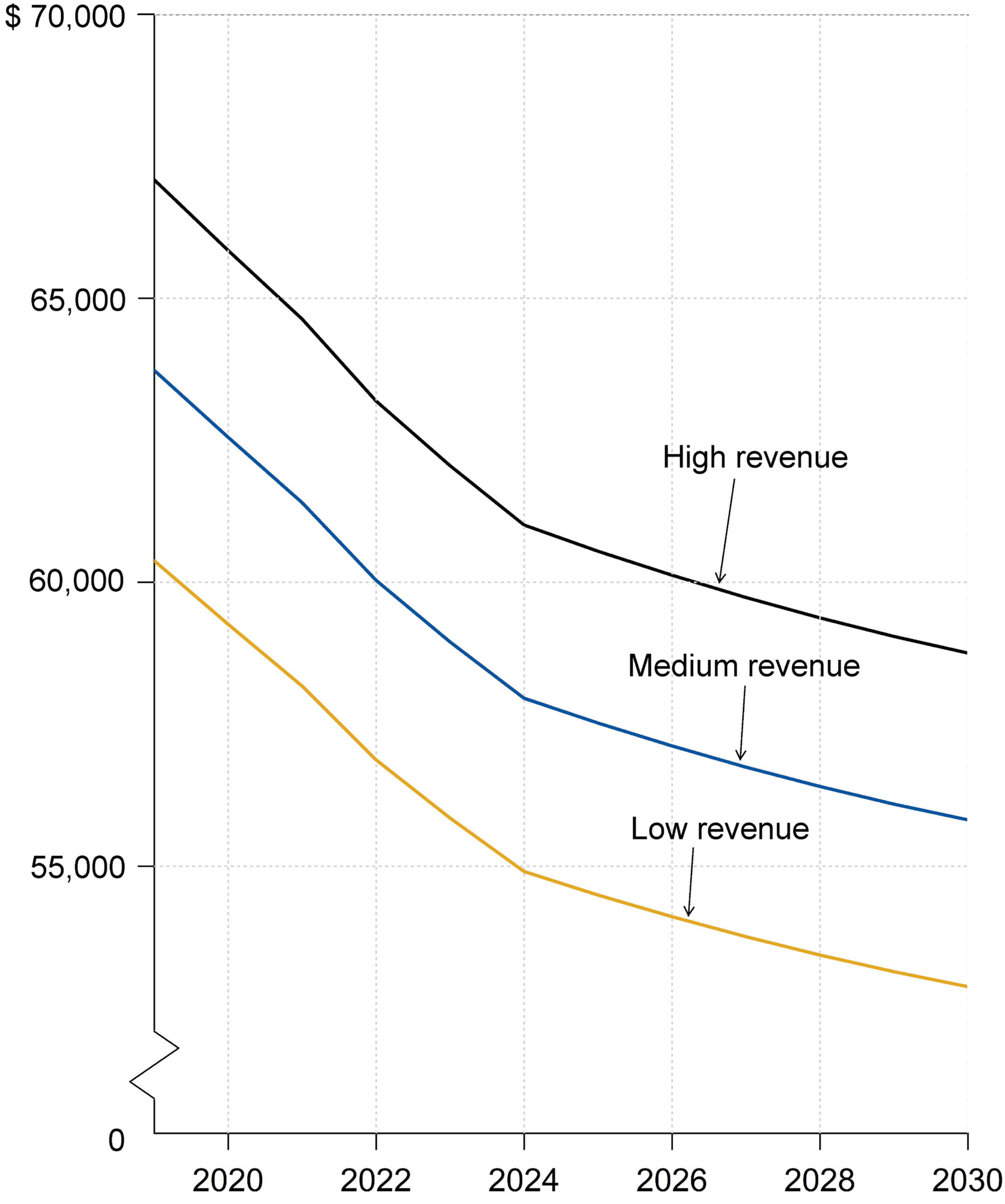

Figure 8. Mean ZEV Vehicle Value: High, Medium, and Low-Revenue Trajectories Used to Construct the Scenarios

TECHNICAL APPENDIX D: PROJECTED TRANSPORTATION REVENUES BY TAX/ FEE

This appendix compares projections for each tax and fee type under the baseline and five COVID-19 recovery scenarios.

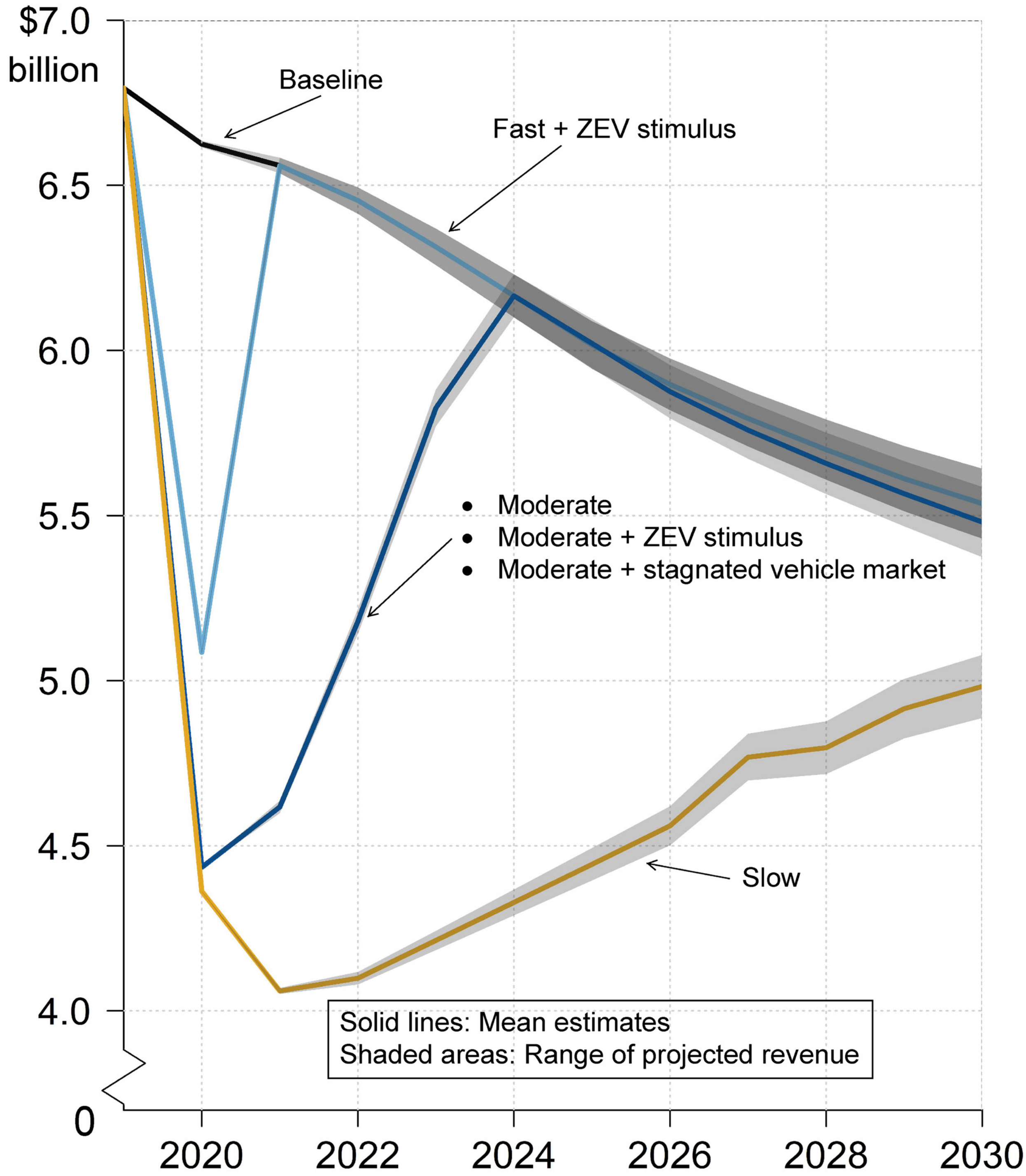

Figure 9. Gasoline Excise Tax Revenue under All Scenarios, 2019–2030

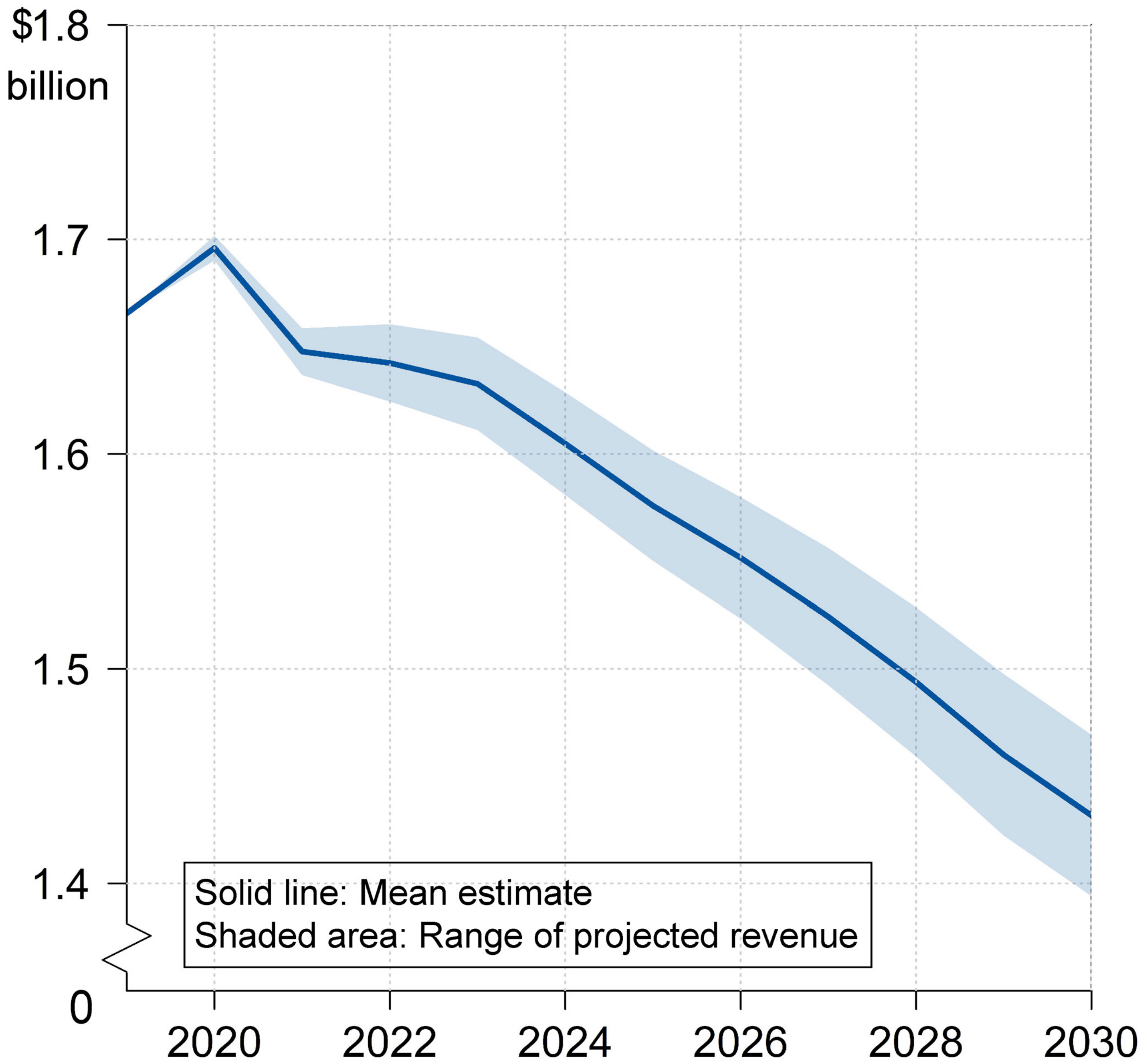

Figure 10. Diesel Excise Tax Revenue under All Scenarios, 2019–2030

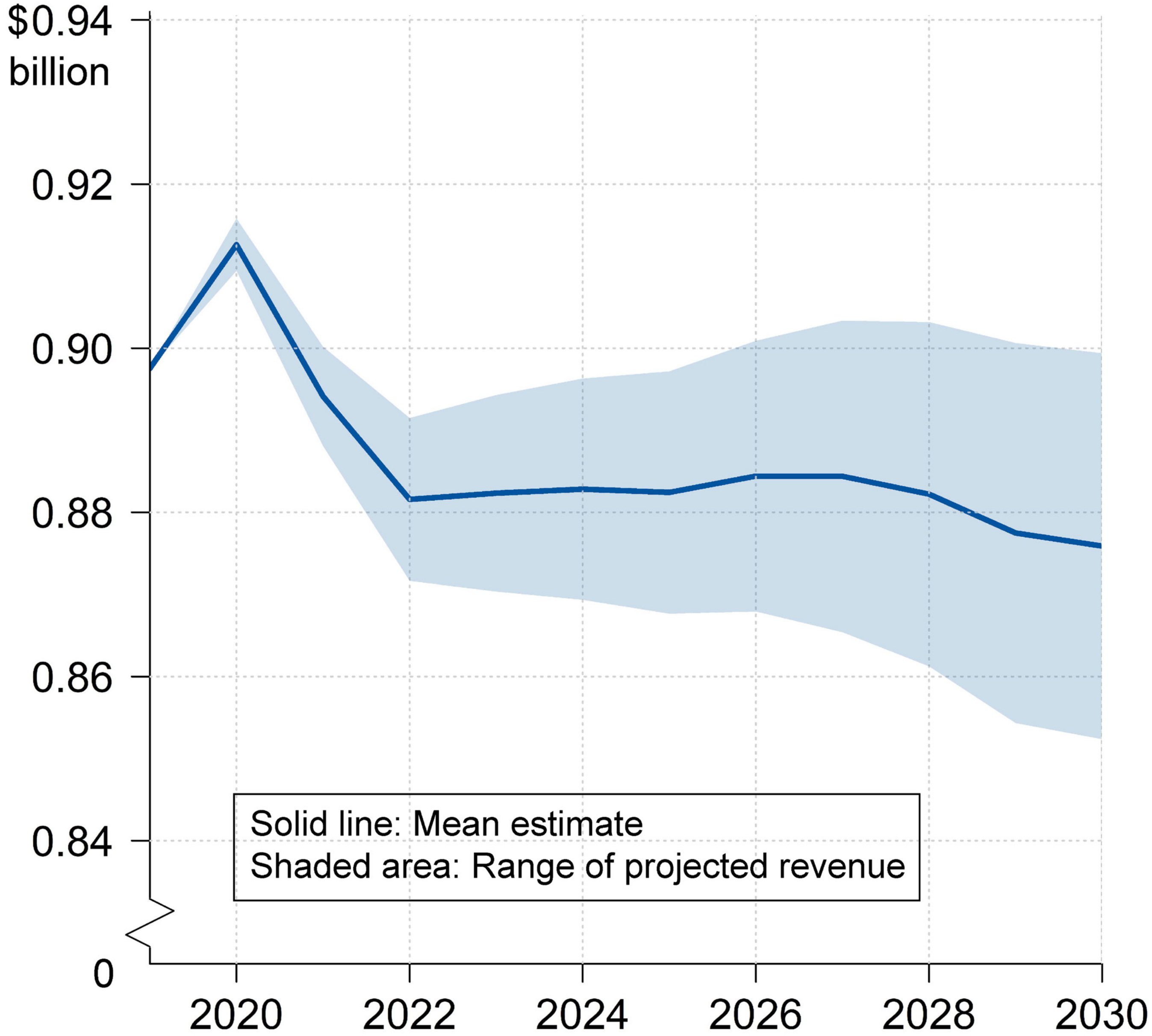

Figure 11. Diesel Sales Tax Revenue under All Scenarios, 2019–2030

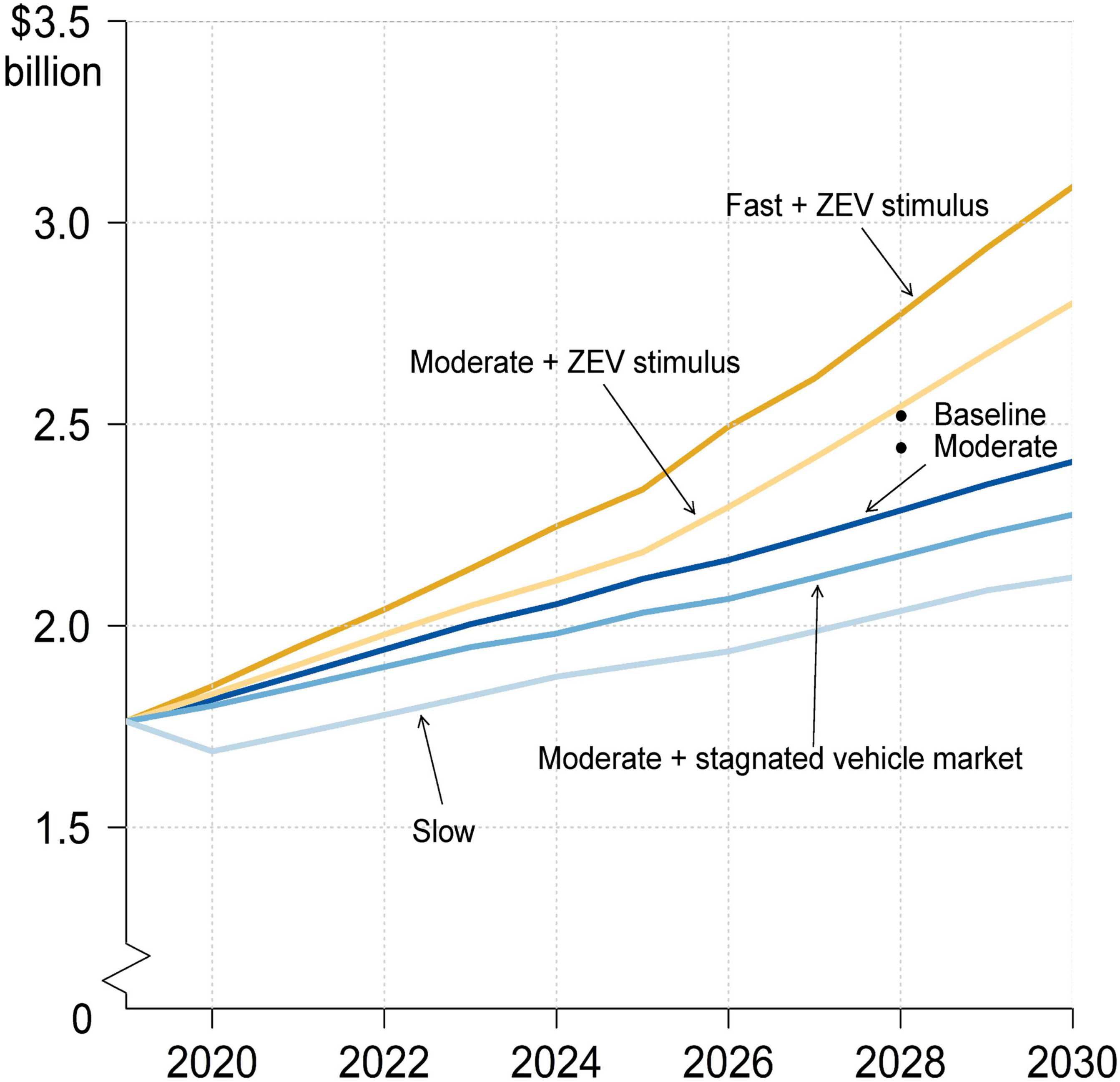

Figure 12. Transportation Improvement Fee (TIF) Revenue under All Scenarios, 2019–2030

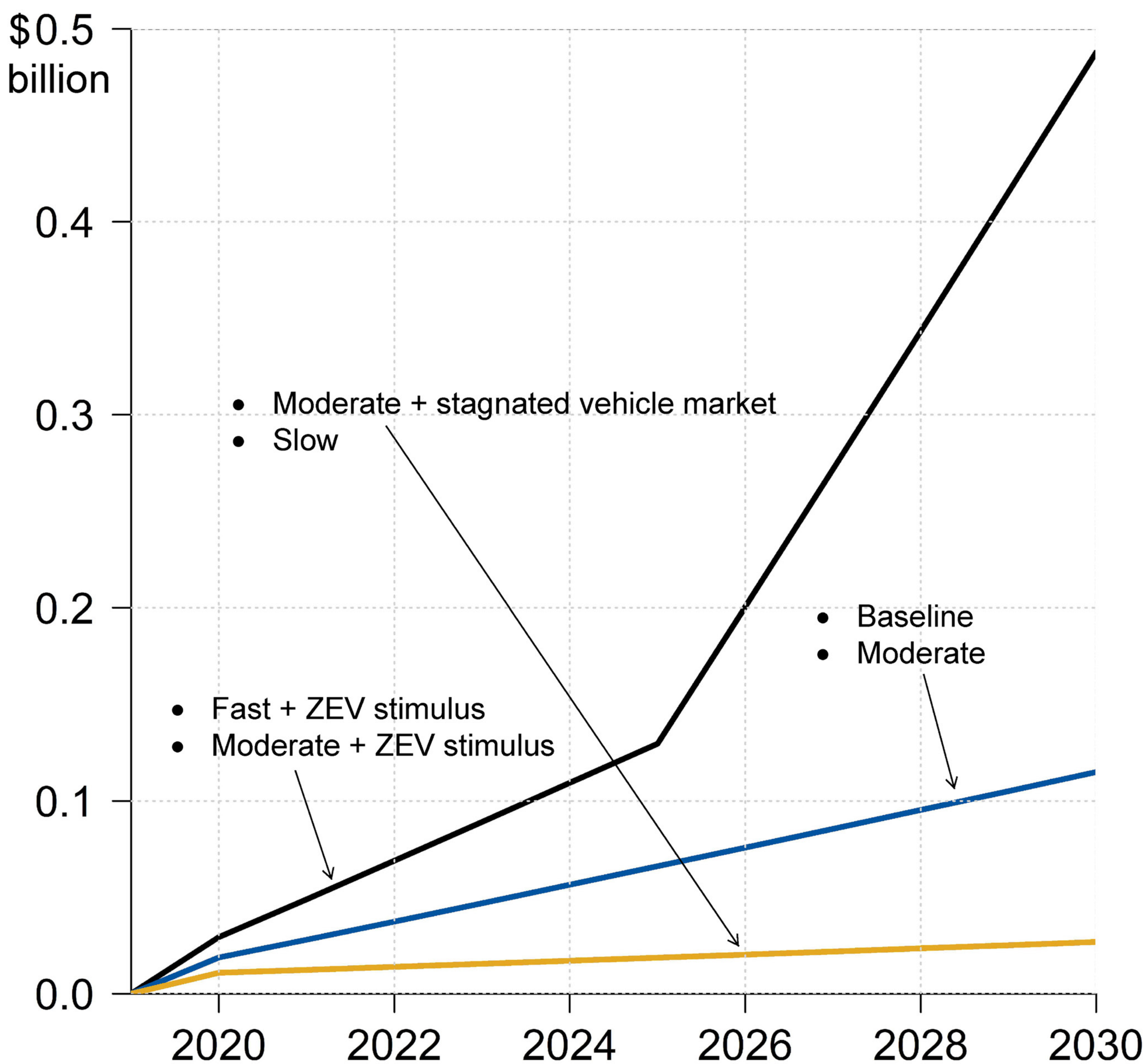

Figure 13. Roadway Improvement Fee (RIF) Revenue under All Scenarios, 2019 - 2030