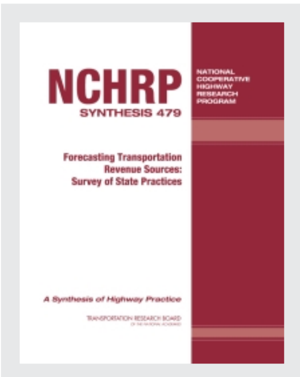

Forecasting Transportation Revenue Sources: Survey of State Practices

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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Forecasting Transportation Revenue Sources: Survey of State Practices

A Synthesis of Highway Practice

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FOREWORD

Highway administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to highway administrators and engineers. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire highway community, the American Association of State Highway and Transportation Officials—through the mechanism of the National Cooperative Highway Research Program—authorized the Transportation Research Board to undertake a continuing study. This study, NCHRP Project 20-5, "Synthesis of Information Related to Highway Problems," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute an NCHRP report series, *Synthesis of Highway Practice*.

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

By Tanya M. Zwahlen
Consultant
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Research Board

This report identifies the current state of the practice regarding revenue forecasting. A primary objective of the study is to document current and proposed forecasting methodologies, as well as shortcomings of methods as reported by state departments of transportation (DOTs). The report also includes information about the types of revenue being forecasted, and how satisfied DOTs have been by the accuracy of their projections.

Information used in this study was acquired through a review of the literature, a survey of voting members of the AASHTO Subcommittee on Transportation Finance Policy, and telephone interviews.

Martin Wachs and Benton Heimsath, University of California at Los Angeles, collected and synthesized the information and wrote the report. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CONTENTS

Note: Photographs, figures, and tables in this report may have been converted from color to grayscale for printing. The electronic version of the report (posted on the web at www.trb.org) retains the color versions.

FORECASTING TRANSPORTATION REVENUE SOURCES: SURVEY OF STATE PRACTICES

SUMMARY

States, and the federal government, face a serious transportation funding and revenue crisis. Both inflation and increasingly demanding fuel economy standards have reduced the real value of transportation revenue streams, while the politics surrounding transportation revenues has become more contentious. Funds required to operate and manage existing programs are in short supply, and these programs often must compete for financial support with proposed new capital investments. This makes accurate forecasting of transportation revenue increasingly important. At the same time, fluctuations in economic conditions and reliance on new sources of revenue that are beyond the control of state authorities, such as voter-approved county sales taxes, make transportation revenues more difficult to forecast at the state level. Even as state and local governments develop their short- and long-range transportation programs and evaluate potential new or alternate funding sources, there is as yet little published guidance on or consistency in the methods used to forecast traditional revenue sources, and even less on techniques for estimating revenue from innovative sources.

This synthesis report presents information based on a review of the literature; a national survey of departments of transportation (DOTs) in the 50 states and the District of Columbia and Puerto Rico; telephone interviews of state officials; and reviews of documents describing state practices.

The results of the synthesis offer a number of findings that help characterize state DOT revenue forecasting. The key findings are:

- Revenue forecasting is commonly practiced, yet the methods, projected years of forecast, and institutional arrangements by which it is done vary significantly.
- The types of transportation revenues that most states report forecasting are generally "traditional," that is, from fees, taxes, and federal or state allocations. States also consider a variety of miscellaneous, less significant sources.
- The methodologies used by states to forecast transportation revenue include trend extrapolation; expert judgment; and econometric modeling, solely or in combination, and with varying degrees of sophistication—no one of which was found to be unambiguously superior.
- States have generally been satisfied by the accuracy of their revenue projections, though several reported that uncertainty concerning relevant conditions, including federal funding and data quality, had increased over the past decade.
- Mathematically sophisticated models were not shown to more accurate than simple projections or expert opinions; or considered to be worth the added procedural burdens and data requirements.
- Most states do not routinely measure nor report on the accuracy achieved by past forecasts.
- Few state DOTs take the lead in forecasting consequences of potential innovative revenue sources; instead, they perceive their roles to be implementing and enforcing policy.

CHAPTER ONE

INTRODUCTION

Almost all states estimate future revenues required for transportation planning, policy formulation, and management, though methods for doing so differ widely. But even as state and local governments develop their short- and long-range transportation programs and evaluate potential new or alternative funding sources, there is a scarcity of published guidance on or consistency among the methods used to forecast traditional revenue sources, such as fuel taxes and vehicle registration fees. There is even less information available about how to forecast revenues from alternative sources which might be used in the future, such as mileage fees that could be implemented through electronic vehicle monitoring systems.

The projection of revenue for short-range operational planning and long-range capital programming are central to policymaking, and methods of estimating future resources are essential tools for state and local officials. Federal transportation regulations impose an increasing variety of fiscal requirements on both state departments of transportation (DOTs) and metropolitan planning organizations (MPOs) for long-range plans, shorter-range programs, and major projects for which compliance requires financial forecasting. For example, state DOTs must demonstrate that their short-term State Transportation Improvement Programs (STIPs) are "fiscally constrained," MPOs must establish "fiscal constraint" for both long-range plans and short-term programs, and major projects must also meet fiscal requirements.

In addition, under MAP-21, the current national highway law, states and MPOs must also measure, and plan to improve and report, their performance with respect to seven specified criteria. This makes the ability to forecast revenues that can be used to address these performance measures even more important (FHWA, Moving Ahead for Progress in the 21st Century: Statewide and Metropolitan Planning 2012).

At the same time that these more stringent federal requirements, revenue shortfalls, and vigorous competition for resources all make accuracy of forecasting increasingly important, financial managers and planners are faced with a range of dynamically changing issues affecting it, including dramatic fluctuations in federal funding of state programs, changes in fuel economy, fluctuating vehicle-miles traveled (VMT) growth rates, and volatility in vehicle registration growth rates.

This synthesis report is intended to help agencies improve methods of forecasting and to assist DOTs as they explore ways to enhance future revenue, including the development of new methods of revenue generation. The primary audience will be transportation officials, most of whom work at the state level and are involved in revenue forecasting and transportation funding. The report documents the range of revenue forecasting techniques and identifies promising new practices as reported by state DOTs. It also identifies shortcomings in current methods and in practices used by state transportation agencies, and problems that states have had in overcoming them.

The information that was synthesized and presented in this report was gathered in several ways. A literature review of recent academic research reports, articles in professional journals, agency newsletters, and websites provided a foundation of information related to current practices and broader contextual information about the dynamic policy challenges related to finance that are currently facing nearly every state. Based on the review, a survey was designed and sent to voting members of the AASHTO Subcommittee on Transportation Finance Policy, whose membership includes all 50 states, the District of Columbia, and Puerto Rico. Members were sent e-mail invitations to complete the on-line survey, which were addressed to each jurisdiction's representative on the AASHTO Subcommittee on Finance. The recipient was also invited to forward the survey or particular questions to the DOT staff members most involved with revenue forecasting. Forty-five (45) of the organizations contacted, or 87%, provided at least one response to the survey. In a few cases, responses were obtained from more than one person because some individuals forwarded questions to others within their state DOTs. Respondents were almost exclusively employed by their state DOTs, and included directors of finance, chief financial officers, financial analysts, economists, program managers, and transportation revenue coordinators, as well as people holding other titles.

The survey questionnaire (presented in Appendix A) included questions eliciting the objectives of and methods and data used in forecasting revenues at the state level. The survey also requested that respondents provide titles of reports of recent forecasts, descriptions of their forecasting methods, and manuals documenting forecasting methods; and instructions as to how websites could be accessed to further document their methods. Telephone and e-mail contact information was requested so that the survey team could follow up when information in the surveys was found to be incomplete, contained apparent contradictions, or referred to reports, manuals, models, or databases that appeared relevant but had not been carefully explained.

The survey was sent in late January 2014. As responses were assembled, several reminders were sent by e-mail and then telephone calls were made to agencies that had been slow to respond. By the end of March 2014, responses had been received from 45 agencies. A selection of illustrative responses is briefly summarized in Appendix B.

Follow-up calls or e-mail requests were made to more than a dozen of the respondents. The calls did not have a set format or protocol and were designed to address particular questions left unresolved by the responses to the web-based questionnaire. Some calls lasted only a few minutes and led to the receipt of further materials by e-mail, whereas others lasted up to an hour and involved detailed discussions of forecasting models and data sources used in forecasting. Some agencies were called several times in order to be sure that the synthesis information was complete and accurate.

The survey responses were tallied to provide summary information that appears in tables and figures later in this report. In addition, based on their responses to the surveys and the literature that clearly identified some unique state practices, half a dozen states were selected for more detailed study and analysis. In these cases, additional telephone interviews took place and more detailed studies were carried out using their manuals, websites, and in a few cases, consultants' reports. To insure accuracy of the accounts in this report of specific procedures employed by states, a draft of this report was provided to each state whose procedures are presented as case examples, and five states provided corrections or comments that were incorporated into this final report.

The remainder of this report presents the findings of this study. Chapter two summarizes some of the background and context for the study, including the growing sense of a national fiscal crisis in transportation and some of the federal and state responses that have been widely reported. Chapter three present the findings of the survey, including in-depth analyses of the types of revenue forecasting processes performed at the state level. Chapter three also examines the responses to the survey that discuss the shortcomings of current techniques and proposed new sources of revenue.

Chapter four examines the institutional arrangements of transportation revenue forecasting, including state laws and statutes that govern reporting requirements, and responses from the survey relating to forecasting responsibilities, processes, and institutions. Chapter five offers conclusions about current practices, shortcomings, and innovations in forecasting techniques, especially as regards new sources of revenue, based on the data provided by the survey. The final chapter also suggests areas of research identified in the course of conducting the study.

CHAPTER TWO

BACKGROUND: FISCAL CRISES AND CHALLENGES TO TRANSPORTATION REVENUE FORECASTING

EARLY ADOPTION OF HIGHWAY USER FEE FINANCING

Before 1920, most states' funding for transportation systems, including highways and bridges, depended on allocations by state legislatures of general funds derived from property and income taxes (Martin 1923; Burnham 1961). But, as automobile purchases rose at an unprecedented rate, states found themselves spending huge sums of money on roads and falling far behind the perceived need for such facilities. For example, in 1922, 44% of the budget of California went to cover investments in transportation, including interest payment on road bonds (Zettel 1946); yet drivers and interest groups such as automobile clubs demanded more investment. Gradually, the states came to believe that the majority of the responsibility for funding road construction and maintenance should devolve on road uses rather than general revenues because at the time, most citizens did not own vehicles; those who did drive had higher than average incomes. Truck traffic was increasing rapidly, requiring more durable pavements, and goods movement was derived from commercial ventures that legislators believed should be responsible for a fair share of the costs of roadways. Some states built toll roads, but tolls had to be collected manually, and the cost of collection at some locations approached or exceeded the revenues obtained from the tolls (Brown 1999).

In 1919, the state of Oregon instituted the first motor fuel tax on gasoline and diesel as a way of approximating revenue from tolls while incurring far lower costs of collection and administration (Burnham 1961). The first state excise taxes levied on motor fuels—a penny or two per gallon—were large in relation to the early sale price of gasoline, but acceptable to road users who widely acknowledged the importance of improving the quality and extent of the networks. Fuel taxes were collected at a relatively few wholesale distribution points and the taxes were passed along at the gasoline pumps to the highway users, minimizing administrative costs and lowering rates of fraud, abuse, and evasion. As traffic grew, motor fuel excise taxes provided an increasingly lucrative and practical source of transportation revenue. By 1940, every state had a motor fuel tax, and to insure equity to those paying the fees, all but a few states dedicated or "earmarked" fuel tax revenues to transportation through state constitutional provisions or legislation. State trust funds became more common, in the form of accounts reserved for surface transportation expenditures into which fuel and other transportation user excise taxes were deposited. In 1932, the federal government added a national motor fuel tax, and in 1956, motor fuel taxes and the U.S. Highway Trust Fund (HTF) became the principal means by which the National Interstate and Defense Highways Act was funded (Brown 2001; Wachs 2003).

Increases in both vehicle registrations and miles travelled per vehicle, coupled with modest increases in rates of taxation, ensured ample financing for one of the most extensive and heavily used public works systems in the world (Brown 1998; Brown et al. 1999). In addition to being lucrative, vehicle registrations and travel grew steadily at stable and highly predictable rates, meaning that the revenues produced by those taxes could accurately be predicted from year to year. Federal and state fuel taxes have been the principal source of revenue for transportation programs for nine decades. In 2004, for example, the AASHTO Center for Excellence in Transportation Project Finance showed that motor fuel taxes provided more than 82% of federal transportation revenue and slightly less than 37% of state revenue, which together yielded more than $62 billion in revenue for surface transportation programs. But even a decade ago, other revenue sources, including tolls, fares, vehicle use taxes, sales taxes, allocations of general government revenues, property taxes, and other fees and charges, produced more funding in aggregate for surface transportation programs than did motor fuel taxes (Cambridge Systematics et al. 2006). Today, more than $200 billion per year is invested in surface transportation by government agencies, and motor fuel taxes are declining precipitously as a share of the total (AASHTO Center for Excellence in Transportation Project Finance).

THE CURRENT CRISIS IN SURFACE TRANSPORTATION FINANCE

States and the federal government today face what is widely recognized as the most serious fiscal challenge in nearly a century. Fuel tax revenue has been declining in relation to road use as measured by VMT for more than 20 years. The federal motor fuel tax rate per gallon has not increased since 1993, causing the value of tax collections to steadily lose purchasing power. Although sales tax revenues automatically rise with inflation, and income taxes rise as people move into higher tax brackets, motor fuel taxes were historically set at a fixed amount per gallon for reasons that were more relevant than they are today. That the tax was based on the quantity of fuel meant that taxes could be charged at the wholesale distribution points and did not depend upon the more variable sale price at the pumps at which consumers filled their tanks. The Institute on Taxation and Economic Policy (2014) recently reported that motor fuel tax revenues are on an unsustainable course because Congress has refused to raise the federal per-gallon tax rate, and many states have also been slow to raise per-gallon rates or change to another type of user charge. Purchasing power has plummeted as a result of inflation and rising construction costs. According to the institute, after accounting for growth in construction costs, the average state motor fuel tax rate has effectively fallen by 20% since it was last increased. States have seen the real value of fuel tax revenues drop by a nationwide total of $10 billion each year. Similarly, the fixed-rate federal gas tax has lost 33% of its purchasing power since it was last raised in 1993. In July 2014, U.S. Secretary of Transportation Anthony Foxx was joined by 11 former Treasury secretaries in issuing a statement calling upon Congress to enact a new long-term federal revenue strategy that would resolve the continuing precipitous fall in national HTF revenues and contributions to state transportation finance—although, tellingly, they did not offer a consensus recommendation for the most effective approach to accomplishing this objective (Hoitsma 2014).

Inflation and failure to raise the motor fuel tax rate are not the only causes of the declining value of transportation revenue streams. There is also great uncertainty as to changes in travel among drivers in the United States. Light-duty vehicle VMT per licensed driver peaked in 2007 at 12,900 miles per year and decreased to 12,500 miles in 2012, and there is debate in the transportation community as to whether this trend will become more pronounced or will be reversed in the future as a result of the gradual economic recovery. The shift in VMT highlights the importance of travel behavior and its influence on energy consumption, and consequently on revenues associated with the taxes levied on motor vehicle fuels. Before the 2007 peak, travel behavior in the United States closely tracked economic growth. The Energy Information Administration (EIA) notes that: "Since 2007, trends in U.S. travel by [light-duty vehicles] have not followed the trends in economic indicators such as income and employment as closely as before. Although economic factors continue to influence travel demand, demographic, technological, social, and environmental factors also have shown the potential to affect personal travel" (Hutchins 2014). This is very important, since this study indicated that in making projections of transportation revenue, many states rely on projections of future travel that are published by that agency. Although projections of factors that influence travel have always been subject to error, the growing uncertainty in socio-economic relationships influencing travel, illustrated in Figure 1, suggest that factors influencing future travel are becoming less certain and more subject to error than they have been in the past.

Improved fuel economy is taking an additional toll, since gasoline consumption in the United States peaked in 2004 at 138,819 million gallons. Since 2008, national fuel consump-

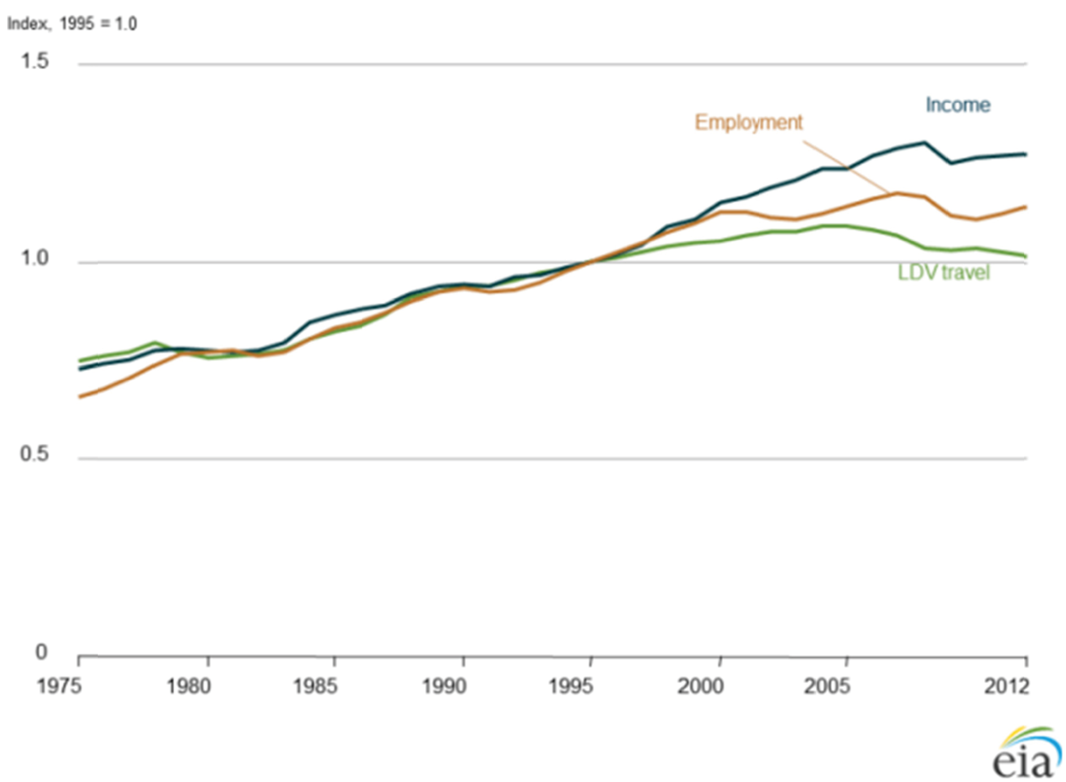

FIGURE 1 Economic indicators of travel changing over time (*Source*: Hutchins 2014).

tion has declined in absolute numbers every year, and in 2012 total national fuel consumption stood at 123,635 million gallons (Sivak 2014). The average fuel economy (window-sticker value) of new vehicles sold in the United States in July 2014 was 25.6 mpg—up 0.1 mpg from the value in June and up 5.5 mpg since October 2007 (University of Michigan Transportation Research Institute website). New and demanding Corporate Average Fuel Economy (CAFE) Standards will require achieving a new car fleet average of 54.5 mpg by 2025 in order to reduce dependency on imported energy, greenhouse gas emissions, and urban air pollution. Although consumers may be pleased that the fuel economy of vehicles is improving at a dramatic rate, this does cause difficulty raising tax revenue for surface transportation programs. Electric vehicles, which use no petroleum-based motor fuels, are as yet a small portion of the vehicle fleet, but the promise of electric and hydrogen-powered autos suggests that at a future date liquid fuel consumption could drop precipitously. The bipartisan Simpson–Bowles deficit reduction commission called for increasing the federal fuel tax by 15 cents per gallon, nearly doubling the federal tax in order to stabilize the Highway Trust Fund and allow for programmatic growth (National Commission on Fiscal Responsibility and Reform 2010). Congress has not taken action on this recommendation, and while some bills have recently been introduced that would raise the federal motor fuel tax, none has been enacted by either house.

Under federal law, the Highway Trust Fund is not allowed to have a negative balance. When the balance becomes dangerously low, U.S.DOT takes administrative action to prevent the fund from heading into the red. When the highway account balance dips below $4 billion, U.S.DOT must either substantially delay payments to states or pay a reduced share of state costs. Similar measures take effect when the mass transit account balance dips below $1 billion. Gasoline tax revenues have fallen so drastically that since fiscal year 2008, Congress has transferred $54 billion in general fund revenues into the HTF to prevent insolvency.

On July 1, 2014, Transportation Secretary Foxx sent letters to all state secretaries of transportation informing them that on August 1, 2014, scheduled and requested federal payments to states for transportation projects would be systematically reduced unless Congress acted prior to that date by transferring additional general fund monies into the HTF (A. Foxx, *Letter to State Departments of Transportation*, July 1, 2014).

Transfers authorized as part of the MAP-21 surface transportation bill were intended to keep the trust fund healthy through the end of FY 2014, but projections that the account would run out of money as early as August 2014 (Center for American Progress 2014) prompted Congress to pass a funding bill before adjourning for its summer recess. An editorial in the *Washington Post* noted that:

> The measure provides $10.8 billion for infrastructure projects around the country, with more than half of the money supplied not by any real increase in revenue or reduction in spending but by an egregious budgetary gimmick known as "pension smoothing."
>
> The law allows companies to put off otherwise mandatory contributions to their defined-benefit employee pension funds, which increases tax revenue for the Treasury, since those contributions would have been tax-deductible. Actually, smoothing increases tax revenue in the short run but decreases it later on, when companies have to make up for the missed payments (Washington Post, "The Post's View," August 19, 2014).

In addition to the decline in revenues from what has traditionally been the most reliable source of transportation funding, uncertainty associated with future revenue is growing so quickly that it also impacts states' abilities to forecast future revenues with accuracy. States' receipt of federal funds for which they are eligible can no longer be taken for granted, since delays, reductions in funding, and "patches" using unprecedented sources of revenue are becoming more common; and infusions of general fund monies can come at times that are extremely difficult to predict.

According to many experts and studies, the current condition of the nation's transportation system is poor and worsening, and increasing the performance of the network will require increasing investments. It is currently estimated that 32% of the nation's transportation network is in poor or mediocre condition, and that 24% or all bridges are in poor condition or are functionally obsolete (National Conference of State Legislators). Thus, as revenue becomes scarcer, the consequences become more severe.

DEVOLVING THE BURDEN OF FINANCE TO THE STATES

Faced with a depleted federal trust fund and poor prospects for new funding from a deficit-conscious Congress, states are seeking to increase revenues for transportation operations, maintenance, and capital investment. In a recent issue of *Innovation Briefs*, C. Kenneth Orski reported that a survey had revealed significant funding initiatives in 18 states. He reported that some states, including Maryland, Wyoming, Massachusetts, and Vermont, have raised gasoline taxes, while others, such as Pennsylvania, have shifted to a tax on fuel at the wholesale level. Still others (Arkansas, Virginia, etc.) have enacted dedicated sales taxes for transportation or floated toll revenue bonds (Ohio).

Burdened with addressing growing revenue shortfalls in a context of increasing uncertainty and accelerating change in transportation finance, it becomes both more important and more difficult for states to forecast transportation revenues. It is more important because forecasts are needed to assess and modify new financing policies, and it is more difficult to do that in a dynamic environment. Revenue measures are increasingly politically challenging, and in many states subject to voter approval. States are increasingly incurring debt in the short run, many issuing bonds to fund transportation capital improvements and some borrowing from state infrastructure banks. These approaches to financing often require longer-term revenue increases, many of which have yet to be enacted. In addition, some states are devolving transportation finance to counties and other units of local government. In California, for example, 20 counties that are home to 81% of the state's population have enacted voter-approved sales taxes for transportation projects (California Self Help Counties Coalition). In the election of November 2013, approximately 80% of local and state transportation taxation ballot measures across the country were approved by voters (Center for Transportation Excellence 2013). It is difficult to forecast the outcomes of increasingly decentralized voter-approved transportation revenue measures. This study was motivated by these concerns, coupled with the fact that there is no other compendium of revenue forecasting practices in the states.

EARLIER REVIEWS OF STATE FORECASTING PRACTICES

With one exception, the review of the published literature revealed very few prior studies that specifically examined transportation revenue forecasts that had been done by states. In 1999, however, economist David Gillen assessed how well states forecast revenues from taxes and fees levied on highway users and examined whether the models they employed in forecasting revenues appeared to be adequate. An academic economist, he was critical of the approaches that were in use at the end of the 20th century. Interestingly, the synthesis survey revealed that most of the approaches he found to be in use at that time continue to dominate state forecasting practices today, even though trends in the socio-demographic determinants of travel and the variables they suggest be used as predictors of transportation revenue are more volatile or variable today than they were when he conducted his study.

Gillen described three approaches to forecasting transportation revenue. The simplest would be to develop a model that uses previous values of revenues in each category, perhaps giving more weight to recent values of variables than values from the more distant past. This approach simply matches a function to past data and extrapolates the values to create a forecast. The models used by most states to forecast travel and other variables affecting fuel tax revenues were described by Gillen as largely "accounting identities" or simple statistical relationships predicting one of the components of revenues; he criticized these as "simplistic and non-behavioral." One common feature of such models is their implicit assumption that the demands for travel, vehicles, and fuel are not especially responsive to changes in social, demographic and economic variables.

A second approach would utilize some econometric time series techniques, such as the Box-Jenkins or Autoregressive Integrated Moving Average (ARIMA) model. Univariate Box-Jenkins models are extrapolation methods which employ past values to generate forecasts. When the absence of data or specification errors make econometric models impractical, Box-Jenkins models are useful for time-series forecasting.

The third approach, causal forecasting, develops an econometric model that explains the underlying causes or sources of variation in the factors that play roles in determining revenues from fuel taxes and registration fees. These utilize relevant demographic and economic variables in a set of "behavioral" equations to produce the forecast. Gillen considered this to be the richest approach, because once the model parameters are estimated, they can be used to develop forecasts of the dependent variables; however, at the time of his study, this method was used far less frequently than the simpler approaches.

Gillen proposed a modeling approach that could serve as the basis for state forecasts and could be useful as prices and sources or revenue become more dynamic. His own approach consists of a system of three equations: two relationships (VMT and fleet fuel efficiency) and one accounting identity (total fuel consumption) that would provide the requisite information to forecast fuel tax and registration fee and other fee revenues. The first two equations would be estimated through regression analysis, whereas the third would combine the results of the first two.

CHAPTER THREE

FEDERAL AND STATE REVENUE FORECASTING PRACTICES

FEDERAL HIGHWAY REVENUE FORECASTING

Because many states incorporate estimates of transportation revenues from the federal government into their own forecasts, and because the procedures used to forecast revenue by the federal government are of general interest to those in the states making similar forecasts, the authors queried the FHWA on its revenue forecasting procedures. The FHWA Office of Transportation Policy Studies developed and maintains a Highway Revenue Forecasting Model (HRFM) for use in preparing Federal Highway Cost Allocation Studies. Staff of that office reported that the revenue estimation procedure is composed of several spreadsheets into which data are entered manually each time the model is updated. Estimates of federal transportation revenue are currently available through 2020; the model is currently under review and subject to modification. Data used in developing these forecasts are generally not published and are subject to frequent revision.

The HRFM currently can estimate revenues derived from federal motor fuel sales taxes and can incorporate the potential indexing of federal motor fuel taxes to inflation. It also has the capability to estimate taxes based on axle-weights or gross vehicle weights of all vehicles; proceeds from potential weight-distance truck fees; and revenues that could be collected based upon the pricing of vehicle air pollutant or greenhouse gas emissions.

The spreadsheet models allow estimation of user fee payments in 20 different classes of vehicles and 30 vehicle weight groups. For each year, vehicle class and weight group entries are made of estimates of the number of vehicles in each category and VMT are then estimated for each category. An overall average of miles per gallon is used to estimate fuel efficiency for all heavy and medium-weight trucks to estimate revenues from motor fuel taxes. Truck and trailer excise tax revenues are estimated based on approximated sales of power units in each category, which are estimated outside of the model. Similarly, revenues from excise taxes from the sale of tires are included; policy studies staff reported that the tire tax revenues estimates are based on data from 2005.

Because the HRFM is out of date and of limited scope, states tended to rely more frequently upon the National Energy Modeling System (NEMS), created at the Energy Information Administration of the U.S. Department of Energy. NEMS projects the production, consumption, conversion, import, and pricing of energy. The model relies on assumptions for economic variables, including world energy market interactions, resource availability (which influences costs), technological choice and characteristics, and demographics. The modules that address transportation energy consumption are updated annually, and are linked with the models representing other sectors of the economy.

Although each individual module is simple in concept, the system of models is complex because of its size and numerous linkages. The system amounts to a detailed accounting system, with linkages among regions of the United States, representations of social and economic activity, and between expenditures on transportation and the economic activities from which they are derived. Of most relevance to states, the NEMS model contains a light-duty vehicle submodule and a freight transportation submodule. These rely on current economic data, information on stocks of vehicles, and current measures of fuel efficiency. Because the EIA devotes substantial resources to updating every element of this model and makes the results and the inputs available for use through its websites, and because states lack resources with which to prepare their own detailed models, many states reported that they rely on the NEMS model when estimating and forecasting energy consumption in transportation, which is the principal determinant of fuel tax revenues. Readers may consult the latest publications of the *National Energy Outlook* (Energy Information Agency 2014a) for an overview of trends in transportation and other energy consumption and to review recent changes in projections. Those working on transportation revenue forecasts might be especially interested in the EIA's web publication entitled *Transportation Demand Module of the National Energy Modeling System: Model Documentation* (Energy Information Agency 2014b) for details as to how the transportation demand estimates are produced and data tables that could be useful when preparing state revenue forecasts.

SHORT-TERM VS. LONG-TERM REVENUE FORECASTING

All of the states reported preparing short-term forecasts, having time horizons of less than five years. Short-term forecasts vary in frequency of modeling and publication. One state reported that short-range forecasts were created by applying subjective judgment to the interpretation of more formal long-range forecast results. Thirty-one (31) states reported that the state DOTs are either partially or exclusively responsible for the forecasting efforts. Partial involvement exists when the process is undertaken jointly with other agencies such as departments of finance or departments of motor vehicles. (Institutional arrangements for accomplishing the forecasts are described in more detail in chapter four.)

Thirty-eight (38) states reported that they prepare long-term forecasts of future revenues, that is, with a time horizon of longer than five years, usually in support of State Transportation Improvement Plans (STIPs). The Iowa DOT produces a five-year forecast of revenues each year. West Virginia uses a six-year forecast for state budgeting purposes.

Seven states—Alabama, Arkansas, Colorado, Maine, New Jersey, Tennessee, and Vermont—do not produce long-term revenue forecasts. One respondent said that long-term forecasts had too many uncertain factors, especially concerning the price of gasoline and the status of federal funding. In other states, the DOT produces both long- and short-term forecasts, but does so using different methodologies. For example, Michigan DOT's short-term, one- to two-year forecast is done in "consensus" with the Michigan Department of Treasury, while forecasts for years three to five are carried out entirely by the DOT.

TRADITIONAL SOURCES

The majority of forecasting activity focuses on traditional revenue sources: disbursements of federal funds as reimbursement for expenditures, state fuel and excise taxes, state vehicle registration fees, tolls, and local taxes and fees. Figure 2 shows the widely reported types of revenue that are forecast by states, according to survey results.

Distributions of Federal Funds

The federal motor fuel tax is a per-gallon tax that is levied on gasoline, diesel, and other special fuels. Along with other federal revenues such as fuel excise taxes, a portion of the motor fuel tax is allocated to states through the Highway Trust Fund through legislative programs (AASHTO Center of Excellence in Transportation Finance 2004). Thirty-nine (39) state DOTs estimate annual levels of federal funds that will be received as the dollar amount from the federal HTF in a given year. In recent years, projections of disbursements of federal funds to the states have also included general fund revenues as well as user fees, because the HTF has been augmented by infusions of general funds authorized by Congress.

State Motor Fuel Tax

State motor fuel taxes are, for many states, the largest single source of dedicated revenue for transportation programs.

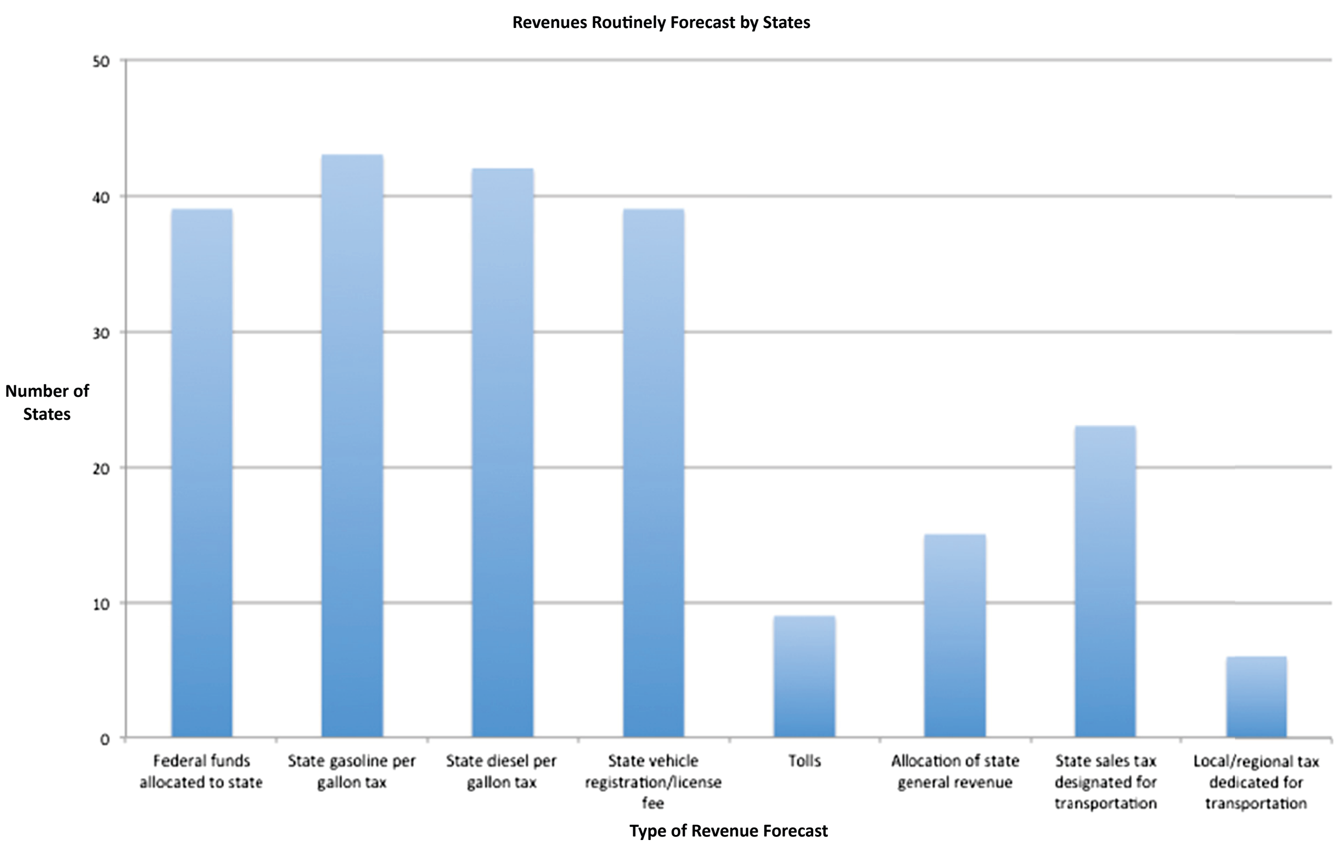

FIGURE 2 State revenue forecasting by revenue type.

These include per-gallon gasoline and diesel excise taxes and ad valorem sales taxes levied on fuel. Forty-three (43) states responded that they typically forecast state motor fuel tax revenue, and 42 states forecast diesel fuel tax revenue.

State Vehicle Registration Fees

State vehicle registration fees are another significant source of dedicated state revenue. Thirty-nine (39) states responded that they forecast this type of revenue. In some states, vehicle registration fees are not available for programs administered by the state DOTs; hence, they do not forecast revenues produced by those fees. For example, in California, vehicle registration fees are earmarked to support the Department of Motor Vehicles and the California Highway Patrol, which are not part of the California Department of Transportation (Caltrans).

Revenue from Tolled Facilities

Nine states regularly forecast toll revenues. In Texas, while some toll roads are operated by the state DOT, others are operated by a separate entity that is responsible for forecasting those toll revenues.

In other cases, the state DOT collects and forecasts revenues from tolled facilities, or supervises consultants' forecasts of revenues. An example of this arrangement is in Washington State, where the DOT (WSDOT) supervises consultants' forecasting of toll revenue on certain Puget Sound bridges. Several states forecast toll revenues using travel demand models and current per-trip tolling rates; however, a Tacoma Narrows Bridge forecasting work group reported that a travel demand model used by the WSDOT consultant in 2013 and 2014 overestimated both bridge traffic volume and toll revenue. Based on this work group's review, WSDOT is evaluating the performance of an alternative econometric forecast model. Since 2010, other consultants have used a travel demand model to forecast toll revenue on another bridge in the Puget Sound region; those forecast projections have come in close to the actual figures.

State General Fund Allocations

Fifteen (15) states forecast general fund allocations to transportation programs. Some state transportation programs' general fund revenue allocations are determined by formula; others are determined by appropriations processes in their legislatures.

State Sales Taxes

State sales tax revenues can be earmarked for transportation programs, or general sales taxes can include some allocations to transportation programs. These taxes are forecast by 23 states.

Local Taxes and Fees

Six states forecast such taxes and fees as local or county excise taxes that are levied for transportation projects in particular areas, as in Arizona's Maricopa County. Similarly, several counties in Georgia have a special local option sales tax that is used to fund capital transit projects.

Other Sources

The remaining traditional revenue sources vary widely by state. Table 1 lists the additional revenue sources that states reported forecasting on a regular basis. This list is not exhaustive, as there may be other streams of revenue being forecast that were not identified by survey respondents.

REVENUE FORECASTING METHODS

This section discusses in more depth the most common methods that state DOTs use to forecast revenues: simple historical trend extrapolation, expert consensus, and econometric

TABLE 1
SURVEY-REPORTED REVENUES THAT ARE FORECAST BY STATES

Sources of Revenue Forecast
Oil company gross receipts tax
Investment income and small revenue sources
Aviation fuel tax
Rental car surcharge
Off-highway sales tax on dyed diesel
Documentary stamp tax
Motor carrier surtax
Fuel tax transfers and refunds
Oversize/overweight permits
Damage to state property
Toll road lease proceeds
Miscellaneous permits and fees
Weight distance tax
Federal revenue reimbursements
2% Special fuel excise tax on dyed fuel usage
Driver's license revenue
Truck regulation and enforcement fees
Projected unencumbered cash balances
Oil company—franchise tax
Contribution from PA Turnpike Commission
Vehicle code fines
Vehicle sales tax
Local participation
Interest on cash balances
Miscellaneous revenue
Dedicated taxes and fees
Ferry boat fees
DMV fees
Traffic violation fees
Airspace leasing

models, including econometric regression analysis. It is important to note that few states use one method exclusively. A state may use different forecasting methods for different revenue sources, or use a combined approach. Differing methods were also reported for short- and long-term forecasting.

Trend Extrapolation

The most straightforward revenue forecasting tools involve applying a mathematical formula to past revenue levels to determine future revenues. Historical trends are extrapolated into the future, either in a linear manner or with some adjustment to account for expected future changes in underlying conditions.

As noted previously, some Georgia jurisdictions rely on local general fund appropriations and a Special Purpose Local Option Sales Tax (SPLOST) to provide the local share of funding for state highway projects. Georgia's DOT develops its forecasts for these local funds using historical allocations. For transit, local funding comes from either general fund allocations or a local option sales tax. To forecast the amounts of these local sales taxes, historical data indicated a 3.5% compounded annual growth rate, and it was assumed that this growth rate would continue throughout the 30-year plan (Georgia Statewide Transportation Plan 2006). To forecast revenue collected from Georgia's statewide gasoline tax, a regression model is used.

Trend extrapolation can also be used to anticipate federal funding disbursements. Montana bases its short-term (five-year) federal revenue forecasts on historic funding levels, known changes in federal program funding levels, anticipated changes in state share, and an estimated moderate inflation rate. The long-term revenue forecast method is similar but somewhat less detailed. According to the respondent from Montana's DOT, "These long-term forecasts are better used for planning efforts—and to ensure that we identify areas of future need."

It appears that trend extrapolations are most relied upon for revenue sources that are historically stable, such as general fund allocations, local contributions, and other sources that are determined by a fixed formula. For revenues that are dependent upon fluctuations in vehicle miles traveled or fuel prices (i.e., motor fuel taxes), states appear to be in transition and some are adopting more sophisticated forecasting methods. In addition, the 2007–2010 recession has made projecting historical trends increasingly risky, and states are reconsidering their practices.

Expert Consensus

A commonly used method of forecasting is referred to as "expert consensus," which relies on the professional judgment of a selected panel or conference of economists, analysts, academics, and others who discuss and try to agree upon future revenue projections or on critical inputs that will affect those projections. Sometimes this method is used in conjunction with econometric models; for example, Arizona uses an econometric model, and the results are reviewed and adjusted as needed by a panel of experts.

Florida's DOT participates in a Revenue Estimating Conference at least twice per year where the 10-year forecast of the Department of Revenue is officially agreed upon and adopted. The other agencies represented at the conferences are the Florida legislature, the governor's office, and Department of Highway Safety and Motor Vehicles. Similarly, Utah's DOT relies on revenue projections from the Office of the Legislative Fiscal Analyst, the Governor's Office of Management and Budget, and the state treasurer's office.

Expert judgment is also used to estimate independent economic variables. In 1992, Arizona introduced a risk analysis process for deriving the independent variables for its regression-based forecast. A panel of experts was asked to judge the likely range, from a high of 90% to a low of 10%, for each independent variable. A spreadsheet of the assumptions of each expert and each variable is regularly published as part of Arizona DOT's Risk Analysis Forecast (RAF) process, shown here in Table 2.

One state respondent mentioned that the persons who provide the forecasts are not necessarily particularly expert at transportation funding. According to this respondent, the economists relied upon to provide forecasts are "more interested in the state general fund forecast" and "sometimes do not fully analyze the factors affecting the forecast of gasoline taxes." This statement may provide insight into why many states choose to empanel experts having different perspectives that may be important in building a meaningful consensus when forecasts are based on judgment.

Econometric Models

According to the survey, the majority of states forecast revenue using some version of econometric analysis. The following section examines the independent variables that are used most often in states' forecasting models, and presents case examples of two states, Oregon and Washington, that use regression analysis to forecast transportation revenues.

Regression models are commonly used to quantify relationships between variables. In their simplest form, linear regression models specify a relationship between independent variables (per-gallon price of gasoline, state population, state employment) and a single dependent variable (e.g., gasoline consumed or total revenue). Regression functions measure the extent to which the dependent variable changes based on changes to the independent variable(s). Regression modeling is often used to forecast a quantity, such as number of passenger vehicles sold or gallons of gasoline consumed, which is then multiplied by the per-unit tax rate to reach a

TABLE 2
ARIZONA'S DOT RISK ANALYSIS FORECAST PANEL GROWTH FORECASTS

	Nominal Personal Income Growth	Pop-ulation Growth	Construction Employment Growth	30 Year Mortgage Rate	Phoenix CPI Growth	Sky Harbor Passenger Traffic Growth	Total Non-Farm Employment Growth
FY2013							
Upper 10%	6.74%	2.14%	14.14%	4.74%	2.74%	4.26%	3.55%
Lower 10%	2.94%	0.99%	4.16%	3.66%	1.00%	1.25%	1.25%
Median	5.17%	1.63%	8.21%	4.19%	1.87%	2.93%	2.53%
FY2014							
Upper 10%	7.83%	2.69%	16.45%	5.18%	3.21%	4.38%	3.83%
Lower 10%	3.52%	1.30%	5.22%	3.84%	1.42%	1.31%	1.38%
Median	5.85%	2.06%	10.53%	4.53%	2.28%	2.95%	2.89%
FY2015							
Upper 10%	8.10%	3.02%	16.67%	5.74%	3.61%	4.57%	4.43%
Lower 10%	3.86%	1.44%	4.41%	4.08%	1.39%	0.93%	1.35%
Median	6.25%	2.34%	10.56%	4.91%	2.40%	2.78%	3.18%
FY2016							
Upper 10%	8.21%	3.01%	13.68%	6.44%	3.79%	4.49%	4.62%
Lower 10%	3.86%	1.42%	2.88%	4.58%	1.41%	0.73%	1.42%
Median	6.15%	2.34%	8.15%	5.55%	2.37%	2.64%	3.33%
FY2017							
Upper 10%	8.24%	2.97%	12.34%	7.13%	4.01%	4.47%	4.63%
Lower 10%	3.50%	1.33%	0.90%	4.94%	1.21%	0.50%	1.20%
Median	5.92%	5.92%	6.20%	5.94%	2.28%	2.45%	3.31%
FY2021							
Upper 10%	8.59%	3.10%	3.10%	7.78%	4.26%	5.03%	5.30%
Lower 10%	2.01%	0.79%	0.79%	5.10%	0.87%	-0.18%	0.12%
Median	5.24%	1.96%	1.96%	6.37%	2.32%	2.26%	2.77%
FY2026							
Upper 10%	8.45%	3.00%	10.43%	7.91%	4.70%	5.06%	5.19%
Lower 10%	1.66%	0.67%	-5.62%	5.15%	0.92%	-0.31%	-0.49%
Median	4.86%	1.74%	3.54%	6.45%	2.38%	2.19%	2.58%

forecast for that particular revenue source. Each revenue source might have its own set of regression equations.

Time series analysis, including ARIMA analysis, is a method used to analyze a series of successive data points that are collected at uniform intervals. This type of analysis is used to predict future variables based on historical trends. State DOTs often use either univariate (meaning a single independent variable) or multivariate regression models to perform time series analyses of historical price and consumption data points. In some cases, models are adjusted to account for seasonal variability.

CASE EXAMPLE: WASHINGTON

WSDOT uses multiple models for short- and long-term forecasts of diesel and gasoline consumption in the state of Washington. In 2010, WSDOT revised its forecasting methodology to use a multivariate regression model with economic independent variables for both its quarterly and annual models. However, WSDOT found that monthly time series analysis provided more accurate forecasts in the short term than the quarterly econometric forecasts (Table 3). It adopted a new model in 2013, which uses historical monthly

TABLE 3
WASHINGTON DOT'S UPDATED ANNUAL GAS CONSUMPTION ECONOMETRIC MODEL OUTPUTS

Dependent Variable: 1st Difference LOG(GAS)				
Variable	Coefficient	Standard Error	T-statistics	Prob.
Intercept	0.00175	0.00204	0.8564	0.401
Log_WA_Emp	0.63306	0.09357	6.7656	0.000
LOG_ US Fuel Efficiency * WA_Gas Price	−0.09749	0.02326	−4.1922	0.0004
AR(1)	−0.50424	0.18475	−2.7294	0.0122
MA(1)	0.19693	0.07612	2.58718	0.0168
MA(2)	−0.15832	0.08271	−1.91407	0.0687
MA(3)	−0.90648	0.06293	−14.4055	0.0000
Adjusted *R* Squared	0.5614	Durbin-Watson	2.0302	
Root Mean Square Error	38.6597	Schwarz Bayesian Criterion	−5.393011	

fuel consumption levels rather than using historical economic data as independent variables. The new model operates using an ARIMA model that is better able to account for seasonal variables that affect fuel consumption. These monthly models also take into account the number of trading days in each month and some holidays; and unusual and unpredictable patterns in the data, such as adverse weather conditions, that could influence fuel consumption. WSDOT has found the ARIMA models to be accurate in the near-term (two to three years). In the long term, it still uses the first-difference multivariate regression model with economic variables as independent variables.

Case Example: Washington DOT's Regression Equations

The equation for annual gasoline consumption in Washington is logarithmic in its formulation. The final model is a log-log functional model, with first difference of natural logs used on both sides of the equation. The equation is customarily referred to as using ordinary least squares.

The equation for annual gasoline consumption in Washington is:

$$Ln(Gas) = \alpha + \varphi \ln(WA\_Emp) + \phi(WA\_GasP * Eff) + \delta \ln(WA\_pop) + \varepsilon$$

Where:

Gas = annual gross gasoline consumption
WA_Emp = annual Washington non-farm employment
$WA\_GasP*Eff$ = annual Washington gasoline prices * U.S. average fuel efficiency
ε = Stochastic disturbance on gasoline consumption.

The individual regression coefficients were selected because they are statistically significant and have economic reasonable values. According to published reports, the model fits historical gasoline consumption data well. "Overall, the independent variables are able to explain most of the variation in gasoline consumption." Table 3 shows the manner in which model outputs are presented for users of the modeling results. According to Washington DOT staff, using the first difference multivariate regression model has led to a more pessimistic forecast and flattened the gas consumption forecast in the long-term than the prior forecast model predictions. This change in Washington state forecasting methodology was made in November 2010.

Diesel Variables

WSDOT has also updated its quarterly and annual diesel consumption models in similar fashion. Prior to 2010, WSDOT's diesel consumption models used historical diesel consumption, with adjustments being made for trading days and certain holidays. This monthly model has proved to be quite accurate. One difficulty that WSDOT found with the long-term diesel fuel consumption model was that it was not able to account for the truck fuel efficiency variable. Truck fuel efficiency has increased slightly and is projected to grow in the future because of new EPA regulations. The revised long-term diesel forecast model has two independent variables: an economic activity variable—state employment in the trade, transportation, and utilities sectors—and residents' real personal income.

Independent Variables

WSDOT uses 10 independent variables for its quarterly forecasts of transportation revenues. Generally, the Washington Economic and Revenue Forecast Council provides WSDOT with the economic variable forecast through FY 2019. WSDOT extends the economic variables' forecast for 14 years. Certain long-term forecasts for economic variables, such as population and employment, are provided by the state's Office of Financial Management (Washington Transportation Revenue Forecast Council 2013). The sources for these variables are listed in Table 4.

Gasoline Consumption Variables

Forecasting transportation revenue levels can be a multistep process. It is common for states to develop forecasts for variables such as statewide gasoline consumption or fuel price that are then inserted into other models. For example, Minnesota uses a national gasoline consumption forecast produced by the consulting firm IHS Global Insight (GI) and regional motor gasoline consumption forecasts produced by the EIA. Minnesota's DOT combines these two sources into an average, and multiplies this average by the current motor fuel tax rate to estimate its revenues. Table 5 shows how

TABLE 4
SOURCES OF DATA FOR WASHINGTON DOT'S ECONOMETRIC MODELS

Variables	Sources
WA personal income	Based on the Washington Economic and Revenue Forecast Council in short-term (through 2017) based on forecasts from Blue Chip average US GDP growth rates and NYMEX fuel prices; and long-term Global Insight forecast
Population	Preliminary Office of Financial Management population projections
Inflation (2 measures: CPI and IPDC)	Washington Economic and Revenue Forecast Council for short-term and Global Insight forecast for long-term
Employment	WA non-ag. imp; WA TTU, WA retail trade and national unemployment rates
Oil price index	2014 Global Insight forecast
Fuel efficiency	2014 short and long-term Global Insight forecast
U.S. sales of light vehicles	2014 Global Insight forecast and November 2013 long-term Global Insight forecast3
U.S. fuel prices (retail gas and diesel and index of petroleum products)	EIA for short-term and Global Insight for long-term

TABLE 5
MINNESOTA'S FUEL CONSUMPTION INPUTS, 2013–2017

Energy Information Administration (EIA) Changes, Feb '14 vs. Nov '13					
	Feb '14 Forecast Annual Energy Outlook 2014 Early Release		Nov '13 Forecast Annual Energy Outlook 2013 Baseline		
Year	Delivered Motor Gasoline Consumption, All Sectors (quadrillion BTU)	Growth (Year over Year)	Delivered Motor Gasoline Consumption, All Sectors (quadrillion BTU)	Growth (Year over Year)	Change
2013	1.26	-0.5%	1.24	-1.2%	0.8%
2014	1.25	-1.2%	1.20	-3.0%	1.8%
2015	1.23	-1.9%	1.17	-2.4%	0.6%
2016	1.21	-1.4%	1.16	-0.8%	-0.6%
2017	1.19	-1.4%	1.15	-0.8%	-0.6%

Global Insight (GI) Changes, Feb '14 vs. Nov '13			
	Feb '14 Forecast	Nov '13 Forecast	
Year	GI Highway Consumption of Fuel Year over Year Growth	GI Highway Consumption of Fuel Year over Year Growth	Change
2013	-0.3%	-0.3%	0.0%
2014	1.0%	0.2%	0.8%
2015	-0.5%	0.0%	-0.5%
2016	1.2%	0.8%	0.4%
2017	1.2%	0.8%	0.4%

MnDOT Consumption Forecast Changes, Feb '14 vs. Nov '13			
	Feb '14 Forecast	Nov '13 Forecast	
Year	Blended Average of EIA/GI	Blended Average of EIA/GI	Change
2013	-0.4%	-0.8%	0.4%
2014*	1.1%	-0.5%	1.6%
2015	-1.2%	-1.2%	0.0%
2016	-0.1%	0.0%	-0.1%
2017	-0.1%	0.0%	-0.1%

*EIA/GI blended average of -0.09% adjusted to 1.07% in FY 2014 to account for actual year-to-date revenues

Source: Minnesota's DOT 2014 Transportation Funds Forecast 2014.

Case Example: Oregon

Over 200 stochastic equations comprise Oregon's DOT (ODOT') short-run revenue forecasting framework. The quantities in the model ("transactions") span taxable gallons of motor fuels (principally gasoline and use fuels including diesel), weight-mile taxes paid by heavy vehicles in lieu of paying diesel fuel taxes (26,001 lb or more), to a very broad array of drivers and vehicles transactions. The latter range from driver' licenses, vehicle registrations, and license plates to titling, as well as to business regulation of auto-related business activities.

As an illustration of the specifications in the model, the forecast equation for motor fuels, which account for nearly 50% of the agency's state-generated revenues, can be initially represented by the general function:

$$Q_t = f\left(\alpha_0, X_1, X_2, X_3, X_4, X_5, X_6, DBFB\right),$$

where the independent variable vector (**X**) is made up of

α_0 = Intercept term,
X_1 = Real retail price index for motor fuels, with a distributed lag structure of 5 quarters,
X_2 = Fuel efficiency of the existing stock of light-duty vehicles,
X_3 = Oregon total non-farm employment,
X_4 = Oregon real aggregate personal income,
X_5 = Oregon labor force participation rate,
X_6 = Consumer sentiment index, and
DBFB = Binary variable for implementation of an ethanol blending mandate in 2008.

Traditional functional forms of linear and multiplicative (linear in logs) specifications are used in parallel. The former forms have mathematically varying elasticities, while the latter have constant elasticities and, therefore, are somewhat more restrictive. The additive specifications are usually the most used for final forecasts, as they permit the elasticities to vary with the point of evaluation.

The equations are more representative of a reduced form structure, rather than as structural demand functions per se. As a result, the estimated elasticities are more properly viewed simply as "sensitivities," not as demand elasticities. Notwithstanding, they are sometimes used interchangeably.

The quarterly observations used in the econometric equations are based on monthly data, tested for seasonality. The equations are estimated using a Generalized Least Squares Estimator (GLSE). The fitted equations explain in excess of 98% of the variation in gallons consumed. The relative standard errors of the regression equations are generally in the range of 1.3–1.6& when compared to mean usage.

The sensitivities routinely obtained from estimation (that is, the percentage change in usage relative to a percent change in an independent variable) are illustrated below.

Elasticity Estimates

Real fuel prices	–0.073
Fuel efficiency of vehicle stock	–0.13
Employment	+0.3
Real personal income	+0.25
Labor force participation rate	+0.17

For example, a 10% increase in the real fuel price brings about a 0.7% decrease in fuel usage, distributed over a five-quarter response period. This relative "inelasticity" conforms closely with a preponderance of other empirical findings, given the largely derived-demand nature of gas consumption.

ODOT modelers also maintain vector autoregression models for a number of usage transactions, although they do not frequently serve as a basis for final forecasts. ARIMA time series models are also used in various driver and vehicle transaction forecast equations.

Minnesota's DOT uses these inputs for its five-year (2013–2017) forecasts.

Several states, including Washington, rely on fuel consumption forecasts from GI and/or EIA as data inputs. Other states, such as Oregon, use GI and EIA for exogenous data only, with fuel consumption observations performed by the state DOT. Good, continuous data for state fleet fuel economy is scarce, making it difficult to consider the regional differences in the composition of the national fleet.

Demographic and Socioeconomic Variables for Econometric Analysis

States rely on a multitude of demographic and socioeconomic data as inputs to their models. For example, Arizona estimates its transportation excise tax revenue with what it describes as a "comprehensive regression-based econometric model." Approved in 1985 by voters in Maricopa County, which includes Phoenix, the excise tax is a half-cent sales tax dedicated to constructing a freeway system within the county. In 2004, the sales tax was extended for another 20 years, with proceeds dedicated to construction and improvements of new and existing freeways, roadways, and transit services. The model uses seven independent variables that relate to state and county demographic information:

- Maricopa County nominal personal income growth
- Maricopa County population growth
- Maricopa County construction employment growth
- Phoenix consumer price index (CPI)
- Sky Harbor Airport passenger traffic growth
- Maricopa County total non-farm employment growth
- The 30-year mortgage rate.

The independent variables used by other states surveyed can be found in Appendix B.

ACCURACY AND SHORTCOMINGS OF FORECASTING METHODS

Respondents were asked to evaluate the accuracy of their current revenue forecasting processes. They were also asked to identify major shortcomings of these practices, and whether any action has been taken to improve their accuracy. While some states are very confident of their findings, seven respondents reported having updated or changed their forecasting methods in the past two years, either for reasons that were internally generated (staff desire to improve accuracy) and/or in response to changes in external factors. In one case, North Dakota's impetus for change was that the state has been experiencing a large increase in fuel usage as a result of the oil extraction activities in the western part of the state. The traditional means of forecasting did not address the new levels of fuel usage.

In Oregon, a review of forecasting accuracy is published quarterly, and the forecast itself is updated every six months. However, most states do not report publishing regular accuracy reviews. In Washington, accuracy has improved with a revised methodology. The biennial revenue forecast variance in the fuel consumption revenue has fluctuated less than 1.5% around the midpoint, which is a direct result of the forecast model changes.

Table 6 presents some of the most informative state responses regarding accuracy.

Many respondents mentioned that they are experiencing increasing uncertainty and difficulty in forecasting federal revenues, particularly in relation to the future decisions of Congress. In some cases, political uncertainty leads to states' choosing not to include federal revenues in their forecasting models. In other cases, the respondents reported that their DOTs simply use their own judgment to pick an estimate of federal distributions that appeared reasonable. WSDOT examines the CBO national forecast for future revenue and expenditures to predict when the HTF will become insolvent, and reduces the Washington share of national total of federal transportation revenue projections by an amount that keeps the HTF from going into deficit.

By contrast to federal funding, revenues from state sources were generally considered more stable and predictable. Illustrative responses about this issue are summarized in Table 7.

Other significant hurdles that states reported were perceived shortcomings in the accuracy of their input data, a paucity of historical information, or a lack of sophistication of methodology. Table 8 presents a variety of additional reasons some states gave as challenges to forecasting accuracy.

Finally, some states expressed concern about the accuracy of their forecasting techniques during economic downturns or recessions; these are presented in Table 9. For example, ODOT reports that staff members have generally been satisfied with the precision of forecasts except during the Great Recession, when error rates were higher.

RESPONSE TO POLICY PROPOSALS

Twenty-four (24) of 45 states reported that they had been asked within the past two years to evaluate proposals to raise additional transportation revenue, either by raising rates or changing the structure of traditional transportation revenue sources. Table 10 presents sources of increases to current revenue sources that were enumerated, and Table 11 lists new sources of revenue.

One state DOT respondent reported feeling constrained as a result of political sensitivities, reporting that the agency

TABLE 6
ILLUSTRATIVE STATE RESPONSES REGARDING FORECAST ACCURACY

Texas	"Overall state revenue forecasts have proved to be accurate within ±5% over the last seven years. However, their forecasts of motor fuel tax and registration fees have been much more accurate."
Arizona	"ADOT has a very robust forecasting process that has been in place since 1992, which has proven highly accurate in all but the most volatile of economic environments."
Iowa	"Our forecast amounts vs. actual receipts have been within 98% each of the last several years due to the relative stability of the traditional transportation revenue sources. Estimation of non-traditional sources would be more difficult."
West Virginia	"The forecasts work for our internal purposes, but they are basic and provide only general information."

Source: State DOT survey respondents.

TABLE 7
ILLUSTRATIVE STATE RESPONSES REGARDING FEDERAL FUNDING IN FORECASTS

Alaska	"The current Congressional bill was only two years long and we are in the last year. No one knows how the next multi-year will be structured or if there will be a next bill. State allocations are just as ephemeral as Alaska's state government is funded by oil production taxes from a rapidly declining field and very uncertain oil prices."
Indiana	"Inability to accurately predict Federal Highway Transportation Funds."
Mississippi	"Our state revenues are fairly consistent each year so our forecasts for these are accurate. Since our federal revenues are dependent on contract expenditures and available obligation authority, they are much harder to forecast."
Missouri	"Comfortable with state revenue sources. Weakness due to uncertainty of federal funding in the current environment."
Nevada	"No problems with techniques - uncertainty of Federal highway Administration program makes forecasting difficult."
Ohio	"The forecasts used by ODOT are fairly accurate. The biggest challenge is the uncertainty of funding, especially at the federal level."
Montana	"Uncertainty in the federal program revenue generation. As mentioned above, the federal program funding size and timing has been generally unstable since the early to mid-2000s, leaving the states that heavily depend on the federal program with little ability to plan/project future program levels. Planning these kinds of infrastructure projects and making the right asset management decisions rely heavily on future program levels, it's difficult to know if we are making the right investment decisions with the current state of the federal program."
Louisiana:	"Federal funds are extremely difficult to forecast because of its dependence on the wishes of Congress and not necessarily the motor fuel taxes collections."
Utah	"Federal funds are basically projected as "flat" increase/decrease. The inability to know whether general fund infusions will actually continue as in the past is difficult."

Source: State DOT survey respondents.

TABLE 8
ILLUSTRATIVE STATEMENTS ABOUT CHALLENGES TO REVENUE FORECAST ACCURACY

North Dakota	"Initially when the oil activity began in the state, the traditional techniques did not fit the traditional model for revenue forecasting. Now that we are gaining additional historical data, the forecasting of revenue projections has been much closer to the actual revenue received."
California	"Lack of sophistication in forecasting revenues leaves us with 'long-term trends' basis rather than an economic basis."
Nebraska	"Stability in motor fuel prices. Two components of our motor fuel tax are derived from a percentage applied to the motor fuel prices."
Utah	"Projections of fuel efficiency of future vehicle fleets on the highways pose challenges."

Source: State DOT survey respondents.

TABLE 9
STATEMENTS REGARDING THE IMPACT OF THE ECONOMIC DOWNTURN ON FORECAST ACCURACY

Oregon	"Major shortcoming of the revenue forecasting techniques currently used by the department is the ongoing inability to more accurately estimate economic downturns and associated detrimental impacts on transportation revenues and more accurately consider fuel efficiency and vehicle miles of travel growth uncertainty in future years."
South Dakota	"They are becoming more unreliable due to economic volatility and slowing VMT rates of growth."
Delaware	"Revenue forecasting has been very accurate, except during recessionary periods. FY09 and Fy10 were difficult."

Source: State DOT survey respondents.

TABLE 10
CHANGES IN REVENUE SOURCES RESPONDENTS WERE ASKED TO EVALUATE

Type of Change	State Providing Response
Half-cent sales tax	AR
Increase in petroleum transfer fee	ID
Increases to the state excise taxes	IA
Gas tax increases	MN, ID
Increased motor vehicle sales taxes	MN
Increased vehicle registration taxes and fees	MN, ID

cannot openly evaluate a full range of revenue options. The respondent also mentioned that the agency feels pressured by outside parties to generate overly optimistic revenue results.

A more typical response came from Oregon. In forecasting revenue, ODOT bases projections on "current law" only; it does not speculate on legislative proposals until they have been enacted. For the purposes of estimating the amount of revenue that would be generated by various proposals, the respondent said that a simple approximation is sufficient. In addition, the respondent finds that attempting to model revenues from new sources is difficult because it is not often clear which variables are most appropriate to consider. To the extent that some options for future revenue are more novel than others, their very novelty makes them inherently more difficult to forecast.

TABLE 11
NEW REVENUE SOURCES RESPONDENTS WERE ASKED TO EVALUATE

New Revenue Source Evaluated	State Providing Response
A dedicated regional transportation tax passed in three regions of the state which fund transportation improvements within the counties and cities throughout the regions	GA
Various bonding proposals	MN
Indexing the fuel tax	IN
Turnpike Revenue Bonds	OH
Application of a sales tax on the price of fuel	IA
Transfer of general funds to transportation	IA
Appropriating a set dollar amount of the state's general fund to transportation progra ms	IN
Appropriating a % of state sales tax for transportation program funding	IN
Electric/hybrid car fee	ID
Rental car fees	ID
Increased dyed diesel enforcement	ID
Increase in sales tax by 1% with proceeds directed to highway account	ID
Transfer of 4.5% sales tax on motor vehicle goods to highways (unsuccessful)	AR
Passage of increase in tax on LPG and CNG (unsuccessful)	AR
A change (revenue-neutral, at least in the short term) in the way we levy motor fuel taxes, from a cents-per-gallon to a wholesale tax rate	DC
Sales tax on tires and other automotive accessories directed to the highway account	ID

Source: State DOT survey respondents.

CHAPTER FOUR

INSTITUTIONAL ARRANGEMENTS FOR STATE REVENUE FORECASTING

This chapter summarizes results of the survey that relate to institutional and organizational approaches to forecasting. Quite a bit of variation was reported among states, including organizations responsible for data inputs, developing and running the forecasting models, and publishing the results. The survey also addressed the role of private consultants in the forecasting process and the ways in which they are brought in from time to time to help improve states' approaches to forecasting.

STATE DEPARTMENTS OF TRANSPORTATION

In many cases, one person or a small team of staff members in the state's DOT undertakes the process of forecasting transportation revenue. For short-term forecasting, 26 states reported that the process is handled entirely within the state DOT, and another five reported that their DOT collaborates with at least one additional entity. For long-term forecasting, 28 state DOTs handle the process themselves, and another three collaborate with other entities.

OTHER, NON-DOT AGENCIES

Twelve (12) states reported that revenue forecasting is done outside their DOTs by other agencies or organizations. In some cases, a panel of experts and/or staff members is convened regularly, and one or more representatives from the state's DOT are included in that process. In other cases, exemplified by New York, the task of forecasting revenue is entirely controlled by state's Division of Budget, which is external to the DOT. The changes to the dollar amounts in future year projections reflect current law and the "latest information regarding the states various tax and fee sources." For the transportation fund, these changes include a more conservative estimate of gasoline price forecast from the previous year.

In some states, statutes mandate the preparation and adoption of economic and revenue forecasts. In Washington, the Office of Financial Management carries out its forecast responsibilities for transportation revenues through the Transportation Revenue Forecast Council. The process is described as follows: "Each quarter, technical staff of the Department of Licensing, Department of Transportation, Washington State Patrol and the Office of Forecast Council produce forecasts. The transportation revenue forecasts agreed upon by the Transportation Revenue Forecast Council members become the official estimated revenues under RCW 43.88.020 21."

PRIVATE CONSULTANTS

A few states have retained consultants to prepare revenue forecasts, and it appears that two firms have been most actively involved in revenue forecasting at the state level: Cambridge Systematics (CS) and HDR|HLB Decision Economics (HDR|HLB). The services of these companies have been retained by several states for two purposes: to perform revenue forecasting directly and/or to analyze and recommend improvements to the forecasting models maintained and operated by the state DOTs.

CASE EXAMPLE: PROPOSED REVISIONS TO MISSOURI'S DEPARTMENT OF TRANSPORTATION FORECASTING MODELS

Missouri's DOT (MoDOT) entered into a contract with HDR|HLB to review and critique its revenue forecasting model. HDR|HLB conducted a review of the existing model and the forecasting assumptions, and made recommendations in a report entitled *Review and Critique of MoDOT's State Revenue Forecasting Model*, which was prepared in 2007. In this report, HDR|HLB reviewed the current practices of Missouri's DOT and recommended updating the modeling process to one that was significantly more complex (HDR|HLB 2007).

Proposed Revision to Missouri's DOT Forecasting Models

The proposed revised forecasting models employed the basic econometric modeling framework, but altered the individual models by adding independent variables and by introducing dummy variables to account for changes in fees as a result of legislation that took effect in particular years. Where appropriate, the proposed changes also introduced autoregressive terms or moving averages. The recommendations were based on a "risk analysis framework," which provided users median (most likely) forecasts as well as lower and upper bounded forecasts showing the range of the resulting forecasts from 10% to 90% of variation within 95% confidence bands.

Figure 3 shows an example of model outputs and Figure 4 is a flow chart that shows the process for forecasting that was recommended by the consultants. Interestingly, in the very short term—two to four years from the date of the forecasts—small differences in forecasted revenues from each source resulted from comparisons between the older MoDOT forecasts and those resulting from the recommended improvements. As forecasts reached farther into the future, the forecasting results from the newer models diverged from the older forecasts to a greater extent.

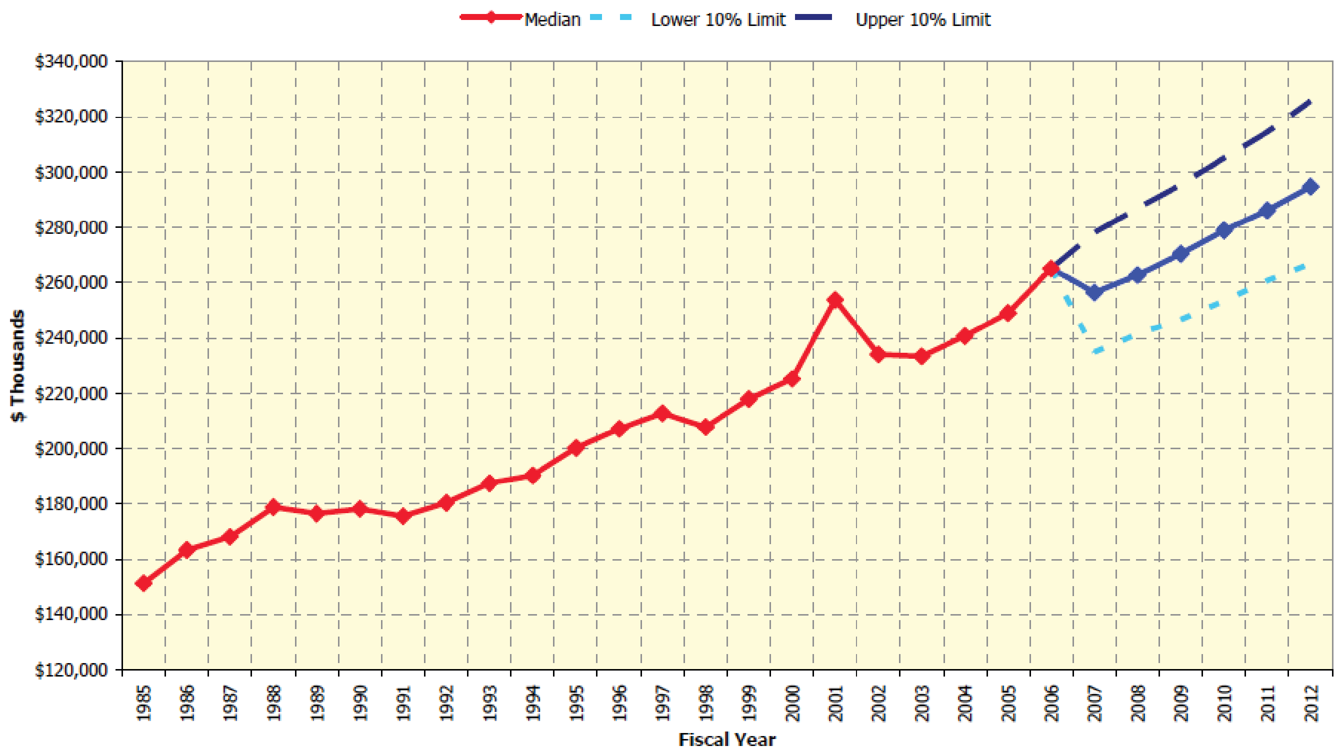

FIGURE 3 Example of HDR|HLB Risk Analysis Forecast Output for Missouri's DOT.

In 2007, Missouri's revenue for transportation came primarily from five sources:

1. Motor Fuel Tax—A tax on the sale of motor fuel (gasoline, diesel, and blends) paid by the fuel supplier and passed on to the consumer. The state tax rate was 17 cents per gallon at the time of the study, and MoDOT's share was estimated at 73% of total receipts.
2. Motor Vehicle Sales Tax—A tax on the purchase of any new or used motor vehicle or trailer in Missouri. The tax rate was 4.225% at the time of the study.
3. Motor Vehicle Use Tax—a tax on vehicles purchased out of the state and titled in Missouri and on the sale of a vehicle between individuals within Missouri. The tax rate was 4.225% at the time of the study.
4. Driver's License Fees—A fee imposed every three years or six years on operators of motor vehicles in Missouri for the issuance of a driver's license. The fee varied from $10 to $22.50 for a three-year license depending on the type of license.
5. Motor Vehicle Fees—A one- or two-year fee for the registration of motor vehicles. The fee varied with the gross weight of commercial vehicles, horsepower of other vehicles, or seating capacity for passenger-carrying commercial motor vehicles.

These remain the main sources of state transportation revenues today, and the rates are unchanged.

At the time of the study by the consultants, MoDOT projected each of these sources of revenue using six separate regression models (different models were used for gasoline and diesel fuel tax revenues) and annual data for the independent variables for the last 20 years. The resulting estimates were summed to arrive at annual projections of future revenue. The MoDOT models did not at that time include autoregressive or moving average terms.

After considering the report, however, MoDOT staff concluded that implementing the revised process was unnecessary. In an interview, a representative of MoDOT reported that the decision not to adopt the proposed changes was likely because of the complexity of the recommended process. Reviewing both the existing modeling practice and the consultant's recommendations, it is clear that the consultants recommended an approach that was methodologically more complex and demanding of data than the process used by the state. There is no objective method by which one can measure whether the recommended change in forecasting methodology, had it been implemented, would have produced forecasts that were more accurate than those produced by the simpler methods used by MoDOT and by most other states.

MoDOT does track and report quarterly on the accuracy of its revenue forecast. Since the agency began reporting the accuracy in 2007, the variance has always been in the band of ±5%. Those variances are then taken into account in the forecast for the subsequent year.

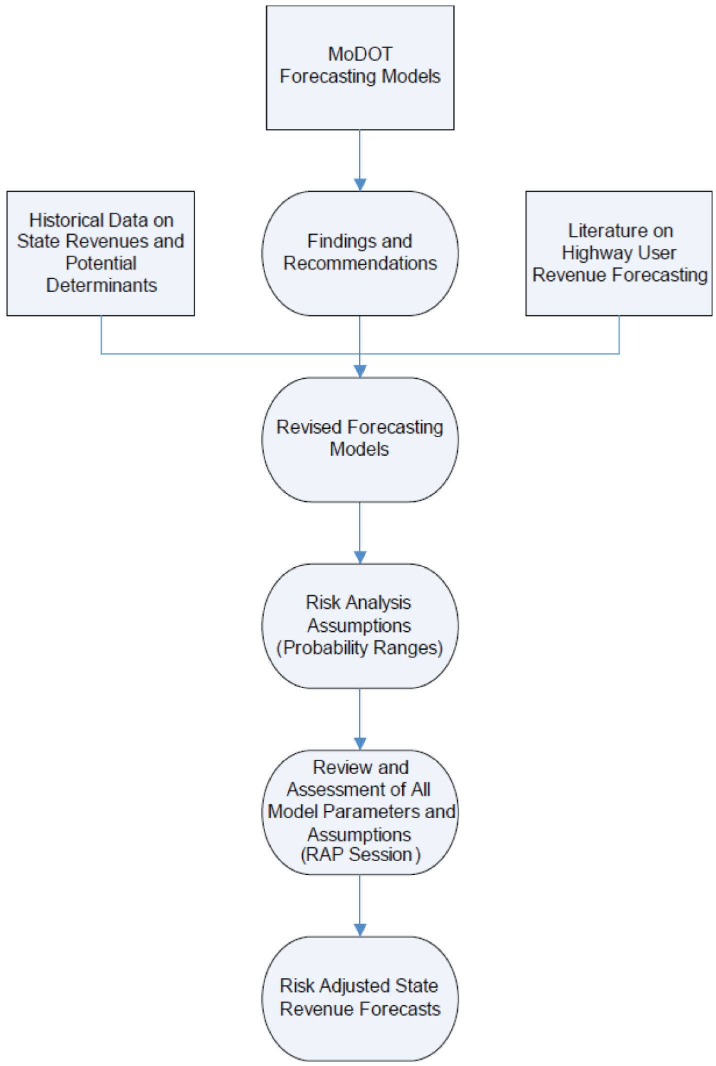

FIGURE 4 Flow chart describing HDR|HLB's recommended approach.

PUBLICATION AND DISTRIBUTION OF RESULTS

Of the 45 states responding, 13 reported that revenue forecasts are regularly published and made widely available: Arizona, Colorado, Connecticut, Georgia, Maine, Michigan, Minnesota, Oregon, Pennsylvania, Texas, Utah, Vermont, and Washington. In these states, short-term revenue forecasts either are published as a separate document on the DOT website or included in the state's annual budget documents. Long-term revenue forecasts are generally published in the State Transportation Improvement Program (STIP).

The remaining states did not provide information about where the forecasting models could be found or how they disseminated their forecasts. They mentioned that the results can be made available in response to requests for them made by contacting DOT staff.

Case Example: Vermont Consensus Revenue Forecast

In Vermont, transportation revenues are forecast by consensus by a designated group of experts. The state revises and publishes the "Consensus Revenue Forecast" at least twice a year, in January and July, or more often when it is deemed necessary. Two state economists prepare the forecast, one representing the administration and the other representing the legislature. The forecast is then discussed and ultimately adopted officially by the Vermont Emergency Board, which includes the governor and the chairs of certain legislative standing committees (Senate Appropriations, Senate Finance, House Appropriations, and House Ways and Means). The reports prepared by the administration's economist are posted in PDF format on the website of the Vermont Department of Finance and Management. Each biannual report for the past five years is available on the website. Table 12 shows the recommendations of the Vermont Emergency Board for changes in revenue forecasts based on emerging trends. The consensus forecast is not limited to transportation, but also includes general fund and education fund estimates.

TABLE 12
VERMONT EMERGENCY BOARD CONSENSUS UPDATE TO FUND FORECASTS

	Staff Recommended Consensus Forecast Update—Difference from July 2013 Forecast					
	2014		2015		2016	
	Dollars	Percent	Dollars	Percent	Dollars	Percent
General Fund	$8.4	0.6%	–$0.4	0.0%	–$13.8	–1.0%
Transportation Fund	$4.2	1.7%	$1.1	0.4%	–$0.6	–0.2%
Education Fund	$1.1	0.6%	–$0.1	–0.1%	–$0.5	–0.3%
Total	$13.7	0.8%	$0.5	0.0%	–$15.0	–0.8%

Source: Revised 2014–2016 Revenue Outlook) Dollars in millions.

California Gas Tax Swap: A Unique Case

An interesting example of an innovation in transportation financing that relates to forecasting is the policy innovation in California that is known colloquially as the "gas tax swap." In California, the responsibility for forecasting motor fuel tax revenue lies with the State Department of Finance rather than Caltrans, the state DOT, but this case is of interest because the forecasting of revenue is central to the innovation itself. This case example makes clear how complex relationships can be among state agencies, how different organizations—the legislature, other state agencies, and state DOTs—can all play roles in forecasting; and that forecasting methods can be prescribed in legislation and become central to the receipt by the state of revenues for transportation programs. It also illustrates that current innovations affecting transportation revenue depend on past legislative decisions as well as recent ones and that this institutional history complicates the process of forecasting revenues. This complexity makes it difficult to generalize about the ways in which forecasts can be updated or forecasting methods can be changed by state DOTs on their own initiative.

Prior to 2010, California collected a per-gallon excise tax and an additional sales tax on each gallon of gasoline and diesel fuel sold in the state; the revenue from these two taxes constituted the largest sources of state revenue for transportation programs. There were two separate fuel taxes because until 1971 the sale of gasoline had been exempted from the general state sales tax in recognition of the existence of the separate excise tax levied on the sale of each gallon of motor fuel. In 1971, to address what was then seen as a critical shortfall in transportation revenues, the legislature enacted, and the governor signed, the Transportation Development Act (TDA). That law raised the statewide sales tax rate on all goods by 0.25% to a total of 5%, applied the sales tax to motor fuel for the first time, and specified that 0.25% of the total state sales tax revenue (on all goods to which the tax applied) be designated for expenditures on transportation.

Any money generated by the state sales tax on motor fuel over and above the amount required to compensate for the 0.25% change in the state sales tax was known as "spillover" money and was designated by the TDA to the support of public transit. Each year, the state compared an estimate of revenue generated by a state sales tax rate of 5% on all goods except motor fuel with the revenue generated by a sales tax rate of 4.75% on all goods including fuel. If the amount estimated at 4.75% was greater than the amount estimated at 5%, the difference was designated to "spill over" to the state's Public Transit Account (PTA). One-quarter of all PTA funds were designated for transit capital improvements and 75% to the State Transit Assistance (STA) program, which provides flexible funds to transit operators and are largely used to support transit operations.

Because spillover money was available in any given year only when 5% the amount spent on California gasoline exceeded 0.25% of the amount spent on all sales taxable goods in the state, that important source of revenue—the only state support exclusively designated for transit—was difficult to forecast. The availability of revenue depended on changes in fuel prices and over time those became more volatile (MacKechnie 2014).

As is the case in many other states, the per-gallon excise tax was "earmarked" to transportation under Article XIX of the state constitution, whereas the sales tax on motor fuels, and hence the spillover funds that were critical for public transit, were not protected for transportation uses in the same manner. In 2003 voters had approved Proposition 42, which ensured that most of the revenue derived from the sales tax on gasoline would be designated for expenditures on transportation, but that exceptions could be made under conditions of fiscal emergency. During the economic downturn of 2008–10, the governor of California declared fiscal emergencies and for several years redirected some of the sales tax revenue on gasoline to other state purposes. This led to concern on the part of transportation interests, especially transit operators, that in an atmosphere of declining motor fuel excise tax revenues, the proceeds of the sales taxes could not be lost without severe consequences. In response to those concerns, the passage of AB 6 in 2010 affected four different taxes: the state portion of the sales tax on gasoline, the excise tax on gasoline, the state portion of the sales tax on diesel fuel, and the excise tax on diesel. Local sales taxes remained unchanged and continued to include gasoline and diesel fuel. AB 6 resulted in the following key changes (http://www.mtc.ca.gov/legislation/state_budget_3-10.htm):

- Beginning July 1, 2010, it eliminated the 6% statewide sales tax on gasoline, and with it, the funding source addressed by Proposition 42 (the 2003 constitutional amendment that required most gasoline sales taxes to go to transportation) and funded the spillover, as the source of funding for public transit.
- It raised the excise tax on gasoline by 17.3 cents on July 1, 2010, resulting in a total excise tax of 35.3 cents per gallon. Starting March 1, 2011, and each March 1 thereafter, the action authorized the State Board of Equalization (BOE) to estimate how much revenue would have been raised by the sales tax on gasoline if it had continued to exist and to adjust the gasoline excise tax in order to produce an equivalent amount of revenue. Under this provision, the tax may sometimes have to be lowered and sometimes raised. For example, on July 1, 2013, the tax was $0.395 per gallon, and on July 1, 2014, it was reduced to $0.36 per gallon (CSPnet.com 2014)
- It retained the existing sales tax on diesel fuel and raised it by another 1.75% on July 1, 2011, to generate about $120 million in additional funds for public transit, for a total of approximately $436 million in FY 2011–12. This was intended in part to compensate for the loss of the "spillover" funds.
- It offset the diesel sales tax rate increase by lowering the diesel excise tax from 18 cents per gallon to 13.6 cents, effective July 1, 2011. Like the gasoline excise tax, the excise tax on diesel fuel is now adjusted by the BOE on March 1st of each year to maintain revenue neutrality.

The legislature also passed, and the governor signed, a companion bill, SB 70, to exempt some consumers of diesel fuel (including freight rail, commuter rail, transit buses, and off-road vehicles) from the diesel fuel sales tax rate increase. Since these sectors are not subject to the diesel excise tax, they would have experienced a sales tax increase without this exemption (California State Board of Equalization, 2014).

The overall tax swap was designed to protect the sales tax revenues on fuel for application to transportation programs. At the same time, it was designed to be "revenue neutral" in order to allow passage by the legislature by a simple majority vote rather than a supermajority of two-thirds required for "new" and "special taxes." Public transit operators in California were estimated collectively to lose more than $1 billion annually owing to the elimination of the sales tax on gasoline, so some measures were taken to address that loss.

This case is relevant to this synthesis for two reasons. First, both the earlier spillover funding and the new funding levels are dependent upon forecasts of sales tax revenues that are specified in law, but in both cases the required forecasts are made for the short term and in both cases the relevant forecasts are not made by transportation agencies. The forecasting of tax revenue, required to be performed annually by the BOE, is part of the policy innovation itself, and it is the only apparent recent case that such a forecasting requirement is incorporated into law. Secondly, the complex changes in state transportation policy initiated by this legislative action illustrate the kinds of challenges that arise when innovations in transportation revenue are undertaken in the current political environment. Entirely new revenue sources were not created and new forecasting methods were not adopted, yet fundamental changes in transportation finance policy in California created programmatic changes that imposed forecasting challenges for several agencies in order to achieve modest but useful revenue stability.

CHAPTER FIVE

CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

CONTEXT FOR TRANSPORTATION REVENUE FORECASTING

There is increasing awareness nationally of a gradual but relentless increase in the gap between transportation revenue requirements and the receipts from traditional sources such as the motor fuel tax. In all likelihood, individual states and federal agencies will have to institute new sources of revenue over the coming decade. A wide range of innovations can be considered for increasing revenue for transportation programs.

The most direct approach to raising new revenue, especially in the short term, is to increase the rates of existing taxes, fees, or charges—raising the per-gallon rates of existing motor fuel taxes, increasing toll charges, etc.—thus continuing but enhancing long-established transportation finance mechanisms. Although simple in concept, these changes are often difficult to accomplish for political reasons. Variations on existing user charges, taxes, or fees include tolling previously free state roads, adding high-occupancy toll lanes to existing facilities, restructuring toll collection programs, or changing tax structures. Virginia recently converted its motor fuels tax to a new tax on wholesale gasoline, and California converted a sales tax on gasoline to a per-gallon excise tax in order to insure that the proceeds are dedicated to transportation programs. If it became possible to do so (as a result of changes in federal law), charging tolls on interstate highways would be another example of applying existing forms of revenue collection in a new way.

A third approach addresses entirely new forms of taxes, charges, or fees. In 2015, in a demonstration program of limited scope, Oregon will begin charging a mileage-based user fee called a Road User Charge, which is a system of revenue collection not previously employed, though it has been tested in some pilot projects. Some states have considered pursuing commercial real estate development on state-owned rights-of-way as a method of enhancing revenue streams that could be used for transportation programs. If such programs were to be adopted, they would be quite novel; however, no state appeared to be ready to use existing methods or to consider new methods to forecast revenue from such sources.

As described previously, states are weighing a wide range of options for new sources of transportation revenue within a larger political and economic context characterized by increasing uncertainty. The federal legislation known as MAP-21 was subject to six years of debate before adoption, but provided only two years of federal funding, adding to states' unease; and recently Congress extended the law rather than enacting a new one. The economic downturn created increasing uncertainty with respect to travel volumes that determine revenue from motor fuel taxes. Changes in demographics and in travel behavior are also becoming more volatile and difficult to predict.

This combination of circumstances led to the decision to undertake this synthesis. It is important to review and codify information about state transportation revenue forecasting because those forecasts are increasingly salient yet increasingly difficult to accomplish. The findings of this survey shed some light on these complexities and raise many new questions as well.

SUMMARY OF FINDINGS

All but two states reported engaging in some form of forecasting of future transportation revenue, but no two states forecast in exactly the same manner. Short-term forecasts were found to be more common, and undertaken using more complex tools; but many states also sought long-term forecasts. Most states rely on relatively straightforward methods of projection, but whether they informally extend trends observed in recent years, use simple linear time-series projection methods, or employ somewhat more formal and multivariate econometric projections varies greatly.

Some states convened panels of experts to consider data inputs and forecast outputs for reasonableness and consistency with other information and to adjust forecasts as they saw appropriate. Although these adjustments were often subjective in nature, they were based upon the knowledge and experience of those participating in the panel exchanges. In a substantial number of states, statutes or custom led to the regular involvement of agencies outside the state departments of transportation (DOTs) in the forecasting process. Some states were required to rely on forecasts made by other state agencies, and a larger number relied on outside agencies for data. Other states regularly used data series that were commercially available from consulting firms.

Although these practices were found to differ to such a great extent that it is difficult to generalize, in nearly every case states' efforts to project future revenues were found to focus on traditional and well-known sources of revenue. Nearly all survey respondents and state officials interviewed reported that they concentrated on traditional sources of revenue and avoided forecasting potential future revenues from entirely new or dramatically different sources for what they considered to be justifiable reasons.

In general, state DOTs did not add potential new revenue sources to their forecasts if these had not been adopted by state legislatures. Respondents reported that innovative revenue sources were beyond the scope of consideration by state DOTS, but rather had to be introduced by state legislatures and/or governors' offices. Often new revenue initiatives were politically complex and the subject of broad public debate. State DOTs interpreted their roles, as defined in statutes or state constitutions, as operating or implementation agencies that could act to put new revenue sources into place; but invariably they stated it would be inappropriate to engage in political debates and saw making projections in advance of the adoption of new charges or fees to be politically sensitive. In addition, representatives of state DOTs reported that when state legislatures or governors were considering new revenue sources for transportation, they were more likely to turn to legislative research staff or analysts to produce estimates than to state DOT staffs.

States' innovations in the forecasting of transportation revenues fell into a few categories:

- Modest innovations in forecasting revenue enhancement: Despite often being prohibited to "lead" state legislatures in seeking new revenue sources, several state DOTs had incorporated into their forecasting procedures innovations in revenue collection that had been enacted by their state legislatures in recent years in order to update the forecasts to improve their accuracy. State legislatures were far more likely to change rates of taxation or amend the structure or administration of previously existing taxes than they were to institute entirely new tax instruments or policies. For example, on July 1, 2013, as part of a comprehensive tax overhaul, Virginia converted its gasoline tax from a per-gallon excise tax to an ad volarem sales tax, at the same time as it added to the state diesel fuel tax and changed other non-transportation related sales taxes. This change imposes obligations on those forecasting future transportation revenues in Virginia, but the change in procedures is structured by innovations that Virginia DOT did not determine.
- Methodological upgrading: Survey results and the literature review indicated that states have generally been satisfied by the accuracy of their revenue projections, but that uncertainty in conditions surrounding their forecasts had grown over the past decade. Some states have introduced innovations to improve methods of forecasting transportation revenues regardless of their sources or their novelty. Several states had become concerned that their methods of forecasting were too simplistic to capture the unstable policy environment within which state DOTs operate today. Consultants were hired or information was gathered from other states in efforts to improve forecasting methods. Some states that considered more advanced forecasting tools, including Washington and Oregon, adopted them, but others, including Missouri, did not. In most of these cases, states considered and sometimes adopted econometric models to replace simpler trend extrapolation that had been used previously. A few other states had considered, but few had adopted, probabilistic forecasts that projected ranges of forecasted quantities within bands of uncertainty in place of previous practices involving simpler point estimates. Although such approaches to forecasting are favored by consultants or academics because of their elegance or sophistication, it would appear that the demands for data necessary to such models lessened their potential attractiveness to practitioners.
- Forecasting accuracy: Despite some interest in upgrading their forecasting models or methods, few agencies formally measured, published, or reported the accuracy of their forecasts. This could be because reporting accuracy could make them vulnerable to criticism from interest groups, political leaders, or the media. It also more simply could be that agencies have limited staff resources and give other tasks higher priority. Because the formal reporting or publication of forecasting accuracy of different models and methods was rare, and most states provided little data about the accuracy of their projections, it was not possible to determine whether more sophisticated mathematical models yield forecasts that are to any extent more accurate than forecasts based on simple models, informal trend extrapolation, or pooled expert judgment. The benefits of sophisticated forecasting tools have yet to be demonstrated to be greater than their costs.

SUGGESTIONS FOR FUTURE RESEARCH AND COLLABORATION

States share a sense of urgency regarding the forecasting of future transportation revenues and recognize that current conditions make such forecasting increasingly challenging; so it would appear productive to develop a forum for the exchange of information. DOT staff responsible for revenue forecasting in some states appear to consult regularly with those having similar responsibilities in other states, but many other state forecasters do not. Information-sharing among the states could likely be greatly improved to the benefit of most. A regularly updated website on transportation revenue forecasting, perhaps maintained by AASHTO's Center of Excellence in Project Finance; a blog to facilitate exchanges between relevant staff and different state agencies; and regular sessions on transportation revenue forecasting at AASHTO and TRB annual meetings could advance the state of the art in state transportation revenue forecasting while recognizing the diversity in state capabilities and approaches and without threatening discontinuity in current practices except where the states themselves see obvious gains from adopting new methods, models, or data. It might be useful for agencies to track forecasts made over time and to include in a longitudinal database the actual revenues collected in the years for which forecasts had previously been made. States could use these comparisons as a resource when evaluating and updating their forecasting methods.

Among the most obvious threats to the validity of revenue forecasts is the increasing difficulty predicting motor fuel tax revenues, as the range of power sources of vehicles grows rapidly and fuel efficiency ratings become increasingly variable. Several states report relying on national fuel economy estimates when preparing revenue forecasts because they have no reliable source of data on changing fuel economy of the vehicle fleet in their particular state. It would appear feasible to develop state-specific vehicle fleet fuel economy profiles and even forecasting tools for changes in fuel economy profiles. Research resulting in such tools could be conducted under the auspices of the NCHRP or through a pooled funding study sponsored by several states.

In addition, although the AASHTO Center of Excellence in Project Finance maintains a website that lists state sources of revenue and rates of transportation finance revenue instruments, such as motor fuel taxes per gallon, the website was, as of March 2015, four years out of date. With the nature and rates of charges, fees, and taxes changing dramatically at the state level, and with 50 states, the District of Columbia, and Puerto Rico seeking current information to inform their deliberations, there is an urgent need to update that website and to keep it current.

While toll financing is likely to be increasingly important in a resource-constrained transportation environment, only a very small number of state DOTs reported that they forecast revenue from tolls. Toll authorities and private financial institutions have forecast toll revenues for decades, and it would be useful for states to become better informed regarding toll forecasting methods in this country as well as in foreign countries, where toll road financing is quite common. A synthesis study on toll revenue forecasting methods would be a useful complement to the present study.

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APPENDIX A

Survey Questionnaire

NCHRP TOPIC 45-07 SURVEY QUESTIONNAIRE

INTRODUCTION

Financial forecasts provide baseline information needed for planning and system management. State transportation financial planning requires the estimation of revenue for both short-range and longer-range planning, and federal transportation planning regulations require state officials to develop estimates of funds expected to be available over both the four-year period of the State Transportation Improvement Plan (STIP) and the 20-year period of the Long Range Transportation Plan (LRTP). Because financial resources are becoming increasingly limited, states are exploring alternative and new revenue sources to meet their funding needs. More information is critically needed on current practices because accuracy in forecasting revenue is increasingly important even as financing mechanisms are increasingly diverse and uncertain.

A review of published literature has revealed little guidance on or consistency in the methods used to forecast traditional revenue sources, such as fuel taxes and vehicle registration fees, and even less published information about how to forecast revenues from alternative sources, such as mileage based user fees (MBUF). State financial managers and transportation policy makers are faced with a range of issues affecting forecasts, including changes in fuel economy, VMT growth rates, and vehicle registration growth. At the same time, the accuracy of forecasting is becoming increasingly important.

The NCHRP Synthesis Program is conducting this study to create an information resource of information on transportation revenue forecasting for traditional and innovative sources of funding. The study will use this survey to inform states of current practices among their peers and to identify further research needs.

I am contacting you because of your membership on the AASHTO Subcommittee on Transportation Finance Policy. This survey will provide me with basic information and will be followed by telephone interviews as appropriate to elaborate upon its initial findings. Because this topic is incompletely addressed in the literature, the usefulness to states of the NCHRP Synthesis that will result from this study will depend in large part upon your participation. I thank you in advance for your time and thoughts. Please return the completed questionnaire via e-mail by [date] to:

Martin Wachs Ph.D. E-mail: mwachs@ucla.edu Phone (323) 424-4075

CONTACT INFORMATION

Please provide your contact information. NCHRP will e-mail you a link to the online report when it is completed.

Agency:

Address:

City: ______________________________ State: __________ ZIP:

Questionnaire Respondent:

Position/Title:

In case of questions and for NCHRP to send you a link to the final report, please provide:

Tel: ____________________ E-mail:

QUESTIONS

1. Does your agency directly produce estimates of revenues that will be available for transportation programs…check a or complete b and check c or complete d:

a) This transportation agency produces short term (e.g., 3–5 year) revenue forecasts ____________________

b) This transportation agency uses short term revenue forecasts produced by others as follows:
____
____
____

c) This transportation agency produces long term revenue forecasts______________________________
____

d) This agency uses long term revenue forecasts produced by others as follows:
____
____
____

2. What sources of revenue are routinely estimated in order to arrive at forecasts of future revenue? (Check those that are estimated.)

   a) Federal funds allocated to the state________
   b) Gasoline per gallon taxes ________
   c) Diesel fuel per gallon taxes _______
   d) Vehicle registration and/or license fees________
   e) Tolls ________________________
   f) Allocations of state general revenues_______
   g) State sales taxes designated for transportation________
   h) Local (county or regional) sales and property taxes________
   i) Others (please enumerate):
   ____
   ____

3. Have the methods by which your agency estimates future transportation revenues been changed or updated during the last two years?

   a. No__________

4. Yes, for the following reasons and in the following ways:

   ____

   the methods by which your agency produces short term and long term estimates of transportation revenues documented on a web-site or in a manual that could be made available to the Synthesis researchers? Please respond to one of the following

a) Yes: The website at which this is available in:
____

b) Yes: The forecasting methods are published in: ____________________________________

c) No: The foresting methods are informal and not documented, but the following resource person can be contacted for further information on how the forecasts are done:
(name and contact information):
____

   a) Has your agency or a closely related agency developed proposals within the past two years to raise additional transportation revenue by raising rates or changing the structure of traditional transportation revenue sources? Examples would include increasing motor fuel tax rates or increasing state vehicle registration rates. If so, have estimates been prepared of the revenue potential of those changes? Please list reports or people who can be contacted for further information.

   b) No changes have been considered___________

   c) The following changes have been considered:
   ____
   ____
   ____
   ____

   d) Further information is available from:
   ____
   ____
   ____

5. Has your agency or a closely related agency developed proposals within the past two years for new "non-traditional" sources of transportation program revenues? If so, have estimates been prepared of the revenue potential of those possible sources of new revenue? Please list reports or people who can be contacted for further information.

   a) No changes have been considered___________

   b) The following changes have been considered:
____
____
____
____

   c) Further information is available from:
____
____
____

7. In the space below please enumerate what you consider to be the major shortcomings of the revenue forecasting techniques currently used by your agency.

THANK YOU FOR YOUR ASSISTANCE.

APPENDIX B

Case Studies of Selected State Practices

Arizona

California

Michigan

Minnesota

Missouri

Oregon

Texas

Washington

ARIZONA

Short-Term Forecasting Entity: Arizona's DOT

Long-Term Forecasting Entity: Arizona's DOT

Types of Revenue Forecast: Federal funds allocated to the state, state gasoline per gallon taxes, state diesel fuel per gallon taxes, state vehicle registration and/or license fees, local (county or regional) sales and property taxes

Type of Forecasting: Expert Consensus, Econometric. "Since 1986, the Arizona Department of Transportation (the Department) has used a comprehensive regression-based econometric model to estimate Transportation Excise Tax revenues for Maricopa County. These revenues, which flow into the Regional Area Road Fund (RARF), are the major funding source for the Maricopa County Freeway Program."

Risk Analysis Panel: "The revenue forecast is highly dependent on estimates of independent variables. In order to deal with variability between estimated and actual values, the Department introduced the Risk Analysis Process (RAP) in 1992. The RAP relies on probability analysis and the independent evaluation of the model's variables by an expert panel of economists. The process results in a series of forecasts, with specified probabilities of occurrence, rather than a single or 'best guess' estimate." An example of the RAP output can be found in this report.

Data Inputs: For Maricopa County excise tax, Arizona's DOT uses the following data inputs: Maricopa County nominal personal income growth, Maricopa County population growth, Maricopa County construction employment growth, Phoenix consumer price index (CPI), Sky Harbor passenger traffic growth, Maricopa County total non-farm employment growth, 30-year mortgage rate.

Innovative revenues that are typically forecast: none

Shortcomings: "ADOT has a very robust forecasting process that has been in place since 1992, which has proven highly accurate in all but the most volatile of economic environments.

Publication: Arizona DOT's revenue forecasts and risk analysis panel results are published in the report entitled: "MARICOPA COUNTY TRANSPORTATION EXCISE TAX Forecasting Process & Results FY 2013–2026" and can be found online at http://www.azdot.gov/docs/default-source/businesslibraries/rarfcastproc1426.pdf?sfvrsn=4

CALIFORNIA

Short-Term Forecasting Entity: Caltrans (California DOT). This agency must also use forecasts developed by the California Department of Finance in certain official budget planning and budget implementation documents.

Long-Term Forecasting Entity: Caltrans (California DOT) and others. The California Transportation Commission (CTC) determines the methodology and assumptions used in the State Transportation Improvement Plan (STIP) Fund Estimate.

Types of Revenue Forecast: Federal, state gasoline tax, state diesel tax

Type of Forecasting: Trend extrapolation, econometric

Data Inputs: California's STIP Fund Estimate is required by statute to "display revenues that are based on current statutes and the most recently enacted state budget. Revenue estimates for future periods utilize historic trends and the economic outlook as a basis" (STIP 2014, p. 5). Annual increases to current levels are assumed at a fixed rate.

Innovative revenues that are typically forecast: none

Shortcomings: Lack of sophistication in forecasting revenues leaves us with "long-term trends" basis rather than an economic basis.

Publication: California's revenue forecasts are not regularly published. For explanation of long term forecasting methodology and assumptions, see the 2014 Statewide Improvement Plan (STIP) Fund Estimate, Adopted by the California Transportation Commission Aug. 6, 2013. http://www.dot.ca.gov/hq/transprog/ctcliaison/misc%20OCTCL%20Info/Final_2014_STIP_FE.pdf

MICHIGAN

Short-Term Forecasting Entity: Michigan's DOT. The 1 to 2 year forecast is done in "consensus" with Michigan Department of Treasury. The DOT and Treasury meet to agree on the two-year revenue forecast. Years 3 to 5 are forecast by DOT entirely.

Long-Term Forecasting Entity: Michigan's DOT.

Types of Revenue Forecast: Federal funds allocated to the state, state gasoline per gallon taxes, state diesel fuel per gallon taxes, state vehicle registration and/or license fees.

Type of Forecasting: Forecasting is described as follows: "State revenue estimate is based on Michigan's DOT's share of the MTF, as estimated by the Department of Treasury, Economic and Revenue Forecasting Division. Future state revenue is forecast using a long-range forecasting model managed by MDOT's Statewide Transportation Planning Division. Federal funding is assumed to remain at for FY 2014–2016 and then increase at a 2.5 percent rate in FY 2017–2018." Specifics of the revenue forecasting methodology were not available at the time of this publication.

Proposals: Within the last two years, the DOT has received proposals from elected officials regarding various revenue enhancements, and provided detailed estimates of revenue projections.

Shortcomings: "Currently using unsupported software. In the coming year or two we will be attempting to rewrite the revenue model in MS Excel. It would be nice to generate 'what if' scenarios with more ease."

Publication: A description of the short-term revenue forecast is available online in the 2014–2018 Five-Year Transportation Program, which can be found online at: http://www.michigan.gov/documents/mdot/MDOTFinal5YearPlan20114-2018_445737_7.pdf. However, the MDOT long-term model is not published online.

MINNESOTA

Short-Term Forecasting Entity: Minnesota's DOT

Long-Term Forecasting Entity: Minnesota's DOT

Types of Revenue Forecast: Federal funds allocated to the state, state gasoline per gallon taxes, state diesel fuel per gallon taxes, state vehicle registration and/or license fees, state sales taxes designated for transportation

Types of Forecasting: Trend extrapolation based on historical trends and national macroeconomic forecasts. To forecast the state per gallon gasoline excise tax, Minnesota uses national macroeconomic forecast of U.S. gasoline consumption from Global Insight, a consultant. MnDOT also reviews regional forecast information from the federal Energy Information Administration (EIA). Finally, a comparison is made of actual local consumption versus previous forecast information provided by GI and EIA. The estimated quantities are then multiplied by the excise tax rate to produce the final forecast.

For the state vehicle registration fee estimate, MnDOT has a model to forecast revenue from passenger vehicles that is largely based on forecasts of the purchase of new passenger vehicles. Forecasts of the sales of new vehicles are provided by GI.

Proposals: The following changes or proposals have been considered: Gas tax increases, increased motor vehicle sales taxes, increased registration taxes, variety of bonding proposals

Shortcomings: "The process for forecasting each specific revenue source is fairly well defined, but not documented, only well known to a few key staff. Mostly standalone Excel files: one for each revenue type."

Publication: Revenue forecasts by biennium are released by Minnesota's DOT. The latest fund summary can be found at the following link: http://www.dot.state.mn.us/funding/documents/transportationfundsforecasts-feb2014.pdf

MISSOURI

Short-Term Forecasting Entity: Missouri's DOT

Long-Term Forecasting Entity: Missouri's DOT

Types of Revenue Forecast: Federal funds allocated to the state, state gasoline per gallon taxes, state diesel fuel per gallon taxes, state vehicle registration and/or license fees, state sales taxes designated for transportation.

Types of Forecasting: Trend extrapolation, expert consensus. Missouri's DOT developed econometric regression models that looked at the following variables: Motor vehicle fees (net of refunds); Driver's license fees (net of refunds); Motor vehicle sales tax revenue (net of refunds) deposited to the State Road Fund; Motor vehicle use tax revenue (net of refunds); Gross gasoline tax revenue. Socioeconomic data are from Department of Energy: an annual energy outlook that includes national fuel prices, and usage.

In 2007, Missouri's DOT hired a consultant to assess and recommend improvements. For a detailed look at this case study, please see chapter four of this report.

Shortcomings: According to the survey respondent from Missouri's DOT, state forecast revenue has come in with positive variance no more than 3.2% within the past five year. The real uncertainty, she says, lies at projecting future federal reimbursements.

Publication: Revenue forecasts for Missouri's DOT are not available in published form. A copy of the consultant's report can be found in "A Review and Critique of MODOT's State Revenue Forecasting Model: Final Report," published by HDR|HLB in 2007 and available online here: http://library.modot.mo.gov/RDT/reports/Ri06024/or07013.pdf

OREGON

Short-Term Forecasting Entity: Department of Transportation and others

Long-Term Forecasting Entity: Department of Transportation and others

Types of Revenue Forecast: Federal, state diesel, state vehicle registration/license, state sales tax, weight-mile tax

Type of Forecasting: Econometric

Data Inputs: Oregon uses 6–8 explanatory variables, including national CPI, employment, housing starts, real GDP, real fuel price, and new automobile sales. Also uses Oregon-specific inputs—employment, housing starts, populations, Portland CPI, real personal income. Oregon uses fuel efficiency national rate from IHS Global Insights "because light-duty vehicle efficiency is hard to measure at the state level."

The independent variables of Oregon's regression equations are quarterly econometric variables. The model is updated every six months with new data. Oregon DOT estimates quantities; e.g., vehicle registrations or gallons of motor fuel, to determine the total volume of transactions. The current rate of tax/fee is then multiplied by the quantities. Finally, to even out the variations Oregon DOT runs monthly time series accounts for seasonal effects. The monthly outputs are aggregated to quarterly forecasts.

To date, Oregon DOT provides revenue forecasts only for traditional revenues, which include vehicle transaction fees (registration, title, transfer) and driver-related fees. Oregon's forecast does not include federal allocations, which are considered "other funds."

Innovative revenues: As a formal exercise, revenue forecasting is based on "current law," DOT does not speculate on proposals until implementation. Therefore the agency's modeling does not include forecasts of innovative revenue proposals.

Shortcomings: "Major shortcoming of the revenue forecasting techniques currently used by the department is the ongoing inability to more accurately estimate economic downturns and associated detrimental impacts on transportation revenues and more accurately consider fuel efficiency and vehicle miles of travel growth uncertainty in future years."

Publication: Revenue Forecast is published twice a year. This document is also available online at: http://www.oregon.gov/ODOT/TD/EA/reports.shtml and scroll down to "Transportation Revenue Forecasts."

TEXAS

Short-Term Forecasting Entity: Texas' DOT

Long-Term Forecasting Entity: Texas' DOT

Types of Revenue Forecast: Federal funds allocated to the state, state gasoline per gallon taxes, state diesel fuel per gallon taxes, state vehicle registration and/or license fees, tolls, allocations of state general revenues, state sales taxes on lubricants designated for transportation, Local participation, Interest on cash balances, other agency and miscellaneous revenue deposited to the highway fund, Taxes and fees dedicated to the Texas Mobility Fund

Types of Forecasting: In Texas, different agencies have responsibility for forecasting different types of revenues. TxDOT forecasts motor fuel tax and sales tax and miscellaneous revenues, while the Department of Motor Vehicles forecasts vehicle registration fees. Toll revenues for TxDOT toll roads are forecast through consultants working with the Toll Operations division of TxDOT. Toll revenues for non-TxDOT toll roads that do not share revenue with TxDOT are forecast by the tolling authority or entity and are not communicated with TxDOT.

Future revenues are projected based on financial analysis that includes historical trends, current statutes, the Comptroller's Biennial Revenue Estimate, and other sources. A set of fixed assumptions are used to estimates of future cash balances. In addition, TxDOT and Texas A&M University jointly manage a scenario analysis program called TRENDS, which is used to estimate revenues under changing assumptions about demographics, fuel price, and other variables. The program is available to the public here: http://trends-tti.tamu.edu/

A set of revenue and expenditure assumptions, reviewed and updated at least annually, along with projections for active and future projects, are used to make estimates of future cash balances.

Shortcomings: Revenue forecasts were reported to be very accurate.

Publication: An Executive Summary of the revenue forecasts and assumptions can be found here: http://ftp.txdot.gov/pub/txdot-info/fin/cash_forecast.pdf

WASHINGTON

Short-Term Forecasting Entity: Washington's DOT is lead agency with assistance from other state economists and some consulting firms

Long-Term Forecasting Entity: Washington's DOT is lead agency with assistance from other state economists and some consulting firms

Types of Revenue Forecast: Federal funds allocated to the state, state gasoline per gallon taxes, state diesel fuel per gallon taxes, state vehicle registration and/or license fees, tolls, allocations of state general revenues, state sales taxes designated for transportation, local (county or regional) sales and property taxes, rental car fee, driver related fees, aviation fees, ferry fares and miscellaneous business related revenues

Types of Forecasting: Econometric, travel demand models and some trend analysis

Washington's DOT uses multiple models for short and long term forecasts of diesel and gasoline consumption in the state of Washington. Until recently, Washington's DOT used a multi-step regression with econometric independent variables for both their quarterly and annual models. The quarterly model has since been revised, and Washington's DOT now uses time series regression to forecast quarterly consumption. This change was made in 2012 for both gasoline and diesel quarterly forecasts. According to Washington's DOT staff, using time series analysis for quarterly consumption has led to less optimistic and therefore more accurate results. Additionally, it is better able to account for seasonal variability, which occurs at a quarterly level. This change is new, and the DOT staff have not yet published or described the changes in forecasting techniques in their technical manuals or publications.

The equation for annual gasoline consumption in Washington is logarithmic in its formulation. The final model is a log-log functional model, with first difference of natural logs used on both sides of the equation. The independent variables in the annual gas consumption model are Washington non-agricultural employment and a composite variable of Washington gas prices and US on-road fuel efficiency.

Shortcomings: The respondents said that, in certain tolling area, Washington's DOT models have relied on travel demand models and some of these models have been prone to overestimate traffic and revenue. In the diesel consumption forecast model, the lack of importance of the truck fuel economy in the forecast models could result in overestimating diesel consumption in the future.

Publication: The study that resulted in an update to the fuel consumption forecast model is published online and can be found here: http://www.ofm.wa.gov/budget/info/Nov10transpo fuelconsumptionsummary.pdf

Abbreviations used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

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